*Technical report No.2/2011*

# Annual European Union greenhouse gas inventory 1990–2009 and inventory report 2011

## Submission to the UNFCCC Secretariat

***27 May 2011***

European Environment Agency

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# Acknowledgements

This report was prepared on behalf of the European Commission (DG CLIMA) by the European Environment Agency's (EEA) European Topic Centre for Air Pollution and Climate Change Mitigation (ETC/ACM) supported by the Joint Research Centre (JRC) and Eurostat.

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The EEA project manager was Ricardo Fernandez. He acknowledges the input provided by Andreas Barkman (EEA), Hermann Peifer (EEA), David Simoens (EEA) and Sheila Cryan (EEA). The EEA also acknowledges the input and comments received from the EU Member States, which have been included in the final version of the report as far as practically feasible.

# CONTENT

# Executive summary

## *Background information on greenhouse gas inventories and climate change*

The European Union (EU), as a party to the United Nations Framework Convention on Climate Change (UNFCCC), reports annually on greenhouse gas (GHG) inventories for the year t–2 and within the area covered by its Member States (i.e. domestic emissions taking place within its territory).

The present inventory also constitutes the EU-15 submission under the Kyoto Protocol and covers information and data from Member States available until 28 March 2011. Under the Kyoto Protocol, the EU-15 took on a common commitment to reduce emissions by 8 % between 2008 and 2012 compared to emissions in the 'base year' ([1]). The EU-27 does not have a common target under the Kyoto Protocol in the same way as the EU-15.

The legal basis for the compilation of the EU inventory is Council Decision 280/2004/EC concerning a mechanism for monitoring Community greenhouse gas emissions and for implementing the Kyoto Protocol ([2]). The purpose of this decision is:

1. to monitor all anthropogenic GHG emissions covered by the Kyoto Protocol in the Member States;

2. to evaluate progress towards meeting GHG reduction commitments under the UNFCCC and the Kyoto Protocol;

3. to implement the UNFCCC and the Kyoto Protocol obligations relating to national programmes, greenhouse gas inventories, national systems and registries of the EU and its Member States, and the relevant procedures under the Kyoto Protocol;

4. to ensure the timeliness, completeness, accuracy, consistency, comparability and transparency of reporting by the EU and its Member States to the UNFCCC secretariat.

The EU GHG inventory comprises the sum of the national inventories compiled by the EU Member States making up the EU-15 and the EU-27. Energy data from Eurostat are used for the reference approach for $CO_2$ emissions from fossil fuels developed by the Intergovernmental Panel on Climate Change (IPCC).

The main institutions involved in the compilation of the EU GHG inventory are the Member States, the European Commission Directorate-General Climate Action (DG CLIMA), the European Environment Agency (EEA) and its European Topic Centre on Air Pollution and Climate Change Mitigation (ETC/ACM), Eurostat, and the Joint Research Centre (JRC).

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([1]) For the EU-15, the base year for $CO_2$, $CH_4$ and $N_2O$ is 1990; for fluorinated gases 12 Member States have selected 1995 as the base year, whereas Austria, France and Italy have chosen 1990. As the EU inventory is the sum of Member State inventories, the EU-15 base year estimates for fluorinated gas emissions are the sum of 1995 emissions for 12 Member States and 1990 emissions for Austria, France and Italy. The EU-15 base year emissions also include emissions from deforestation for the Netherlands, Portugal and the United Kingdom.

([2]) OJ L 49, 19.2.2004, p.1. Note that Council Decision No. 280/2004/EC entered into force in March 2004. Therefore, the compilation of the 2004 inventory report started under the previous Council Decision 1999/296/EC.

The process of compiling the EU GHG inventory is as follows. Member States submit their annual GHG inventories by 15 January each year to the European Commission, DG CLIMA, with a copy to the EEA. The EEA and its ETC/ACM, Eurostat and JRC then perform initial checks on the submitted data. The draft EU GHG inventory and inventory report are circulated to Member States for review and comments by 28 February. Member States check their national data and the information presented in the EU GHG inventory report, send updates if necessary and review the EU inventory report itself by 15 March. The EEA prepares the final EU GHG inventory and inventory report through its ETC/ACM by 15 April for submission by the European Commission to the UNFCCC Secretariat; a resubmission is prepared by 27 May, if needed.

On 23 January 2008 the European Commission adopted the 'Climate and energy package'. The proposal was part of draft legislation implementing the 'Integrated energy and climate change package' of 10 January 2007, which was endorsed by the European Council in March 2007. In December 2008 the European Parliament and the Council reached agreement on the package. It was adopted by the Council on 6 April 2009. The package underlines the objective of limiting the rise in global average temperature to no more than two degrees Celsius above pre-industrial levels. To achieve this goal the EU committed to a unilateral emission reduction target of 20 % ([3]) by 2020, compared with 1990 levels, and agreed to a reduction of 30 % provided that other major emitters agree to take on their fair share of a global reduction effort.

Both trading, i.e. EU Emissions Trading System (ETS), and non-trading sectors will contribute to the 20 % objective. Minimizing overall reduction costs implies a 21 % reduction in emissions from EU ETS sectors compared to 2005 by 2020 and a reduction of approximately 10 % compared to 2005 by 2020 for non-EU ETS sectors. The non-trading sectors broadly include direct emissions from households and services, as well as emissions from transport, waste and agriculture. The coverage of the non-trading sectors currently represents about 60 % of total greenhouse gas emissions.

Information on Land Use, Land-Use Change and Forestry (LULUCF) activities is covered in the Kyoto Protocol under Art. 3.3 (afforestation, reforestation and deforestation) and Art. 3.4. (forest land management, cropland management, grazing land management and revegetation). Detailed information on 3.3 and 3.4 LULUCF activities are provided in chapter 11 of this report, for the first time.

In addition, all parties to the Kyoto Protocol must provide information on how they are implementing their greenhouse gas commitments in such a way as to minimize potential adverse social, environmental and economic impacts on developing countries. This information is required under Article 3, paragraph 14 of the Protocol and is set out in chapter 15 of this report.

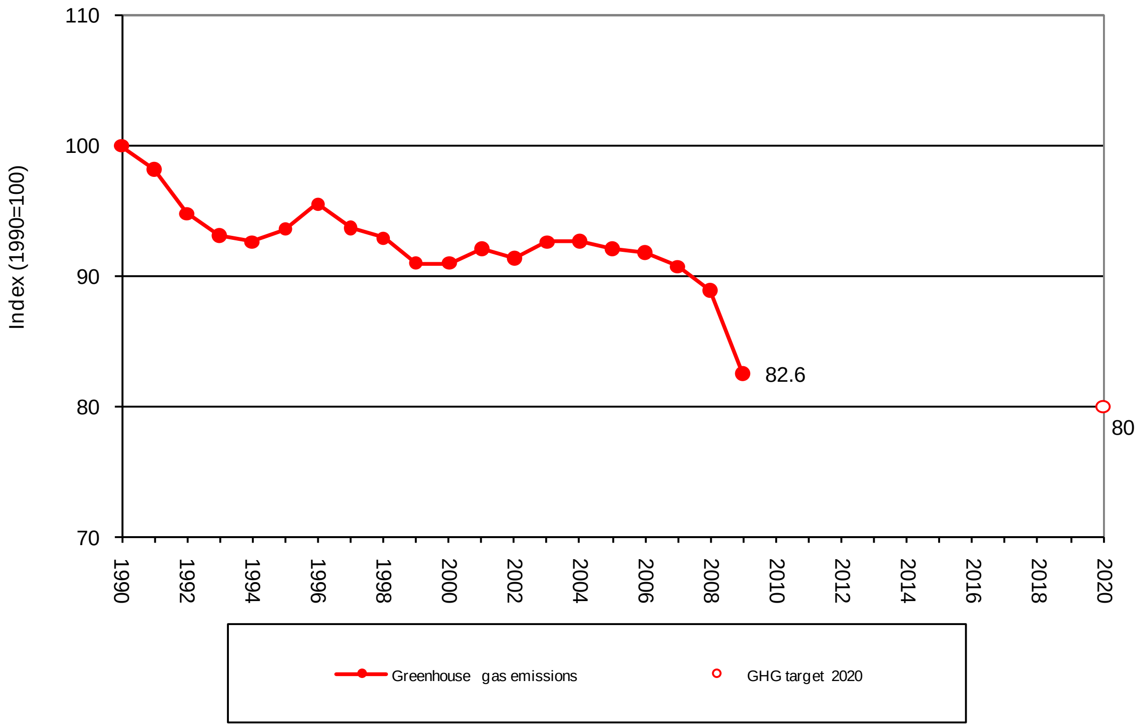
## *Summary of greenhouse gas emission trends in the EU*

### *EU-27*

Total GHG emissions, without Land Use, Land-Use Change and Forestry (LULUCF), in the EU-27 decreased by 17.4 % between 1990 and 2009 (974 million tonnes $CO_2$ equivalents). Emissions decreased by 7.1 % (355 million tonnes $CO_2$ equivalents) between 2008 and 2009 (Figure ES.1).

([3]) All emission information for the EU-27 in this report uses 1990 as the starting point when addressing emission reductions. The EU-27 does not have a common target under the Kyoto Protocol in the same way as the EU-15.

**Figure ES.1** **EU-27 GHG emissions from 1990 to 2009 (excl. LULUCF)**




Note: GHG emission data for the EU-27 as a whole refer to domestic emissions (i.e. within its territory) and do not include emissions and removals from LULUCF or emissions from international aviation and international maritime transport. $CO_2$ emissions from biomass with energy recovery are reported as a Memorandum item according to UNFCCC Guidelines and are not included in national totals. In addition, no adjustments for temperature variations or electricity trade are considered. The global warming potentials are those from the 1996 revised IPCC Guidelines for National Greenhouse Gas Inventories.

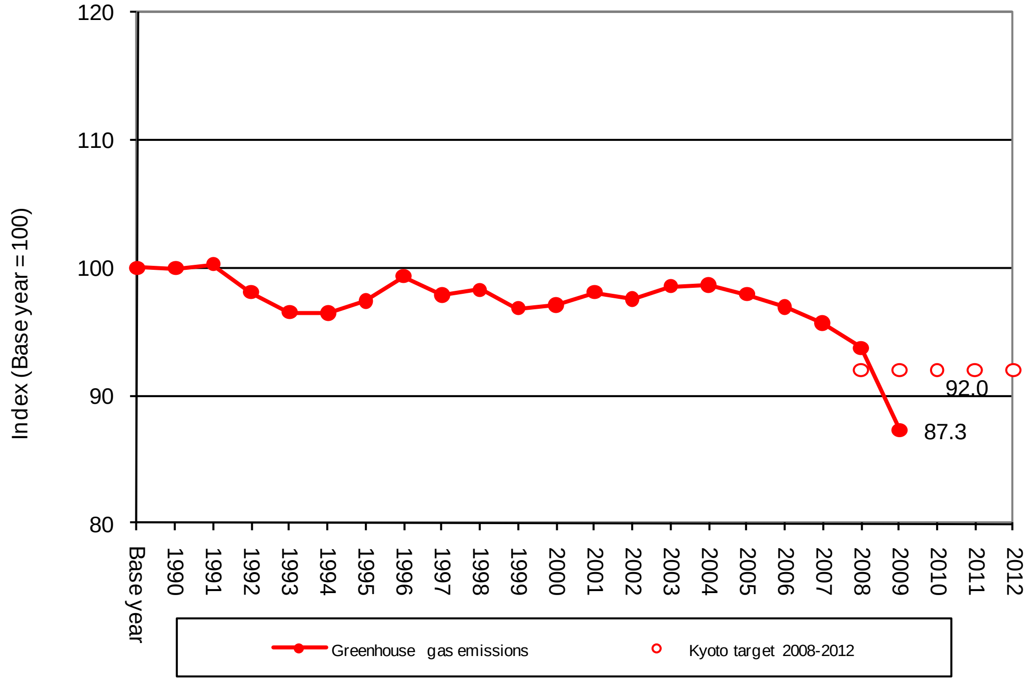
***EU-15***

In 2009, total GHG emissions in the EU-15, without LULUCF, were 12.7 % (542 million tonnes $CO_2$ equivalents) below its Kyoto base year. Emissions decreased by 6.9 % (274 million tonnes $CO_2$ equivalents) between 2008 and 2009.

Under the Kyoto Protocol, the EU agreed to reduce its GHG emissions by 8 % by 2008–12 compared to the 'base year' ([4]). This can be achieved by a combination of existing and planned domestic policies and measures, the use of carbon sinks and the use of Kyoto mechanisms. 2009 was the first year emissions (i.e. domestic) fell below the EU-15 Kyoto target (Figure ES.2).

([4]) Following the UNFCCC reviews of Member States' 'initial reports' during 2007 and 2008 and pursuant to Article 3, Paragraphs 7 and 8 of the Kyoto Protocol, the base-year emissions for the EU-15 have been fixed to 4 265.5 Mt $CO_2$ equivalent.

**Figure ES.2** EU-15 GHG emissions from 1990 to 2009, compared with the target for 2008–12 (excl. LULUCF)




Note: GHG emission data for the EU-15 as a whole refer to domestic emissions (i.e. within its territory) and do not include emissions and removals from LULUCF or emissions from international aviation and international maritime transport. $CO_2$ emissions from biomass with energy recovery are reported as a Memorandum item according to UNFCCC Guidelines and are not included in national totals. In addition, no adjustments for temperature variations or electricity trade are considered. The global warming potentials are those from the 1996 revised IPCC Guidelines for National Greenhouse Gas Inventories.

Following the UNFCCC reviews of Member States' 'initial reports' during 2007 and 2008 and pursuant to Article 3, Paragraphs 7 and 8 of the Kyoto Protocol, the base-year emissions for the EU-15 have been fixed to 4 265.5 Mt $CO_2$ equivalent. The EU-15 would need to reduce greenhouse gas emissions by about 341 million tonnes, on average between 2008–2012, in order to meet its 8 % Kyoto target. This can be achieved by a combination of existing and planned domestic policies and measures, the use of carbon sinks and the use of Kyoto mechanisms.

### *Main trends by source category in the period 1990–2009*

Between 1990 and 2009, EU-15 emissions decreased by 12.7 %, while in the EU-27 emissions decreased by 17.4 % (see Table ES.1).

**Table ES.1 Overview of EU-27 and EU-15 source categories whose emissions increased or decreased by more than 20 million tonnes $CO_2$ equivalents in the period 1990–2009**

| Source category | EU-15 | EU-27 |
|---|---|---|
| | Million tonnes ($CO_2$ eq.) | |
| Road transport (CO2 from 1A3b) | 115.0 | 164.8 |
| Consumption of Halocarbons (HFC from 2F) | 63.0 | 69.9 |
| Cement production ($CO_2$ from 2A1) | -14.7 | -20.5 |
| Enteric Fermentation ($CH_4$ from 4A) | -16.4 | -38.9 |
| Nitric acid production (N2O from 2B2) | -24.4 | -33.4 |
| Production of Halocarbons (HFC from 2E) | -25.6 | -25.6 |
| Agricultural Soils ($N_2O$ from 4D) | -42.0 | -76.7 |
| Fugitive Emissions ($CH_4$ from 1B) | -46.8 | -71.0 |
| Adipic acid production ($N_2O$ from 2B3) | -48.1 | -49.1 |
| Manufacture of Solid fuels (CO2 from 1A1c) | -55.6 | -57.6 |
| Households and services ($CO_2$ from 1A4) | -59.6 | -117.3 |
| Public Electricity and Heat Production (CO2 from 1A1a) | -61.6 | -232.3 |
| Iron and steel production ($CO_2$ from 1A2a+2C1) | -69.3 | -105.1 |
| Solid Waste Disposal ($CH_4$ from 6A) | -69.4 | -63.9 |
| Manufacturing industries (excl. iron and steel) (Energy-related $CO_2$ from 1A2 excl. 1A2a) | -131.8 | -227.7 |
| **Total** | **-541.2** | **-974.3** |

Note: As the table only presents sectors that have increased or decreased by 20 Mt $CO_2$ equivalents or more, the sum for each country grouping EU-15/EU-27 does not match the total change listed at the bottom of the table.

### *Main trends by source category in the period 2008–2009*

Between 2008 and 2009, EU-15 emissions decreased by 6.9 % while in the EU-27 emissions decreased by 7.1% (Table ES.2).

**Table ES.2 Overview of EU-27 and EU-15 source categories whose emissions increased or decreased by more than 3 million tonnes $CO_2$ equivalents in the period 2008–2009**

| Source category | EU-15 | EU-27 |
|---|---|---|
| | Million tonnes ($CO_2$ eq.) | |
| Public Electricity and Heat Production ($CO_2$ from 1A1a) | -77.1 | -103.2 |
| Manufacturing industries (excl. iron and steel) (Energy-related $CO_2$ from 1A2 excl. 1A2a) | -54.1 | -65.9 |
| Iron and Steel production ($CO_2$ from 1A2a+2C1) | -41.6 | -53.6 |
| Road transport ($CO_2$ from 1A3b) | -20.5 | -23.7 |
| Households and Services ($CO_2$ from 1A4) | -21.2 | -22.0 |
| Cement production ($CO_2$ from 2A1) | -13.9 | -18.6 |
| Manufacture of Solid Fuels ($CO_2$ from 1A1c) | -10.1 | -10.8 |
| Nitric acid production (N2O from 2B2) | -3.4 | -9.4 |
| Refineries (CO2 from 1A1b) | -8.0 | -8.4 |
| Agricultural Soils ($N_2O$ from 4D) | -6.7 | -8.0 |
| Fugitive Emissions ($CH_4$ from 1B) | -1.2 | -4.1 |
| **Total** | **-274.3** | **-354.5** |

Notes: As the table only presents sectors whose emissions have increased or decreased by 3 million tonnes of $CO_2$ equivalents or more, the sum for each country grouping does not match the total change listed at the bottom of the table.

### *Main reasons for emission changes in EU-15 in the period 2008–2009*

The 274.3 million tonnes ($CO_2$ equivalents) decrease in GHG emissions between 2008–2009 was mainly due to:

- A steep decrease of $CO_2$ emission (77.1 million tonnes or 8 %) from public electricity and heat production. The United Kingdom (22.1 million tonnes $CO_2$), Germany (19.8 million tonnes $CO_2$), Italy (16.5 million tonnes $CO_2$) and Spain (15.7 million tonnes $CO_2$) contributed most to this decrease. Seven countries, however, report increases (Belgium, Denmark, Finland, Luxembourg, the Netherlands, Portugal, Sweden). In Spain, Germany and the United Kingdom the main reason for emission reductions was the strong decline in coal use for power generation; in Italy the strong decline in gaseous fuels.
- Strong emission reduction (54.1 million tonnes or 12.5 %) in manufacturing industries excluding iron and steel industry (mainly caused by Germany, Italy, United Kingdom and Spain) as a result of the 2009 economic recession and contraction of industrial output.
- A strong decrease in emissions (41.6 million tonnes or 30.2 %) in the iron and steel production due to a significant decline in crude steel production in all major steel producing countries (a fall of 29.8 % in the EU-15 as a whole, according to the World Steel Association).
- Emissions also fell in households and services (by 21.2 million tonnes or 4 %), despite the colder winter, and in road transport (by 20.5 million tonnes or 2.7 %).

The severity of the 2009 recession affected all economic sectors in the EU. Consumption of fossil fuels (coal, oil and natural gas) fell compared to the previous year, mainly for coal. The decreased demand for energy linked to the economic recession was accompanied by increased renewable energy use, which together contributed to lower emissions. Despite the relatively cold winter of 2009, emissions fell in the residential sector.

In relative terms, the largest emission reductions occurred in industrial processes, reflecting lower activity levels in the cement, chemical and iron and steel industries. The 2009 verified emissions from the sectors covered by the EU Emission Trading System (EU-ETS) decreased by 11.6 % compared to 2008. The recession in 2009 accelerated, temporarily, the downward trend in total greenhouse gas emissions. The sustained strong growth in the use of renewables was the other key factor explaining the strong decrease in greenhouse gas emissions in 2009.

For a detailed analysis at EU-27 level, see, *Why did greenhouse gas emissions fall in the EU in 2009? EEA analysis in brief*[5].

**Table ES.3 Greenhouse gas emissions in $CO_2$ equivalents (excl. LULUCF) and Kyoto Protocol targets for 2008–12**

| MEMBER STATE | 1990 (million tonnes) | Kyoto Protocol base year [(a)] (million tonnes) | 2009 (million tonnes) | 2008–2009 (million tonnes) | Change 2008–2009 (%) | Change 1990-2009 (%) | Change base year–2009 (%) | Targets 2008–12 under Kyoto Protocol and "EU burden sharing" (%) |
|---|---|---|---|---|---|---|---|---|
| Austria | 78.2 | 79.0 | 80.1 | -6.9 | -7.9% | 2.4% | 1.3% | -13.0% |
| Belgium | 143.3 | 145.7 | 124.4 | -10.7 | -7.9% | -13.2% | -14.6% | -7.5% |
| Denmark | 68.0 | 69.3 | 61.0 | -2.7 | -4.2% | -10.3% | -12.0% | -21.0% |
| Finland | 70.4 | 71.0 | 66.3 | -4.1 | -5.8% | -5.7% | -6.6% | 0.0% |
| France | 562.9 | 563.9 | 517.2 | -21.9 | -4.1% | -8.1% | -8.3% | 0.0% |
| Germany | 1247.9 | 1232.4 | 919.7 | -61.4 | -6.3% | -26.3% | -25.4% | -21.0% |
| Greece | 104.4 | 107.0 | 122.5 | -6.0 | -4.7% | 17.4% | 14.5% | 25.0% |
| Ireland | 54.8 | 55.6 | 62.4 | -5.4 | -8.0% | 13.8% | 12.2% | 13.0% |
| Italy | 519.2 | 516.9 | 491.1 | -50.6 | -9.3% | -5.4% | -5.0% | -6.5% |
| Luxembourg | 12.8 | 13.2 | 11.7 | -0.58 | -4.7% | -8.9% | -11.3% | -28.0% |
| Netherlands | 211.9 | 213.0 | 198.9 | -5.7 | -2.8% | -6.1% | -6.6% | -6.0% |
| Portugal | 59.4 | 60.1 | 74.6 | -3.4 | -4.3% | 25.5% | 24.0% | 27.0% |
| Spain | 283.2 | 289.8 | 367.5 | -37.2 | -9.2% | 29.8% | 26.8% | 15.0% |
| Sweden | 72.5 | 72.2 | 60.0 | -3.6 | -5.6% | -17.2% | -16.9% | 4.0% |
| United Kingdom | 776.1 | 776.3 | 566.2 | -54.0 | -8.7% | -27.0% | -27.1% | -12.5% |
| **EU-15** | **4264.9** | **4265.5** | **3723.7** | **-274.3** | **-6.9%** | **-12.7%** | **-12.7%** | **-8.0%** |
| Bulgaria | 111.4 | 132.6 | 59.5 | -9.5 | -13.8% | -46.6% | -55.1% | -8.0% |
| Cyprus | 5.3 | Not applicable | 9.4 | -0.8 | -7.7% | 78.3% | Not applicable | Not applicable |
| Czech Republic | 195.5 | 194.2 | 132.9 | -8.2 | -5.8% | -32.0% | -31.6% | -8.0% |
| Estonia | 41.1 | 42.6 | 16.8 | -3.2 | -16.1% | -59.0% | -60.5% | -8.0% |
| Hungary | 96.8 | 115.4 | 66.7 | -6.4 | -8.7% | -31.1% | -42.2% | -6.0% |
| Latvia | 26.6 | 25.9 | 10.7 | -1.2 | -10.0% | -59.7% | -58.6% | -8.0% |
| Lithuania | 49.6 | 49.4 | 21.6 | -2.4 | -10.1% | -56.4% | -56.3% | -8.0% |
| Malta | 2.1 | Not applicable | 2.9 | -0.14 | -4.7% | 38.8% | Not applicable | Not applicable |
| Poland | 452.9 | 563.4 | 376.7 | -19.1 | -4.8% | -16.8% | -33.2% | -6.0% |
| Romania | 250.1 | 278.2 | 130.8 | -22.6 | -14.7% | -47.7% | -53.0% | -8.0% |
| Slovakia | 74.1 | 72.1 | 43.4 | -4.8 | -9.9% | -41.4% | -39.8% | -8.0% |
| Slovenia | 18.5 | 20.4 | 19.3 | -1.9 | -9.1% | 4.7% | -5.0% | -8.0% |
| **EU-27** | **5588.8** | **Not applicable** | **4614.5** | **-354.5** | **-7.1%** | **-17.4%** | **Not applicable** | **Not applicable** |

(a) Cyprus, Malta and the EU-27 do not have targets under the Kyoto Protocol and do not have applicable Kyoto Protocol base years .

## *Summary of emissions and removals by main greenhouse gas*

### *EU-27*

Table ES.4 gives an overview of the main trends in EU-27 GHG emissions and removals for 1990–2009. The most important GHG by far is $CO_2$, accounting for 81.6 % of total EU-27 emissions in 2009 excluding LULUCF. In 2009, EU-27 $CO_2$ emissions without LULUCF were 3 765 Tg, which was 14.3 % below 1990 levels. Compared to 2008, $CO_2$ emissions decreased by 8.0 %.

5 http://www.eea.europa.eu/publications/european-union-greenhouse-gas-inventory-2011 /

**Table ES.4 Overview of EU-27 GHG emissions and removals from 1990 to 2009 in $CO_2$-equivalents (Tg)**

| GREENHOUSE GAS EMISSIONS | 1990 | 1995 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Net $CO_2$ emissions/ removals | 4,043 | 3,767 | 3,732 | 3,780 | 3,795 | 3,890 | 3,883 | 3,852 | 3,826 | 3,795 | 3,675 | 3,325 |
| $CO_2$ emissions (without LULUCF) | 4,396 | 4,150 | 4,111 | 4,189 | 4,164 | 4,249 | 4,262 | 4,241 | 4,237 | 4,185 | 4,092 | 3,765 |
| $CH_4$ | 610 | 551 | 494 | 483 | 474 | 464 | 452 | 445 | 439 | 433 | 428 | 418 |
| $N_2O$ | 532 | 471 | 424 | 418 | 408 | 403 | 406 | 398 | 387 | 384 | 377 | 358 |
| HFCs | 28 | 41 | 46 | 46 | 49 | 53 | 56 | 60 | 62 | 67 | 70 | 72 |
| PFCs | 20 | 13 | 9 | 8 | 10 | 8 | 6 | 5 | 5 | 4 | 4 | 3 |
| $SF_6$ | 11 | 16 | 11 | 10 | 9 | 8 | 8 | 8 | 8 | 7 | 7 | 6 |
| **Total (with net $CO_2$ emissions/removals)** | **5,244** | **4,859** | **4,716** | **4,744** | **4,744** | **4,827** | **4,810** | **4,768** | **4,727** | **4,691** | **4,560** | **4,182** |
| **Total (without $CO_2$ from LULUCF)** | **5,597** | **5,242** | **5,095** | **5,154** | **5,114** | **5,186** | **5,189** | **5,157** | **5,138** | **5,080** | **4,977** | **4,622** |
| **Total (without LULUCF)** | **5,589** | **5,232** | **5,086** | **5,145** | **5,105** | **5,177** | **5,181** | **5,149** | **5,129** | **5,071** | **4,969** | **4,615** |

### *EU-15*

Table ES.5 gives an overview of the main trends in EU-15 GHG emissions and removals for 1990–2009. As in the EU-27, the most important GHG in the EU-15 is $CO_2$, accounting for 82.3 % of total EU-15 emissions in 2009. In 2009, EU-15 $CO_2$ emissions without LULUCF were 3 063 Tg, which was 8.8 % below 1990 levels. Compared to 2008, $CO_2$ emissions decreased by 7.8 %.

**Table ES.5 Overview of EU-15 GHG emissions and removals from 1990 to 2009 in $CO_2$ equivalents (Tg)**

| GREENHOUSE GAS EMISSIONS | 1990 | 1995 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Net CO2 emissions/removals | 3,125 | 3,026 | | 3,126 | 3,157 | 3,227 | 3,230 | 3,212 | 3,164 | 3,138 | 3,040 | 2,765 |
| CO2 emissions (without LULUCF) | 3,359 | 3,290 | 3,362 | 3,428 | 3,419 | 3,478 | 3,490 | 3,473 | 3,450 | 3,396 | 3,323 | 3,063 |
| CH4 | 452 | 423 | 379 | 369 | 360 | 348 | 337 | 331 | 325 | 321 | 317 | 311 |
| N2O | 403 | 382 | 343 | 334 | 326 | 320 | 321 | 312 | 300 | 299 | 291 | 280 |
| HFCs | 28 | 41 | 45 | 44 | 46 | 50 | 51 | 55 | 57 | 60 | 63 | 66 |
| PFCs | 17 | 11 | 7 | 6 | 8 | 7 | 5 | 4 | 4 | 3 | 3 | 2 |
| SF6 | 11 | 15 | 10 | 9 | 8 | 8 | 8 | 8 | 7 | 7 | 6 | 6 |
| **Total (with net CO2 emissions/removals)** | **4,036** | **3,898** | **3,864** | **3,889** | **3,905** | **3,960** | **3,954** | **3,922** | **3,857** | **3,828** | **3,720** | **3,430** |
| **Total (without CO2 from LULUCF)** | **4,270** | **4,162** | **4,146** | **4,191** | **4,167** | **4,211** | **4,214** | **4,183** | **4,143** | **4,085** | **4,003** | **3,729** |
| **Total (without LULUCF)** | **4,265** | **4,155** | **4,140** | **4,185** | **4,162** | **4,205** | **4,208** | **4,178** | **4,137** | **4,080** | **3,998** | **3,724** |

## *Summary of emissions and removals by main source and sink categories*

### *EU-27*

Table ES.6 gives an overview of EU-27 GHG emissions in the main source categories for 1990–2009. The most important sector by far is energy (i.e. combustion and fugitive emissions) accounting for 79.3 % of total EU-27 emissions in 2009. The second largest sector is agriculture (10.3 %), followed by industrial processes (7.0 %).

**Table ES.6 Overview of EU-27 GHG emissions in the main source and sink categories from 1990 to 2009 in $CO_2$-equivalents (Tg)**

| GHG SOURCE AND SINK | 1990 | 1995 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Energy | 4,284 | 4,044 | 3,984 | 4,071 | 4,043 | 4,116 | 4,113 | 4,085 | 4,073 | 4,010 | 3,934 | 3,660 |
| 2. Industrial Processes | 463 | 441 | 391 | 377 | 372 | 385 | 398 | 403 | 400 | 411 | 387 | 321 |
| 3. Solvent and Other Product Use | 17 | 14 | 14 | 14 | 13 | 13 | 13 | 13 | 13 | 13 | 12 | 11 |
| 4. Agriculture | 610 | 528 | 515 | 507 | 503 | 496 | 495 | 490 | 487 | 485 | 487 | 476 |
| 5. Land-Use, Land-Use Change and Forestry | -345 | -373 | -370 | -401 | -360 | -351 | -371 | -381 | -402 | -381 | -409 | -432 |
| 6. Waste | 214 | 205 | 182 | 176 | 174 | 168 | 162 | 159 | 157 | 152 | 149 | 147 |
| 7. Other | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Total (with net CO2 emissions/removals)** | **5,244** | **4,859** | **4,716** | **4,744** | **4,744** | **4,827** | **4,810** | **4,768** | **4,727** | **4,691** | **4,560** | **4,182** |
| **Total (without LULUCF)** | **5,589** | **5,232** | **5,086** | **5,145** | **5,105** | **5,177** | **5,181** | **5,149** | **5,129** | **5,071** | **4,969** | **4,615** |

### *EU-15*

Table ES.7 gives an overview of EU-15 GHG emissions in the main source categories for 1990–2009. More detailed trend descriptions are included in chapters 3 to 9 of this report.

**Table ES.7 Overview of EU-15 GHG emissions in the main source and sink categories 1990 to 2009 $CO_2$-equivalents (Tg)**

| GHG SOURCE AND SINK | 1990 | 1995 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Energy | 3,274 | 3,200 | 3,252 | 3,323 | 3,313 | 3,361 | 3,363 | 3,342 | 3,317 | 3,258 | 3,196 | 2,973 |
| 2. Industrial Processes | 353 | 351 | 309 | 298 | 295 | 303 | 311 | 309 | 302 | 306 | 290 | 250 |
| 3. Solvent and Other Product Use | 14 | 12 | 12 | 12 | 11 | 11 | 10 | 11 | 11 | 10 | 10 | 9 |
| 4. Agriculture | 441 | 419 | 419 | 410 | 404 | 399 | 398 | 393 | 387 | 388 | 387 | 379 |
| 5. Land-Use, Land-Use Change and Forestry | -229 | -257 | -276 | -296 | -257 | -245 | -255 | -255 | -280 | -252 | -278 | -293 |
| 6. Waste | 184 | 173 | 148 | 142 | 138 | 132 | 126 | 123 | 121 | 117 | 115 | 112 |
| 7. Other | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Total (with net CO2 emissions/removals)** | **4,036** | **3,898** | **3,864** | **3,889** | **3,905** | **3,960** | **3,954** | **3,922** | **3,857** | **3,828** | **3,720** | **3,430** |
| **Total (without LULUCF)** | **4,265** | **4,155** | **4,140** | **4,185** | **4,162** | **4,205** | **4,208** | **4,178** | **4,137** | **4,080** | **3,998** | **3,724** |

## *Summary of EU Member State emission trends*

Table ES.8 gives an overview of Member State contributions to EU GHG emissions for 1990–2009. Member States show large variations in GHG emission trends.

**Table ES.8 Overview of Member State contributions to EU GHG emissions excluding LULUCF from 1990 to 2009 in $CO_2$-equivalents (Tg)**

| Member State | 1990 | 1995 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Austria | 78 | 80 | 80 | 84 | 86 | 92 | 91 | 93 | 90 | 87 | 87 | 80 |
| Belgium | 143 | 150 | 145 | 145 | 144 | 146 | 147 | 143 | 138 | 133 | 135 | 124 |
| Denmark | 68 | 76 | 68 | 70 | 69 | 74 | 68 | 64 | 72 | 67 | 64 | 61 |
| Finland | 70 | 71 | 69 | 74 | 77 | 84 | 80 | 68 | 80 | 78 | 70 | 66 |
| France | 563 | 560 | 567 | 569 | 564 | 566 | 566 | 569 | 553 | 545 | 539 | 517 |
| Germany | 1,248 | 1,120 | 1,042 | 1,057 | 1,037 | 1,031 | 1,021 | 1,000 | 1,002 | 980 | 981 | 920 |
| Greece | 104 | 109 | 126 | 127 | 127 | 131 | 131 | 134 | 131 | 133 | 129 | 123 |
| Ireland | 55 | 58 | 68 | 70 | 68 | 68 | 68 | 69 | 69 | 68 | 68 | 62 |
| Italy | 519 | 530 | 552 | 557 | 559 | 573 | 577 | 575 | 564 | 555 | 542 | 491 |
| Luxembourg | 13 | 10 | 10 | 10 | 11 | 11 | 13 | 13 | 13 | 12 | 12 | 12 |
| Netherlands | 212 | 223 | 213 | 215 | 214 | 215 | 217 | 211 | 207 | 205 | 205 | 199 |
| Portugal | 59 | 69 | 81 | 82 | 87 | 82 | 84 | 86 | 81 | 79 | 78 | 75 |
| Spain | 283 | 315 | 380 | 380 | 397 | 404 | 420 | 434 | 426 | 437 | 405 | 368 |
| Sweden | 72 | 74 | 69 | 70 | 70 | 71 | 70 | 68 | 67 | 66 | 64 | 60 |
| United Kingdom | 776 | 710 | 670 | 674 | 653 | 658 | 656 | 651 | 645 | 634 | 620 | 566 |
| **EU-15** | **4,265** | **4,155** | **4,140** | **4,185** | **4,162** | **4,205** | **4,208** | **4,178** | **4,137** | **4,080** | **3,998** | **3,724** |
| Bulgaria | 111 | 81 | 63 | 66 | 63 | 68 | 68 | 67 | 68 | 72 | 69 | 59 |
| Cyprus | 5 | 7 | 9 | 9 | 9 | 9 | 9 | 10 | 10 | 10 | 10 | 9 |
| Czech Republic | 196 | 154 | 147 | 150 | 145 | 144 | 145 | 145 | 146 | 147 | 141 | 133 |
| Estonia | 41 | 20 | 18 | 18 | 18 | 19 | 20 | 19 | 19 | 22 | 20 | 17 |
| Hungary | 97 | 78 | 77 | 79 | 77 | 80 | 79 | 79 | 78 | 75 | 73 | 67 |
| Latvia | 27 | 13 | 10 | 11 | 11 | 11 | 11 | 11 | 12 | 12 | 12 | 11 |
| Lithuania | 50 | 22 | 19 | 20 | 21 | 21 | 22 | 23 | 23 | 25 | 24 | 22 |
| Malta | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| Poland | 453 | 440 | 389 | 386 | 373 | 385 | 386 | 388 | 402 | 401 | 396 | 377 |
| Romania | 250 | 188 | 142 | 148 | 155 | 161 | 160 | 156 | 160 | 156 | 153 | 131 |
| Slovakia | 74 | 53 | 49 | 51 | 50 | 51 | 51 | 50 | 50 | 48 | 48 | 43 |
| Slovenia | 18 | 18 | 19 | 20 | 20 | 20 | 20 | 20 | 20 | 21 | 21 | 19 |
| **EU-27** | **5,589** | **5,232** | **5,086** | **5,145** | **5,105** | **5,177** | **5,181** | **5,149** | **5,129** | **5,071** | **4,969** | **4,615** |

The overall EU GHG emission trend is dominated by the two largest emitters, Germany and the United Kingdom, together accounting for about one third of total EU-27 GHG emissions. These two Member States have achieved total GHG emission reductions of 538 million tonnes $CO_2$-equivalents compared to 1990 ([6]).

The main reasons for the favourable trend in Germany were increasing efficiency in power and heating plants and the economic restructuring of the five new Länder after German reunification. The reduction of GHG emissions in the United Kingdom was primarily the result of liberalising energy markets and the subsequent fuel switches from oil and coal to gas in electricity production, and $N_2O$ emission reduction measures in the production of adipic acid.

France and Italy were the third and fourth largest emitters with a share of 11.2 % and 10.6 % of total emissions, respectively. Italy's GHG emissions were 5.4 % below 1990 levels in 2009. Italian GHG emissions initially increased, primarily from road transport, electricity and heat production and petrol refining, however, they have decreased significantly between 2008 and 2009 (by 9.3 %). France's emissions were 8.1 % below 1990 levels in 2009. In France, large reductions were achieved in $N_2O$ emissions from adipic acid production, but $CO_2$ emissions from road transport and HFC emissions from consumption of halocarbons increased considerably between 1990 and 2009.

Poland and Spain are the fifth and sixth largest emitters in the EU-27, each accounting for about 8 % of total EU-27 GHG emissions in 2009. Spain increased emissions by almost 30 % between 1990 and 2009. This was largely due to emission increases from road transport, electricity and heat production, and manufacturing industries. Poland decreased GHG emissions by 16.8 % between 1990 and 2009 (and 33.2 % since its base year of 1988). The main factors for decreasing emissions in Poland — as for other new Member States — were the decline of energy-inefficient heavy industry and the overall restructuring of the economy in the late 1980s and early 1990s. The notable exception was transport (especially road transport), where emissions increased.

## *International aviation and maritime transport*

EU-27 emissions of greenhouse gases from international aviation and shipping activities decreased as a whole for the second year in a row, which partly reflects the impacts of economic recession. Between 2008 and 2009 emissions from these sectors, currently not included in the national greenhouse gas totals, decreased by 7 % for aviation and by 10 % for international shipping. EU greenhouse gas emissions from international aviation are lower than for international maritime transport but are growing significantly more rapidly. The average annual EU-27 growth rates in emissions since 1990 were 3.6 % and 2.0 %, respectively. Together, the two sectors currently equal 6.3 % of total greenhouse gas emissions.

For detailed information on emissions from international bunkers see section 3.7 of this report.

## *Information on recalculations*

The UNFCCC has permanently fixed the base year emissions for the EU-15 (at 4 265.5 million tonnes CO2-equivalents) based on reviews during 2007 and 2008. However, recalculations of past emissions data occur every year, based on the inventory improvements that Member States are required to undertake for the whole time series.

Based on Member State inventories in 2011, total EU-15 emissions in both 1990 and 2008 were 0.4 percentage points higher than indicated in the 2010 inventories.

([6]) The EU-15 as a whole needs GHG emission reductions of 8 %, i.e. 341 million tonnes, in order to meet the Kyoto target. This can be achieved by a combination of existing and planned domestic policies and measures, the use of carbon sinks and the use of Kyoto mechanisms.

Similarly, recalculation of EU-27 emissions in 1990 and 2008 based on the comparison of the inventories submitted in 2011 and 2010 revealed increases of 0.4 percentage points for each.

**Table ES.9 Overview of major recalculations in the EU-15 in 1990**

| | | 1990 | | Main explanations |
|---|---|---|---|---|
| | MS | Gg CO2 equiv. | Percent | |
| 1A2_Manufacturing Industries and Construction CO2 | DE | 21,152 | 13.6924369 | - Reallocation of CO2 emissions from blast furnace gas combustion in sinter plants and rolling mills from source catagory 2C1 to source catagory 1A2a.<br>- new available data from national statistics |
| 1A1_Energy Industries CO2 | DE | 8,564 | 2.06438207 | - Reallocation of CO2 emissions from blast furnace gas combustion in cokeries from source catagory 2C1 to source catagory 1A1<br>- new available data from national statistics |
| 4D_Agricultural soils N2O | DE | 7,343 | 17.1906876 | - Estimation procedure has been corrected in accordance with IPCC (1996b) procedure. Correction of error in the estimation of TAN-immobilization in solid manure systems.<br>- Correction of emission factors (1996 GL instead of 2006 GL).<br>- Revision of method that considers N-losses due to emissions from N-species. |
| 6A_Solid waste disposal on land CH4 | UK | 6,377 | 12.8497363 | - Major review and update to the model used to estimate emissions from landfilled waste.<br>- A new time series of waste sent to landfill and waste composition has been identified and is now used. |
| 2E_Production of halocarbons HFC | DE | 4,329 | 100 | From the submission 2011 the so far confidential emissions of the production can be reported in 2E. But the producer requested to report the HFCs as unspecified mix. |
| 6A_Solid waste disposal on land CH4 | DE | 2,688 | 7.48538012 | Revision of methane recovery from landfills |
| 1A3_Transport CO2 | ES | -2,223 | -3.93437979 | New methodology following application of the national MECETA model for aviation. The revision has effect in the fuel consumption as well as in the emission factors. |
| 1A3_Transport CO2 | UK | -2,639 | -2.26691841 | - Road transport - updated distribution of vkm data between road types and between buses and coaches. Update to vkm data for motorcycles.<br>- Revised activity data for freight railways from the ORR for all years. Revised data for passenger rail from 2005 onwards.<br>- Reallocation of flights between UK and OTs/CDs between domestic and international as appropriate. Reallocation of shipping emissions between international and domestic based on port movement data. Coal use in rail reported from 2005. |
| 1A2_Manufacturing Industries and Construction CO2 | FR | -3,083 | -3.61350158 | Data consumption for the auto-production in industry have been corrected since 1990 due to a revision of data by SOes (french energy statistics) has been made. |
| 2C_Metal production CO2 | DE | -25,614 | -51.468154 | Recalculation of CO2 emissions from blast furnace gas combustion in industrial power plants from source category 2C1 to 1A2f and 1A1 |

Note: explanations for recalculations as provided by the Parties in their national greenhouse gas inventory reports

**Table ES.10 Overview of major recalculations in the EU-15 in 2008**

| | MS | 2008 Gg $CO_2$ equiv. | 2008 percent | Main explanations |
|---|---|---|---|---|
| 1A2_Manufacturing Industries and Construction CO2 | DE | 23,011 | 24 | - Reallocation of CO2 emissions from blast furnace gas combustion in sinter plants and rolling mills from source catagory 2C1 to source catagory 1A2a.<br>- new available data from national statistics |
| 6A_Solid w aste disposal on land CH4 | FR | 11,230 | 194 | Mise a jour taux de captage du biogaz suite à la revue CCNUCC |
| 1A1_Energy Industries CO2 | DE | 10,296 | 3 | - Reallocation of CO2 emissions from blast furnace gas combustion in cokeries from source catagory 2C1 to source catagory 1A1<br>- new available data from national statistics |
| 4D_Agricultural soils N2O | DE | 6,663 | 17 | - Estimation procedure has been corrected in accordance w ith IPCC (1996b) procedure. Correction of error in the estimation of TAN-immobilization in solid manure systems.<br>- Correction of emission factors (1996 GL instead of 2006 GL).<br>- Revision of method that considers N-losses due to emissions from N-species. |
| 1A4_Other sectors CO2 | DE | 3,168 | 2 | New available data from national statistics. |
| 1A2_Manufacturing Industries and Construction CO2 | UK | 2,818 | 4 | - Method of calculating activity data in lime production review ed and improved. Also causes reallocation of petcoke and gas and coal and coke in other industry. Method improvement in cement industry affects activity data of lubricants<br>- National energy stats changes affected EFs for coal coke coke over gas and BF gas as based on reported emissions. EU ETS EFs now used from 2005 for Colliery methane and from 2008 for OPG and pet coke. Earlier years interpolated.<br>- Other industry timeseries affected by reallocation of burning oil and fuel oil and gas oil to the crow n dependancies. Other activity data affected from 2005 onw ards by changes to national energy statistics. |
| 6A_Solid w aste disposal on land CH4 | DE | 2,352 | 31 | Revision of methane recovery from landfills |
| 6A_Solid w aste disposal on land CH4 | IT | 2,288 | 21 | - Industrial w astes disposed into MSW landfills have been added and revision of rapidly biodegradable fractions<br>- Revision of sludge time series and addition of industrial w astes. New w aste composition from 2006 and revision of previous w aste compositions |
| 2B_Chemical industries CO2 | DE | 2,080 | 14 | - For the CO2-Emissions from methanol production the default emission factor of the IPCC GL 2006 is used, because the old emissions could not be explained.<br>- Inclusion of CO2 recovery from amonia production |
| 1A3_Transport CO2 | ES | -2,135 | -2 | New methodology follow ing application of the national MECETA model for aviation. The revision has effect in the fuel consumption as w ell as in the emission factors. |
| 1A2_Manufacturing Industries and Construction CO2 | FR | -2,394 | -3 | Data consumption for the auto-production in industry have been corrected since 1990 due to a revision of data by SOes (french energy statistics) has been made. |
| 1A4_Other sectors CO2 | UK | -2,699 | -3 | - New EF based on carbon content measurements for domestic pet coke. GCV revised for coal for 2006 onw ards. Revision to national energy statistics for coke for 2007 onw ards.<br>- Northern Ireland domestic peat use data for all years. Revised national energy stats 2005 onw ard. Updates to CDs caused reallocation of LPG fuel oil and gas oil for all years. New AD for domestic petcoke. Improvements to offroad model 2004 onw ards.<br>- Addition of fishing vessels in 1A4c |
| 6A_Solid w aste disposal on land CH4 | UK | -3,784 | -19 | - Major review and update to the model used to estimate emissions from landfilled w aste.<br>- A new time series of w aste sent to landfill and w aste composition has been identified and is now used. |
| 1A3_Transport CO2 | UK | -4,167 | -3 | - Road transport - updated distribution of vkm data betw een road types and betw een buses and coaches. Update to vkm data for motorcycles.<br>- Revised activity data for freight railw ays from the ORR for all years. Revised data for passenger rail from 2005 onw ards.<br>- Reallocation of flights betw een UK and OTs/CDs betw een domestic and international as appropriate. Reallocation of shipping emissions betw een international and domestic based on port movement data. Coal use in rail reported from 2005. |
| 2C_Metal production CO2 | DE | -24,087 | -55 | Recalculation of CO2 emissions from blast furnace gas combustion in industrial pow er plants from source category 2C1 to 1A2f and 1A1 |

Note: explanations for recalculations as provided by the Parties in their national greenhouse gas inventory reports

For detailed information on recalculations see chapter 10 and the sector specific recalculations.

## *Information on indirect greenhouse gas emissions for the EU-15*

Emissions of CO, $NO_x$, NMVOC and $SO_2$ have to be reported to the UNFCCC Secretariat because they influence climate change indirectly: the former three substances are precursor substances for ground-level ozone which itself is a greenhouse gas. Sulphur emissions can contribute to formation of microscopic particles (aerosols) that can reflect sunlight back out into space and also affect cloud formation.

Table ES.11 shows the total indirect GHG and $SO_2$ emissions in the EU-15 between 1990–2009. All emissions were reduced significantly from 1990 levels: the largest reduction was achieved in $SO_2$ (84 %), followed by CO (65 %), NMVOC (54 %) and $NO_x$ (45 %).

**Table ES.11 Overview of EU-15 indirect GHG and $SO_2$ emissions for 1990–2009 (Gg)**

| GREENHOUSE GAS EMISSIONS | 1990 | 1995 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | (Gg) | | | | | | | | | | | |
| NOx | 13,555 | 11,963 | 10,517 | 10,312 | 10,060 | 9,902 | 9,749 | 9,502 | 9,207 | 8,900 | 8,201 | 7,503 |
| CO | 52,547 | 41,837 | 31,817 | 30,166 | 28,174 | 27,046 | 25,954 | 24,002 | 22,782 | 21,642 | 20,685 | 18,310 |
| NMVOC | 15,928 | 13,012 | 10,634 | 10,131 | 9,608 | 9,604 | 8,966 | 8,730 | 8,629 | 8,070 | 7,697 | 7,265 |
| SO2 | 16,485 | 9,981 | 6,153 | 5,887 | 5,638 | 5,161 | 4,932 | 4,560 | 4,348 | 4,162 | 3,100 | 2,608 |

In the EU-27, $SO_2$ emissions decreased by 78 %, followed by CO (61 %), NMVOC (50 %) and $NO_x$ (44 %) (Table ES.12).

**Table ES.12 Overview of EU-27 indirect GHG and SO2 emissions for 1990–2009 (Gg)**

| GREENHOUSE GAS EMISSIONS | 1990 | 1995 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | (Gg) | | | | | | | | | | | |
| NOx | 16,954 | 14,714 | 12,728 | 12,468 | 12,193 | 12,133 | 11,957 | 11,716 | 11,453 | 11,155 | 10,351 | 9,528 |
| CO | 64,783 | 51,436 | 40,716 | 37,841 | 35,624 | 34,492 | 33,779 | 30,600 | 29,423 | 28,252 | 27,506 | 24,965 |
| NMVOC | 18,491 | 14,944 | 12,389 | 11,806 | 11,301 | 11,345 | 11,037 | 10,636 | 10,598 | 10,500 | 9,501 | 9,260 |
| SO2 | 25,367 | 16,795 | 10,387 | 10,201 | 9,713 | 9,255 | 8,685 | 8,037 | 7,877 | 7,667 | 6,392 | 5,509 |

EU Member States also annually report emissions of these substances to the United Nations Economic Commission for Europe (UNECE) Convention on Long-Range Transboundary Air Pollution (LRTAP), and report emissions of NOx, NMVOCs and $SO_2$ under the EU's National Emissions Ceilings Directive (NECD).

## *Information on using EU ETS data for national GHG inventories in EU Member States*

This report also includes an analysis of the use of data and emissions reported under the European Union Greenhous Gas Emission Trading System (EU ETS) for preparing national GHG inventories in the EU-15. The analysis shows that most Member States used the ETS data to improve and refine the estimation and reporting of $CO_2$ emissions from energy and industrial processes. Twenty-six of 27 Member States indicated that they used ETS data at least for quality assurance/quality control purposes and checked data consistency between both sources. This is a higher share of Member States than in 2010.

Sixteen Member States have used verified emissions reported by installations under the EU ETS in their national greenhouse gas inventories. Eighteen Member States used ETS data to improve country-specific emission factors. Twelve Member States reported that they used activity data (e.g. fuel use) provided under the ETS in their national inventory. The use of ETS data improved the quality of greenhouse gas inventory data with respect to completeness (additional emission sources can be estimated for which no data were available before the EU ETS), accuracy (e.g. due to improved country-specific emission factors) and allocation of emissions to correct CRF source categories.

# PART 1: ANNUAL INVENTORY SUBMISSION (EU-15)

# 1 INTRODUCTION TO THE EU GREENHOUSE GAS INVENTORY

This report is the annual submission of the European Union (EU) to the United Nations Framework Convention on Climate Change (UNFCCC). It presents the greenhouse gas (GHG) inventory of the EU, the process and the methods used for the compilation of the EU inventory as well as GHG inventory data of the individual EU Member States for 1990 to 2009. The GHG inventory data of the Member States are the basis of the EU GHG inventory. The data published in this report are also the basis of the progress evaluation report of the European Commission, required under Council Decision No 280/2004/EC concerning a mechanism for monitoring Community greenhouse gas emissions and for implementing the Kyoto Protocol.

This report aims to present transparent information on the process and methods of compiling the EU GHG inventory. It addresses the relevant aspects at EU level, but does not describe detailed sectoral methodologies of the Member States' GHG inventories. Detailed information on methodologies used by the Member States is available in the national inventory reports of the Member States, which are included in Annex 1.12. Note that all Member States' submissions (common reporting format (CRF) tables and inventory reports), which are included in Annex 1.12 and made available at the European Environment Agency (EEA) website, are considered to be part of the EU submission. Several chapters in this report refer to information provided by the Member States, where additional insights can be gained. In many cases this Member State information is presented in summary overview tables.

The EU greenhouse gas inventory has been compiled under Council Decision No 280/2004/EC concerning a mechanism for monitoring Community greenhouse gas emissions and for implementing the Kyoto Protocol (7). The emissions compiled in the EU GHG inventory are the sum of the respective emissions in the respective national inventories, except for the Intergovernmental Panel on Climate Change (IPCC) reference approach for $CO_2$ from fossil fuels. Since the data are revised and updated for all years, they replace EU data previously published, in particular, in the 2009 submission by the European Commission to the UNFCCC Secretariat of the *Annual European Community greenhouse gas inventory 1990–2008 and inventory report 2010* (EEA, 2010).

This part of the EU GHG inventory report includes data for the EU-15 Member States. The EU-15 Member States are Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Sweden and the United Kingdom. This part includes all the detailed information provided in previous reports for the EU-15.

## 1.1 Background information on greenhouse gas inventories and climate Change

The annual EU GHG inventory is required for two purposes.

Firstly, the EU, as the only regional economic integration organisation having joined the UNFCCC and the Kyoto Protocol as a party, has to report annually on GHG inventories within the area covered by its Member States.

Secondly, under the monitoring mechanism, the European Commission has to assess annually whether the actual and projected progress of Member States is sufficient to ensure fulfilment of the EU's commitments under the UNFCCC and the Kyoto Protocol. For this purpose, the Commission has to prepare a progress evaluation report, which has to be forwarded to the European Parliament and the Council. The annual EU inventory is the basis for the evaluation of actual progress.

(7)OJ L 49, 19.2.2004, p. 1.

The legal basis of the compilation of the EU inventory is Council Decision No 280/2004/EC concerning a mechanism for monitoring Community greenhouse gas emissions and for implementing the Kyoto Protocol (8). The purpose of this decision is to: (1) monitor all anthropogenic GHG emissions covered by the Kyoto Protocol in the Member States; (2) evaluate progress towards meeting GHG reduction commitments under the UNFCCC and the Kyoto Protocol; (3) implement the UNFCCC and the Kyoto Protocol as regards national programmes, greenhouse gas inventories, national systems and registries of the EU and its Member States, and the relevant procedures under the Kyoto Protocol; (4) ensure the timeliness, completeness, accuracy, consistency, comparability and transparency of reporting by the EU and its Member States to the UNFCCC Secretariat.

Under the provisions of Article 3.1 of Council Decision No 280/2004/EC, the Member States shall determine and report to the Commission by 15 January each year (year X) inter alia:

- their anthropogenic emissions of greenhouse gases listed in Annex A to the Kyoto Protocol (carbon dioxide ($CO_2$), methane ($CH_4$), nitrous oxide ($N_2O$), hydrofluorocarbons HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride $SF_6$)) during the year before last (X – 2);
- provisional data on their emissions of carbon monoxide (CO), sulphur dioxide (SO2), nitrogen oxides (NOx) and volatile organic compounds (VOCs) during the year before last (year X – 2), together with final data for the year three-years previous (year X – 3);
- their anthropogenic greenhouse gas emissions by sources and removals of carbon dioxide by sinks resulting from land-use, land-use change and forestry during the year before last (year X – 2);
- information with regard to the accounting of emissions and removals from land-use, land-use change and forestry, in accordance with Article 3(3) and, where a Member State decides to make use of it, Article 3(4) of the Kyoto Protocol, and the relevant decisions thereunder, for the years between 1990 and the year before last (year X – 2);
- any changes to the information referred to in points (1) to (4) relating to the years between 1990 and the year three-years previous (year X – 3);
- the elements of the national inventory report necessary for the preparation of the EU greenhouse gas inventory report, such as information on the Member State's quality assurance/quality control plan, a general uncertainty evaluation, a general assessment of completeness, and information on recalculations performed.

The reporting requirements for the Member States under Council Decision 280/2004/EC are elaborated in the Commission Decision 2005/166/EC laying down rules implementing Decision 280/2004/EC of the European Parliament and of the Council concerning a mechanism for monitoring Community greenhouse gas emissions and for implementing the Kyoto Protocol (9). According to the Council decision and the Commission decision the reporting requirements are exactly the same as for the UNFCCC, regarding content and format. The EU and its Member States use the '*UNFCCC guidelines on reporting and review*' (Document FCCC/CP/2002/8), and prepare inventory information in the common reporting format (CRF) and the 'national inventory report' that contains background information.

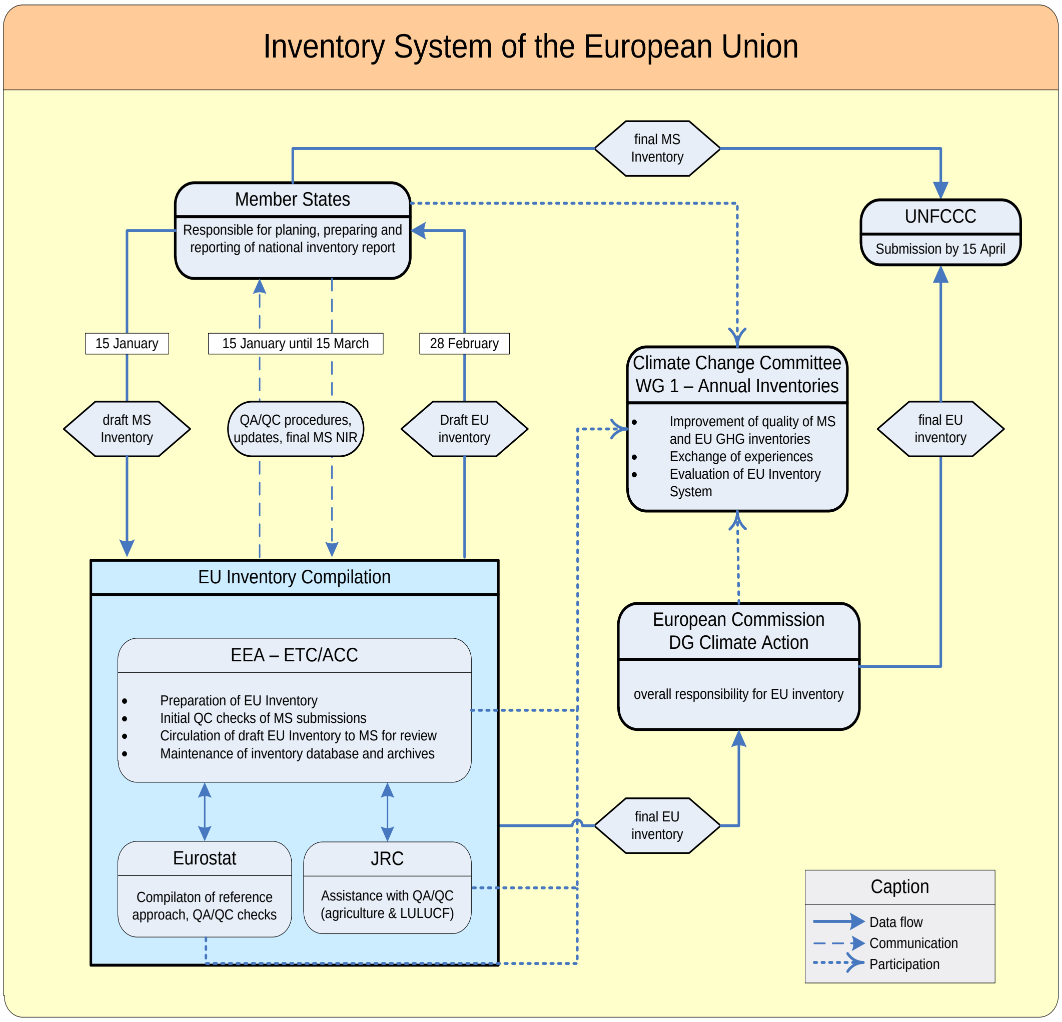
In accordance with UNFCCC guidelines, the EU and its Member States use the *IPCC Good practice guidance and uncertainty management in national greenhouse gas inventories* (IPCC, 2000), which is consistent with the *Revised 1996 IPCC guidelines for national greenhouse gas inventories* (IPCC, 1997). The use of IPCC (2000) by countries is expected to lead to higher quality inventories and more reliable estimates of the magnitude of absolute and trend uncertainties in reported GHG inventories.

(8)OJ L 49, 19.2.2004, p. 1.
(9)OJ L 55, 1.3.2005, p. 57.

### 1.1.1 *A description of the institutional arrangements for inventory preparation*

Figure 1.1 shows the inventory system of the European Union. The DG Climate Action of the European Commission is responsible for preparing the inventory of the European Union (EU) while each Member State is responsible for the preparation of its own inventory which is the basic input for the inventory of the European Union. DG Climate Action is supported in the establishment of the inventory by the following main institutions: the European Environment Agency (EEA) and its European Topic Centre on Air Pollution and Climate Change Mitigation (ETC/ACM) as well as the following other DGs of the European Commission: Eurostat, and the Joint Research Centre (JRC) (10).

**Figure 1.1: Inventory system of the European Union**




(10) The Statistical Office of the European Communities (Eurostat) and the Joint Research Centre (JRC) are DGs of the European Commission. For simplicity reasons, these institutions are referred to as ‘Eurostat’ and the ‘JRC’ in this report.

Table 1.1 shows the main institutions and persons involved in the compilation and submission of the EU-15 inventory.

**Table 1.1 List of institutions and experts responsible for the compilation of Member States' inventories and for the preparation of the EU inventory**

| Member State/EU institution | Contact address |
|---|---|
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| **France** | Ministère de l'Écologie, de l'Énergie,du Développement Durable et de la Mer (MEEDDM) en charge des Technologies vertes et des Négociations sur le climat<br>Direction Générale de l'Energie et du Climat (DGEC)<br>Arche de La Défense<br>Paroi Nord<br>92055 La Défense CEDEX<br>Frédérique Millard<br>Centre Interprofessionel Technique d'Etudes de la Pollution Atmosphérique (CITEPA)<br>7 Cité Paradis, F-75010 Paris<br>Jean-Pierre Fontelle |
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| **Ireland** | Paul Duffy<br>Environmental Protection Agency<br>Richview, Clonskeagh Road, Dublin 14, Ireland |
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| **Luxembourg** | Eric De Brabanter<br>Département de l'Environnement<br>Ministère du Développement durable et des Infrastructures<br>L-2918 Luxembourg<br>Dr Marc Schuman<br>Administration de l'Environnement<br>16 rue Eugène Ruppert<br>L-2453 Luxembourg |
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| **Portugal** | Teresa Costa Pereira<br>Agência Portuguesa do Ambiente<br>Rua da Murgueira — Bairro do Zambujal, P-2721-865 Amadora |
| **Spain** | Ángleles Cristóbal<br>Ministerio de Medio Ambiente<br>Plaza de San Juan de la Cruz s/n, E-28071 Madrid |
| **Sweden** | Conny Hägg and Nilla Thomson<br>Ministry of Environment<br>Tegelbacken 2<br>S-103 33 Stockholm<br>Sweden |
| **United Kingdom** | Sarah Choudrie<br>AEA<br>The Gemini Building, Fermi Avenue, Harwell, Didcot Osfordshire, OX11 0QR |
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| | Rue de la Loi 200, B-1049 Brussels, Belgium |
| **European Environment Agency (EEA)** | Ricardo Fernandez<br>European Environment Agency<br>Kongens Nytorv 6, DK-1050 Copenhagen, Denmark |
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| **Eurostat** | Nikolaos Roubanis<br>Statistical Office of the European Communities (Eurostat),<br>Jean Monnet Building, L-2920 Luxembourg, Luxembourg |
| **Joint Research Centre (JRC)** | Frank Raes, Giacomo Grassi, Adrian Leip<br>Joint Research Centre, Institute for Environment and Sustainability, Climate Change Unit<br>Via Enrico Fermi, I-21020 Ispra (VA), Italy |

### *1.1.2 The Member States*

All EU-15 Member States are Annex I parties to the UNFCCC. Therefore, all EU-15 Member States have committed themselves to prepare individual GHG inventories in accordance with UNFCCC reporting guidelines and to submit those inventories to the UNFCCC secretariat by 15 April. In addition, all EU Member States are required to report individual GHG inventories prepared in accordance with UNFCCC reporting guidelines to the Commission by 15 January every year under Council Decision 280/2004/EC.

The European Union's inventory is based on the inventories supplied by Member States. The total estimate of the EU greenhouse gas emissions should accurately reflect the sum of Member States' national greenhouse gas inventories. Member States are responsible for choosing activity data, emission factors and other parameters used for their national inventories as well as the correct application of methodologies provided in the IPCC 1996 Guidelines, IPCC Good Practice Guidance and IPCC Good Practice Guidance for LULUCF. Member States are also responsible for establishing quality assurance/quality control (QA/QC) programmes for their inventories. The QA/QC activities of each Member State are described in the respective national inventory reports and summarised in the European Union inventory report.

Apart from submitting their national GHG inventories and inventory reports the Member States take part in the review and comment phase of the draft EU inventory report, which is sent to the Member States by 28 February each year. The purpose of circulating the draft EU inventory report is to improve the quality of the EU inventory. The Member States check their national data and information used in the EU inventory report and send updates, if necessary. In addition, they comment on the general aspects of the EU inventory report.

The Member States also take part in the Climate Change Committee established under Council Decision No 280/2004/EC. The purpose of the Climate Change Committee is to assist the European Commission in its tasks under Council Decision No 280/2004/EC.

Under Council Decision 280/2004/EC all Member States are required to establish national systems. Table 1.2 summarises the information on national systems/institutional arrangements in the EU-15 Member States.

**Table 1.2 Summaries of institutional arrangements/national systems of EU-15 Member States**

| MS | Institutional arrangements/national systems | Source |
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| Austria | Austria has a centralized inventory system, with all the work related to inventory preparation be-ing carried out at a single national entity. The most important legal arrangement is the Austrian Environmental Control Act (Umweltkontrollgesetz12), which defines the main responsibility for inventory preparation and identifies the Umweltbundesamt as the single national entity with the overall responsibility for inventory preparation. Within the Umweltbundesamt the "Inspection Body for Emission Inventories" is responsible for the compilation of the greenhouse gas inventory.<br>Within the inventory system specific responsibilities for the different emission source/sink cate-gories ("sector experts") are defined. Sector experts collect activity data, emission factors and all relevant information needed for finally estimating emissions. The sector experts are also re-sponsible for the choice of methods, data processing and archiving and for contracting studies, if needed. As part of the quality management system, the head of the "Inspection body for GHG inventory" approves the methodological choices. Finally, sector experts perform Quality Assurance and Quality Control (QA/QC) activities.<br>The Austrian Inventory is based on the SNAP nomenclature and has to be transformed into the UNFCCC CRF to comply with the reporting obligations under the UNFCCC.<br>In addition to the actual emission data, the background tables of the CRF are filled in by the sector experts, and finally QA/QC procedures as defined in the inventory planning process are carried out before the data are submitted to the UNFCCC.<br>As part of the QMS"s documentation and archiving procedures a reliable data management sys-tem has been established to fulfil the data collecting and reporting requirements. This ensures the necessary documentation and archiving for future reconstruction of the inventory and con-sequently enables easy access to up-to-date and previously submitted data for the quantitative evaluation of recalculations.<br>As part of the QMS (Corrective and Preventive Actions) an efficient process is established to grant transparency when collecting and analyzing findings by UNFCCC review experts or any other issues concerning the quality of activity data, emission factors, methods and other relevant technical elements of inventories. Any findings and discrepancies are documented; responsibilities, resources and a time schedule are attributed to each of these in the improvement plan. Measures, which include possible recalculations, are taken by the sector experts.<br>The national energy balance is the most important data basis for the Austrian Air Emissions Inventory. The Austrian statistical office (Statistik Austria) is required by contract with the Federal Ministry of Agriculture, Forestry, Environment and Water Management and with the Federal Ministry of Economics and Labour to annually prepare the national energy balance. The compilation of several other relevant statistics is regulated by law. Other data sources include reporting obligations under national and European regulations and reports of companies and associations. The main data sources used for activity data were:<br>• Energy Balance from Statistik Austria; EU-ETS; Steam boiler database (for the sector Energy)<br>• Energy Balance from Staistik Austria (for the sector Transport)<br>• National production statistics, import/export statistics; EU-ETS; direct information from industry or associations of industry (for the sector Industry)<br>• Short term statistics for trade and services, Austrian foreign trade statistics, structural business statistics, surveys at companies and associations (for the sector Solvents)<br>• National Studies, national agricultural statistics obtained from Statistik Austria (for the sector Agriculture)<br>• National forest inventory obtained from the Austrian Federal Office and Research Centre for Forests (for the sector LULUCF)<br>• Database on landfills Umweltbundesamt (for the sector Waste).<br>The main sources for emission factors are: (1) national studies for country specific emission factors, (2) plant-specific data reported by plant operators (3) IPCC GPG (4) Revised IPCC 1996 Guidelines (5) EMEP/CORINAIR Guidebook. | Austria's Annual Greenhouse Gas Inventory 1990–2008<br>Jan 2010<br>pp. 21-24<br>No change since 2010 submission |

| MS | Institutional arrangements/national systems | Source |
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| Belgium | In the Belgian federal context, major responsibilities related to environment lie with the regions. Compiling greenhouse gas emissions inventories is one of these responsibilities. Each region implements the necessary means to establish their own emission inventory in accordance with the IPCC guidelines. The emission inventories of the three regions are subsequently combined to compile the national greenhouse gas emission inventory. Since 1980, the three regions have been developing different methodologies (depending on various external factors) for compiling their atmospheric emission inventories. During the last years important efforts are made to tune these different methodologies, especially for the most important (key) sectors. Obviously, this requires some co-ordination to ensure the consistency of the data and the establishment of the national inventory. This co-ordination is one of the permanent tasks of the Working Group on « Emissions » of the Coordination Committee for International Environmental Policy (CCIEP), where the different actors decide how the regional data will be aggregated to a national total, taking into account the specific characteristics and interests of each region as well as the available means. This working group consists of representatives of the 3 regions and of the federal public services. The Interregional Environment Unit (CELINE - IRCEL) is responsible for integrating the emission data from the inventories of the three regions and for compiling the national inventory. The National inventory report is than formally submitted to the National Climate Commission, established by the Cooperation agreement of 14 November 2002, for approval, before its submission to the secretariat of the United Nations Framework Convention on Climate Change and to the European Commission, under the Council Decision 280/2004/EC concerning a Mechanism for Monitoring Community greenhouse gas emissions and for implementing the Kyoto Protocol. | Belgium's GHG Inventory (1990 – 2009) National Inventory Report Jan 2011 p. 2<br>No major change since 2010 submission |
| Denmark | The National Environmental Research Institute NERI, Aarhus University, is responsible for the annual preparation and submission to the UNFCCC and the EU of the National Inventory Report and the GHG inventories in the Common Reporting Format in accordance with the UNFCCC Guidelines. NERI have been and are engaged in work in connection to the meetings of the Conference of Parties (COP) to the UNFCCC and the meetings of the parties (COP/MOP) to the Kyoto protocol and its subsidiary bodies, where the reporting rules are negotiated and settled. Furthermore, NERI participates in the EU Monitoring Mechanisms on greenhouse gases Working Group 1 (WG1), where the guidelines, methodologies etc. on inventories to be prepared by the EU Member States are regulated. | Danish Annual EC Greenhouse Gas Report 2010: Inventories 1990-2008 Jan 2010 p.26 |

| MS | Institutional arrangements/national systems | Source |
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| Finland | In accordance with the Government resolution of 30 January 2003 on the organisation of climate policy activities of Government authorities in Finland, Statistics Finland assumed the responsibilities of the National Entity for Finland´s greenhouse gas inventory from the beginning of 2005. Statistics Finland as the general authority of the official statistics of Finland is independently responsible for greenhouse gas inventory submissions under the UNFCCC, the Kyoto Protocol and the EU monitoring mechanism. Besides Statistics Finland, the Finnish Environment Institute, MTT Agrifood Research Finland and the Finnish Forest Research Institute take part in the inventory preparation. Statistics Finland acquires also parts of the inventory calculations as purchased services from VTT (Technical Research Centre of Finland) and Finavia.<br>In Finland the national system, as intended in the Kyoto Protocol (Article 5.1), is based, besides regulations concerning Statistics Finland, on agreements on the production of emission/removal estimations and reports between the inventory unit at Statistics Finland and the expert organisations mentioned above. Statistics Finland has also agreements with the responsible ministries defining the responsibilities and collaboration in relation to the reporting requirements under the UNFCCC and Kyoto Protocol, as well as the EU monitoring mechanism.<br>In Finland the National System is established on a permanent footing and it guides the development of emission calculation in the manner required by the agreements. The National System is designed and operated to ensure the transparency, consistency, comparability, completeness, accuracy and timeliness of greenhouse gas emission inventories. The quality requirements are fulfilled by implementing consistently the inventory quality management procedures. A detailed description of the National Greenhouse Gas Inventory System in Finland can be found from the report "National Greenhouse Gas Inventory System in Finland" which is available on the web: http://stat.fi/greenhousegases.<br>The following changes in Finland‟s national system have been implemented during 2010:<br>Finavia did not renew the contract for the estimation of the emissions from aviation. The intention was that Eurocontrol would take over this task. Negotiations with Eurocontrol had been initiated earlier, but the general assembly of the Eurocontorl gave its acceptance for the provision on the data for inventory purposes only late in 2010. Eurocontrol will start developing a portal, from which its member states could retrieve the information needed to estimate the emissions for the national GHG. Finland will participate in this development work. If the development work progresses as planned, Finland will estimate the emissions from aviation based on Eurocontrol data from the 2012 submission onwards. Finavia has agreed to provide Statistics Finland with the necessary data and support for the inventory calculations until the agreement with Eurocontrol is implemented. Finavia currently responsible for the negotiations on this issue with Eurocontrol, and will also take part in the development of the portal mentioned above. Finavia will also provide further technical assistance in this issue, depending on the details of the futre agreement with Eurocontrol. For 2009 the emissions from aviation were estimated based on data provided by Finavia and calculations made by Statistics Finland.<br>The agreement between Statistics Finland and the Energy Market Authority has been updated in 2010. The new agreement defines in more detail the collaboration as well as contents and timelines for data/other information exchange between the organisations in the reporting of the data to UNFCCC secretariat. The new agreement gives Statistics Finland also access to the more detailed data collected by the Energy Market authority. | GHG Emissions in Finland 1990-2009 Draft Jan 2011 pp. 19-21, 393 |

| MS | Institutional arrangements/national systems | Source |
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| France | The responsibility of the definition and control of the National Air Pollutant Emissions Inventory System (Système National d'Inventaire des Emissions de Polluants dans l'Atmosphère (SNIEPA)) is pertained by the Ministère de l'Ecologie, du Développement durable, des Transports et du Logement (MEDDTL).<br>The MEDDTL is in charge of overseeing production of the inventories and overall coordination of the system.<br>Other ministries and public bodies contribute to the emission inventories by providing data and statistics used in the preparation of the inventories.<br>The MEDDTL has entrusted CITEPA (Interprofessional Technical Centre for Studies on Air Pollution or Centre Interprofessionnel Technique d'Etudes de la Pollution Atmosphérique) with the following tasks: preparing the emission inventories with regard to methods and preparing their updating, data collection and processing, data storage, production of the reports and various means of disseminating the information, control and quality management. CITEPA assists the MEDDTL in overall coordination of the National Air Pollutant Emissions Inventory System. Mention should be specifically made of the coordination that must be ensured between the emission inventories and emitter registers such as the E-PRTR and the greenhouse gas emission allowance register in the frame of the ETS directive, not forgetting other aspects (guides published by the MEDDTL, the annual pollutant emission reporting system, etc.).<br>The MEDDTL provides CITEPA with all information it has at its disposal under existing legislation and regulations, such as the annual notifications made by Classified Installations under the pollutant emission reporting system, as well as the results of different studies providing greater knowledge on emissions that it commissioned either internally (ie within its departments) or from other bodies, such as the National Institute for Industry, Environment and Risks (INERIS).<br>The MEEDDM steers the Emissions Inventories Consultation and Information Group (GCIIE) whose tasks are to:<br>• give its opinion on the results of estimates produced in the inventories,<br>• give its opinion on the changes made to the methodology for estimating emissions,<br>• give its opinion on the action plan for improving inventories for the future, issue recommendations on all subjects directly or indirectly linked to emission inventories in order to ensure consistency and smooth running of actions, and encourage synergies, etc.,<br>• recommend actions for improving the estimation of emissions in the context of research programmes.<br>The GCIIE is made up of representatives:<br>• of the Ministry of Ecology, Energy, Sustainable Development and Sea (MEDDTL), and specifically the General Directorate for Energy and Climate (DGEC), General Directorate for Spatial Planning, Housing and Nature (DGALN), the General Directorate for Infrastructure, Transport and Maritime Affairs (DGITM), and the General Directorate for Civil Aviation (DGAC)<br>• of the Ministère de l'agriculture, de l'alimentation, de la pêche, de la ruralité et de l'aménagement du territoire (MAPRAT), particularly the Statistics and Forward Studies Department (SSP) and the General Directorate for Agricultural, Agri-food and Land Policies (DGPAAT), the Ministère de l'Economie, des Finances et de l'Industrie (MINEFI), and specifically the General Directorate of the National Institute of Statistics and Economic Studies (INSEE), the General Directorate of the Treasury and Economic Policy (DGTPE) and the General Directorate of Companies (DGE),<br>• of the General Sustainable Development Commission (CGDD), particularly the Observation and Statistics Department. | direct communication, March 2010<br>Some changes in the national system with compared to 2010 submissions regarding names of Ministries |

| MS | Institutional arrangements/national systems | Source |
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| **Germany** | The national Inventory System in Germany complies with the requirements laid down in the Guidelines for National Systems (UNFCCC Decision 19/CMP.1). The use of the IPCC-Guidelines and IPCC Good Practice Guidance and a continuous Quality Management and continuous improvement of the inventory ensure a transparent, consistent, comparable, complete and accurate inventory. In the position paper "Nationales System" (June 2007) Umweltbundesamt was laid down as the national coordination centre for emission inventory reporting.<br>Other involved institutions and agencies:<br>• Federal Ministry of the Environment, Nature Conservation and Nuclear Safety (BMU)<br>• Federal Ministry for Consumer Protection, Food and Agriculture (BMELV)<br>• Federal Ministry of of the Interior (BMI)<br>• Federal Ministry of Defence (BMVg)<br>• Federal Ministry of Finance (BMF)<br>• Federal Ministry of Economis and Technology (BMWi)<br>• Federal Ministry of Transport, Building and Urban Affairs (BMVBS)<br>Tasks of the national coordination centre (Umweltbundesamt) are:<br>• Planning of the inventories<br>• Compilation of the inventories<br>• Archiving of the inventories<br>• Quality control and Quality Assurance<br>To meet these tasks the national coordination centre has developed a database "Zentrale System Emissionen" (which is the main instrument for documentation and quality assurance on the level of data) and the Quality sytem "Emissionsinventare" (which regulates responsibilities and quality targets).<br>The national coordination centre within UBA cooperates with other working groups within UBA. For coordination of the tasks within UBA a working team "Arbeitskreis Emissionsinventare" was installed. Research centres contribute to inventory compilation with research projects that are carried out within the framework of the research programme "Umweltforschungsplan". For the integration of non-governmental organisation a convention was devised that binds the respective entities to contribute to the inventory compilation. | Nationaler Inventar-bericht Zum Deutschen Treib-hausgas-inventar 1990 - 2009<br>Jan 2011<br>pp. 64ff<br>(submited in German, translated) |

| MS | Institutional arrangements/national systems | Source |
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| Greece | The Ministry of Environment, Energy and Climate Change, MEECC (former Ministry for the Environment, Physical Planning and Public Works) is the governmental body responsible for the development and implementation of environmental policy in Greece, as well as for the provision of information concerning the state of the environment in Greece in compliance with relevant requirements defined in international conventions, protocols and agreements. Moreover, the MEECC is responsible for the co-ordination of all involved ministries, as well as any relevant public or private organization, in relation to the implementation of the provisions of the Kyoto Protocol, according to the Law 3017/2002 with which Greece ratified the Kyoto Protocol.<br>In this context, the MEECC has the overall responsibility for the national GHG inventory, and the official consideration and approval of the inventory prior to its submission. The entities participating in the organizational structure of the National Inventory System are:<br>The MEECC designated as the national entity responsible for the national inventory, which keeps the overall responsibility, but also plays a more active role in the inventory planning, preparation and management.<br>The National Technical University of Athens (NTUA) / School of Chemical Engineering, which has the technical and scientific responsibility for the compilation of the annual inventory.<br>Governmental agencies and ministries, international associations, along with individual private industrial companies.<br>The MEECC, as the national entity, has the overall responsibility for the national GHG inventory. Among its responsibilities are the following:<br>• The co-ordination of all ministries and governmental agencies involved, as well as any relevant public or private organization. In this context, it oversees the operation of the National System and decides on the necessary arrangements to ensure compliance with relevant decisions of the COP and the COP/MOP.<br>• The official consideration and approval of the inventory prior to its submission.<br>• The response to any issues raised by the inventory review process under Article 8 of the Kyoto Protocol, in co-operation with the technical consultant (NTUA Inventory Team), who has the technical and scientific responsibility for the inventory planning, preparation and management of all sectors, as mentioned above.<br>• The timely submission of the GHG inventory to the European Commission and to the UNFCCC Secretariat<br>• The keeping of the Centralised Inventory File, which is delivered to the institute which has the technical responsibility for the inventory planning, preparation and management (currently NTUA) at the beginning of each inventory cycle. The Centralised Inventory File is kept at the premises of MEECC.<br>• The administration of the National Registry.<br>• The supervision of Quality Assurance/Quality Control Plan (QA/QC).<br>As it appears from the above description, the role of the MEECC is not narrowed to the coordination of the entities involved in the inventory process and to facilitate the activity data transfer from the data providers to the NTUA's Inventory Team. MEECC has an active role in monitoring and overseeing the inventory process through continuous communication and frequent scheduled and / or ad-hoc meetings with the Inventory Team of NTUA and the competent ministries or other agencies involved. | Greece – Climate change emission inventory<br>Information under Article 3(1) of the Decision 280/2004/EC,<br>Jan 2011, pp.3-6 |

| MS | Institutional arrangements/national systems | Source |
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| Ireland | In 2005, UK consultants NETCEN carried out a scoping study to identify the essential elements and structure of a national inventory system for Ireland to meet the needs of Decision 280/2004/EC and to comply with obligations under Articles 5 and 7 of the Kyoto Protocol. The establishment of Ireland's national inventory system was completed by Government Decision in early 2007, building on the framework that has been applied for many years. It puts in place formal procedures for the planning, preparation and management of the national atmospheric inventory and identifies the roles and responsibilities of all the organisations involved in its compilation. All formal mechanisms together with the QA/QC procedures are fully operational in this present reporting cycle. The EPA Office of Climate, Licensing and Resource Use (OCLR) is the inventory agency and the EPA is also designated as the single national entity with overall responsibility for the annual greenhouse gas inventory. The national system is also exploited for the purpose of inventory preparation and reporting under the LRTAP Convention ensuring efficiency and consistency in the compilation of emission inventories for a wide range of substances using common datasets and inputs. As a formal management system, the national system aims for continuous improvement to increase the quality and robustness of the national atmospheric inventory over time.<br>In addition to the primary data received from the key data providers, the inventory team obtains considerable supplementary information from other teams in OCLR and the Office of Environmental Enforcement within the EPA. These sources include Annual Environmental Reports (AER) submitted by licensed companies and the National Waste Database. The inventory team also draws on national research related to greenhouse gas emissions and special studies undertaken from time to time to acquire the information needed to improve the estimates for particular categories and gases. The approval of the completed annual inventory involves sign-off by the QA/QC manager and the inventory manager before it is transmitted to the Board of the EPA via the Programme Manager of the Climate Change Unit in OCLR. Any issues arising from the Board's examination of the estimates are communicated to the inventory experts for resolution before final adoption of the inventory. The results are released at national level in advance of their official submission to the European Commission in accordance with Decision 280/2004/EC in January of the reporting year and subsequently to the UNFCCC secretariat. For the 2008/2009 reporting cycle, the inventory agency was able to comply with a request from Government to produce preliminary greenhouse gas emissions estimates for 2007 by mid October 2008. | Ireland National Inventory Report 2009,GHG emissions 1990-2007 reported to the UNFCCC Mar 2009<br>pp.6-7 |

| MS | Institutional arrangements/national systems | Source |
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| Italy | A Legislative Decree, issued on 7th March 2008, institutes the National System for the Italian Greenhouse Gas Inventory. The Institut of Environmental Protectioen and Research (ISPRA), former Agency for Environmental Protection and Technical Services (APAT) is the single entity in charge of the development and compilation of the national greenhouse gas emission inventory. The Ministry for the Environment, Land and Sea is responsible for the endorsement of the inventory and for the communication to the Secretariat of the Framework Convention on Climate Change and the Kyoto Protocol. The inventory is also submitted to the European Commission in the framework of the Greenhouse Gas Monitoring Mechanism.<br>The Institute annually develops a national system document which includes all updated information on institutional, legal and procedural arrangements for estimating emissions and removals of greenhouse gases and for reporting and archiving inventory information. The last year report is publicly available at: http://www.apat.gov.it/site/_files/NationalSystemItaly08.pdf.<br>A specific unit of the Agency is responsible for the compilation of the Italian Atmospheric Emission Inventory and the Italian Greenhouse Gas Inventory in the framework of both the Convention on Climate Change and the Convention on Long Range Transboundary Air Pollution.<br>The whole inventory is compiled by the agency; scientific and technical institutions and consultants may help in improving information both on activity data and emission factors of some specific activities. All the measures to guarantee and improve the transparency, consistency, comparability, accuracy and completeness of the inventory are undertaken.<br>ISPRA bears the responsibility for the general administration of the inventory, co-ordinates participation in reviews, publishes and archives the inventory results.<br>Specifically, ISPRA is responsible for all aspects of national inventory preparation, reporting and quality management. Activities include the collection and processing of data from different data sources, the selection of appropriate emissions factors and estimation methods consistent with the IPCC 1996 Revised Guidelines, the IPCC Good Practice Guidance and Uncertainty management and the IPCC Good Practice Guidance for land use, land- use change and forestry, the compilation of the inventory following the QA/QC procedures, the assessment of uncertainty, the preparation of the National Inventory Report and the reporting through the Common Reporting Format, the response to the review process, the updating and data storage.<br>Different institutions are responsible for statistical basic data and data publication, which are primary to ISPRA for carrying out emission estimates. These institutions are part of the National Statistical System (Sistan), which provides national official statistics, and therefore are asked periodically to update statistics; moreover, the National Statistical System ensures the homogeneity of the methods used for official statistics data through a coordination plan, involving the entire public administration at central, regional and local levels.<br>The National Statistical System is coordinated by the Italian National Institute of Statistics (ISTAT). Ministries, public agencies and other bodies are obliged to provide the data and information specified in the annual statistical plan; the same obligations regard the private entities. All the data are protected by the principles of statistical disclosure control and can be distributed and communicated only at aggregate level. The main Sistan products, which are primarily necessary for the inventory compilation, are:<br>• National Statistical Yearbooks, Monthly Statistical Bulletins, by ISTAT (National Institute of Statistics)<br>• Annual Report on the Energy and Environment, by ENEA (Agency for New Technologies, Energy and the Environment)<br>• National Energy Balance (annual), Petrochemical Bulletin (quarterly publication), by MSE (Ministry of Economic Development)<br>• Transport Statistics Yearbooks, by MINT (Ministry of Transportation)<br>• Annual Statistics on Electrical Energy in Italy, by TERNA (National Independent System Operator)<br>• Annual Report on Waste, by ISPRA<br>• National Forestry Inventory, by MIPAAF (Ministry of Agriculture, Food and Forest Policies).<br>• The national emission inventory itself is a Sistan product. | Italian Greenhouse Gas Inventory<br>1990-2007<br>National Inventory Report 2009, Apr 2009, pp.20-23 |

| MS | Institutional arrangements/national systems | Source |
|---|---|---|
| Luxembourg | A Grand-Ducal Regulation designates a Single National Entity, the National Inventory Compiler and the National GHG Inventory Focal Point. It also defines and allocates specific responsibilities for the realization of the GHG Inventories both within the Single National Entity and within the other administrations and/or services that are involved in the inventory preparation in the future.<br>The Department of the Environment of the Ministry of Sustainable Development and Infrastructures (MDDI-DEV) is acting as UNFCCC National Focal Point. Thus, the "political" responsibility lies with the MDDI-DEV and it is the Ministry that officially submits the inventories and their related reports to the UNFCCC Secretariat and the European Commission (see Article 8 of the Regulation).<br>In addition, the regulation designates the Environment Agency (Administration de l'Environnement, AEV) as the "Single National Entity with overall responsibility for the GHG Inventory". Overall management of the Single National Entity is assigned to one staff member of the Environment Agency that is nominated GHG Inventory Focal Point. The Agency also acts as "National Inventory Compiler" compiling and checking the information and GHG emission estimates coming from sector experts working within the AEV or in other administrations or services. The Environment Agency has therefore the "technical" knowledge and responsibility for the GHG Inventories.<br>Luxembourg has, thus, adopted an "integrated approach" to avoid redundant and overlapping activities in different administrative services. This concentration of air emission reporting in one department also allows an improved consistency between different reporting schemes (UNFCCC, EU-MMD, EU-PRTR, EU-LCPD, EU-ETS, UNECE-CLRTAP and EU-NECD). | National Inventory Report 1990-2008 Luxembourg<br>May 2010<br>pp.30-35 |
| Netherlands | The Ministry of Infrastructure and Environment (IenM) has overall responsibility for climate change policy issues including the preparation of the inventory. In August 2004, VROM assigned SenterNovem (now NL agency) executive tasks bearing on the National Inventory Entity (NIE), the single national entity required under the Kyoto Protocol. In December 2005, SenterNovem (now NL Agency) was designated by law as the NIE. In addition to coordinating the establishment and maintenance of a National System, the tasks of NL Agency include overall coordination of improved QA/QC activities as part of the National System and coordination of the support/response to the UNFCCC review process. The National System is described in more detail in the (Fourth and Fifth National Communication (VROM, 2009). Since 1 January 2010, RIVM has been assigned by IenM to take over the role of PBL as coordinating institute for compiling and maintaining the pollutants emission register/inventory (PRTR system), containing about 350 pollutants including the greenhouse gases. The PRTR project system is used as basis for the NIR and for filling the CRF. After the general elections in the Netherlands on 2010, the responsibilities of the former VROM moved to the restructured Ministry of Infrastructure and Environment (IenM)..<br>The Dutch Pollutant Release & Transfer Register (PRTR) has been in operation in the Netherlands since 1974. This system encompasses data collection, data processing and registering and reporting emission data for some 350 policy-relevant compounds and compound groups that are present in air, water and soil. The emission data is produced in an annual (project) cycle (MNP, 2006). This system is also the basis for the national greenhouse gas inventory. The overall coordination of the PRTR was outsourced by (IenM) to the RIVM. The main objective of the PRTR is to produce an annual set of unequivocal emission data that is up-to-date, complete, transparent, comparable, consistent and accurate. In addition to RIVM, various external agencies contribute to the PRTR by performing calculations or submitting activity data. These include: CBS (Statistics Netherlands), PBL, TNO (Netherlands Organisation for Applied Scientific Research), NL Agency, Centre for Water Management, Deltares and several institutes related to the Wageningen University and Research Centre (WUR).<br>The NIR part 1 is prepared by RIVM as part of the PRTR project. Most institutes involved in the PRTR also contribute to the NIR (including CBS and TNO). In addition, NL Agency is involved in its role as NIE. NL Agency also prepares the NIR part 2 and takes care of integration and submission to the UNFCCC in its role as NIE. Submission to the UNFCCC only takes place after approval by IenM. | Greenhouse Gas Emissions in the Netherlands 1990-2009<br>Jan 2011<br>Introduction |

| MS | Institutional arrangements/national systems | Source |
|---|---|---|
| **Portugal** | In order to comply with the commitments at the international and EC levels, respectively, the Article 5(1) of the Kyoto Protocol and Decision 280/2004/EC of the European Parliament and of the Council, a National Inventory System of Emissions by Sources and Removals by Sinks of Air Pollutants - (SNIERPA) was created. This system contains a set of legal, institutional and procedural arrangements that aim at ensuring the accurate estimation of emissions by sources and removals by sinks of air pollutants, as well as the communication and archiving of all relevant information.<br>The principal objective of the national system is to prepare and ensure the transparency, consistency, comparability, completeness, accuracy and timeliness of the inventory of air pollutants (INERPA), in accordance with the directives defined at international and EC levels, in order to make easier and more cost-effective the tasks of inventory planning, implementation and management,<br>The system was established through Council of Ministers Resolution 68/2005, of 17 March, which defines the entities relevant for its implementation, based on the principle of institutional cooperation. This clear allocation of responsibilities is essential to ensure the inventory takes place within the defined deadlines.<br>For the sake of efficiency, the Portuguese national system has been broadened to include a wider group of air pollutants than just GHG not covered by the Montreal Protocol, allowing for improvements in information quality, as well as an optimisation of human and material resources applied to the preparation of the inventory.<br>Three bodies are established with differentiated responsibilities. These are:<br>1. The Portuguese Environmental Agency (APA)/ Ministry of Ministry for the Environment and Land Use Planning, is the Responsible Body responsible for: the overall coordination and updating of the National Inventory of Emissions by Sources and Removals by Sinks of Air Pollutants (INERPA); the inventory's approval, after consulting the Focal Points and the involved entities; and its submission to EC and international bodies to which Portugal is associated, in the several communication and information formats, thus ensuring compliance with the adopted requirements and directives.<br>2. InventAr, Estudos e Projectos Unip Lda, was contracted by APA to work in close collaboration with the inventory team on the calculation of emission estimates and the elaboration of the NIR and the compilation of the CRF tables.<br>3. Ecoprogresso, Consultores em Ambiente e Desenvolvimento, was contracted by APA to apply QC procedures and to work and support the inventory unit on the development of a methodological approach and the implementation of a procedure to quantify KP-LULUCF activities.<br>The sectoral Focal Points work with APA in the preparation of INERPA, and are responsible for fostering intra and inter-sectoral cooperation to ensure a more efficient use of resources. Their main task includes coordinating the work and participation of the relevant sectoral entities over which it has jurisdiction. It is also the Focal Points duty to provide expert advice on methodological choice, emission factor determination and accuracy of the activity data used. Focal Points play a vital role in sectoral quality assurance and methodological development.<br>The involved entities are public or private bodies which generate or hold information which is relevant to the INERPA, and which actions are subordinate to the Focal Points or directly to the Responsible Body.<br>All governmental entities have the responsibility to ensure, at a minimum, co-funding of the investment needed to ensure the accuracy, completeness and reliability of the emissions inventory.<br>The RCM also includes a procedure for the official consideration of the inventory. This consideration is done at the level of the designated representatives of Focal Points and Involved Entities.<br>The SNIERPA is composed of three technical elements:<br>1. A Quality Control and Quality Assurance System (QA/QC System)<br>2. A Methodological Development Programme (MDP), and<br>3. An integrated IT system for the management (SIGA) of the SNIERPA (this last not yet implemented). | Short Portuguese National Inventory Report on Greenhouse Gases, 1990-2009, Jan 2011, pp. 5ff |

| MS | Institutional arrangements/national systems | Source |
|---|---|---|
| Spain | The “Directorate-General for Environmental Quality and Evaluation at the Ministry of the Environment” (DGCEA) is the National Authority for the National Air Pollutant Emissions Inventory System.<br>The air pollutant emissions inventories are considered to be statistics for State purposes and as such, in accordance with article 149.1.31 of the Spanish Constitution, are performed on the basis of the exclusive responsibility of the State. In this sense, the regulatory frame of reference is provided by the Spanish Public Statistical Function Act (Law 12 dated May 9th, 1989) and by the 2005-2008 National Statistical Plan, approved by Royal Decree 1 911 dated September 17th, 2004.<br>With regard to data collection, Law 12/1989 establishes two different regimes for the regulation of statistics depending on whether data are demanded in a compulsory manner or individuals are free to provide information voluntarily. Since they form part of the National Statistical Plan and their preparation represents an obligation for the Spanish State under European Union regulations, emissions inventories fall into the first of these two regimes, i.e. the submission of data by individuals is compulsory.<br>The DGCEA is the national entity under the Spanish national inventory system. It is technically supported by the company Análisis Estadístico de Datos, S.A. (AED). Further, DGCEA cooperates with Research Institutes and University Departments, e.g. with Sistema y Technoligías de la Producción Animal-Universidad Politécnica de Valencia (STEPA-UPV) for the sector agriculture or Tecnologías y Servicios Agrarios, S.A. (TRAGSATEC) for LULUCF. In addition, several ministries participate in the NIS:<br>• Ministry of Agriculture, fisheries and food (Agriculture)<br>• Ministry of Industry, Tourism and Trade (Energy and Industrial Processes)<br>• The Tax Ministry (general statistics (e.g. census))<br>• Ministry of Public Safty (Transport Statistics)<br>• Ministry of Development (Transport) | Inventario de Emisiones de gases de efecto invernadero de España, años<br>1990-2009<br>Jan 2011, pp. 1.5ff<br>(submitted in Spanish, translated) |

| MS | Institutional arrangements/national systems | Source |
|---|---|---|
| **Sweden** | The Swedish Ministry of Environment is the single national entity and has overall responsibility and submits the inventory report to the European Commission and to the UNFCCC secretariat. The Swedish Environmental Protection Agency (Swedish EPA) co-ordinates the activities for developing the inventory report and is also responsible for the final quality control and quality assurance of the data before it is submitted.<br>A consortium called Swedish Environmental Emissions Data (SMED) conducts the inventory and reporting under a framework contract between the Swedish Environmental Protection Agency and SMED. The contract runs from 2005 and for nine years and thus covers the first commitment period under the Kyoto Protocol. SMED is composed of Statistics Sweden, the Swedish Meteorological and Hydrological Institute (SMHI), the Swedish Environmental Research Institute AB (IVL) and the Swedish University of Agricultural Sciences (SLU).<br>A national system meeting the requirements laid down in article 5.1 of the Kyoto Protocol has been developed and is confirmed as Ordinance (2005:626) Concerning Climate Reporting. This ordinance provides the basis for the national system and describes the roles and responsibilities of the government agencies in the context of climate reporting.<br>The process of inventory preparation is carried out differently for the different sectors:<br>ENERGY- STATIONARY COMBUSTION: Activity data is collected for the following subgroups:<br>Energy industries: Data from quarterly fuel statistics, a total survey conducted by Statistics Sweden at plant level and by fuel type. For some petroleum refining plants, data from the European Union Emission Trading Scheme (ETS) is used.<br>Manufacturing industries: Data mainly from the quarterly fuel statistics, a sample survey conducted by Statistics Sweden. In some cases data from the industrial energy statistics is used as a complement. All data is at plant level and by fuel type.<br>Other sectors: Data from official statistical reports prepared by Statistics Sweden at national level and by fuel type.<br>ENERGY- MOBILE COMBUSTION: Data on fuel consumption at national level and by fuel type is collected and used in combination with emissions data and fuel data from the National Road Administration, the National Rail Administration, the Civil Aviation Administration and the Swedish Military.<br>INDUSTRIAL PROCESSES: The reported data for industrial processes is mainly based on information from environmental reports. The data in the environmental reports refer to emissions derived from plant specific measurements or estimates such as mass balances. The use of default emission factors is limited.<br>SOLVENT AND OTHER PRODUCT USE: Data used for estimating emissions from solvent and other product use are based on emission factors and national activity data obtained from the Products register kept by the Swedish Chemicals Agency.<br>AGRICULTURE: Data on animal numbers, crop areas, yields, sales of manure, manure management and stable periods are taken from official statistical reports published by the Swedish Board of Agriculture and Statistics Sweden. Some complementary information is collected from organisations and researchers, such as the Swedish Dairy Association, Swedish Poultry Meat Association, SLU and the Swedish Institute of Agricultural and Environmental Engineering.<br>LAND USE, LAND USE CHANGE AND FORESTRY: Estimates presented in the LULUCF sector are mainly based on data from the SLU. The SLU is responsible for the National Forest Inventory, which focuses on living biomass, and for the Swedish Forest Soil Inventory, that focuses on dry organic matter and on soil organic carbon. The two inventories are integrated and use the same infrastructure for the field sample.<br>WASTE: Statistics on deposited waste quantities, methane recovery and nitrogen emissions from wastewater handling, are provided by the Swedish Association of Waste Management (Avfall Sverige, former RVF), Statistics Sweden, the Swedish Forest Industries Federation and the Swedish EPA. If new data on organic content in household waste or other relevant research is published, such reports are also considered.<br>A new system for handling emission data, entitled TPS, has been developed and used for the first time in submission 2007. It supports data input from Microsoft Excel sheets, and provides different types of quality gateways. | National Inventory Report Sweden 2011<br>Jan 2011<br>pp.33ff |

| MS | Institutional arrangements/national systems | Source |
|---|---|---|
| United Kingdom | The UK Greenhouse Gas Inventory is compiled and maintained by AEA of AEA Technology plc – the Inventory Agency - under contract with the Climate, Energy, Science and Analysis (CESA) Division in the UK Department of Energy and Climate Change (DECC). AEA is directly responsible for producing the emissions estimates for CRF categories Energy (CRF sector 1), Industrial Processes (CRF sector 2), Solvent and Other Product Use (CRF sector 3), and Waste (CRF Sector 6). AEA is also responsible for inventory planning, data collection, QA/QC and inventory management and archiving. Agricultural sector emissions (CRF sector 4) are produced by the Defra's Land Management Improvement Division via a contract with North Wyke Research. Land-Use Change and Forestry emissions (CRF sector 5) are calculated by the UK Centre for Ecology and Hydrology (CEH), under separate contract to CESA (DECC).<br>DECC is the Single National Entity responsible for submitting the UK's greenhouse gas inventory (GHGI) to the UNFCCC. AEA compiles the GHGI on behalf of DECC, and produces disaggregated estimates for the Devolved Administrations within the UK.<br>Key Data Providers include other Government Departments such as Department for Environment, Food and Rural Affairs (Defra) and Department for Transport (DfT), Non-Departmental Public Bodies such as the Environment Agency for England and Wales (EA) and the Scottish Environmental Protection Agency (SEPA), private companies such as Corus, and business organisations such as UK Petroleum Industry Association (UKPIA).<br>As the designated Single National Entity for the UK GHG National Inventory System (NIS), DECC has the following roles and responsibilities:<br>• National Inventory System Management and Planning (overall control of the NIS development and function; management of contracts and delivery of GHG inventory; definition of performance criteria for NIS key organisations)<br>• Development of Legal & Contractual Infrastructure (review of legal and organisational structure; implementation of legal instruments and contractual developments as required to meet guidelines.)<br>• As the designated Inventory Agency for the UK GHG National Inventory System, AEA has the following roles and responsibilities:<br>• Planning (Co-ordination with DECC to deliver the NIS, Review of current NIS performance and assessment of required development action, and Scheduling of tasks and responsibilities to deliver GHG inventory and NIS.<br>• Preparation (drafting of agreements with key data providers; review of source data and identification of developments required to improve GHG inventory data quality.<br>• Management (documentation and archiving; dissemination of information regarding NIS to Key Data Providers; management of inventory QA/QC plans, programmes and activities).<br>• Inventory Compilation (data acquisition, processing and reporting; delivery of NIR) | UK Greenhouse Gas Inventory 1990-2011 Short NIR,<br>Jan 2010<br>pp. 4-7 |

### *1.1.3 The European Commission, Directorate-General Climate Action*

The European Commission's DG Climate Action in consultation with the Member States has the overall responsibility for the EU inventory. Member States are required to submit their national inventories and inventory reports under Council Decision No 280/2004/EC to the European Commission, DG Climate Action; and the European Commission, DG Climate Action itself submits the inventory and inventory report of the EU to the UNFCCC Secretariat. In the actual compilation of the EU inventory and inventory report, the European Commission, DG Climate Action, is assisted by the EEA including its ETC/ACM and by Eurostat and the JRC.

The consultation between the DG Climate Action and the Member States takes place in the Climate Change Committee established under Article 9 of Council Decision No 280/2004/EC. The Committee is composed of the representatives of the Member States and chaired by the representative of the DG Climate Action. Procedures within the Committee for decision-making, adoption of measures and voting are outlined in the rules of procedure, adopted in November 2003. In order to facilitate decision-making in the Committee, three working groups have been established: Working Group 1 'Annual inventories', Working Group 2 'Assessment of progress (effect of policies and measures, projections)' and Working Group 3 'Emission trading'.

The objectives and tasks of Working Group 1 under the Climate Change Committee include:

- the promotion of the timely delivery of national annual GHG inventories as required under the monitoring mechanism;
- the improvement of the quality of GHG inventories on all relevant aspects (transparency, consistency, comparability, completeness, accuracy and use of good practices);
- the exchange of practical experience on inventory preparation, on all quality aspects and on the use of national methodologies for GHG estimation;
- the evaluation of the current organisational aspects of the preparation process of the EU inventory and the preparation of proposals for improvements where needed.

### *1.1.4 The European Environment Agency*

The European Environment Agency assists the European Commission, DG Climate Action, in the compilation of the annual EU inventory through the work of the ETC/ACM. The activities of the ETC/ACM include:

- initial checks of Member States' submissions in cooperation with Eurostat, and the JRC, up to 28 February and compilation of results from initial checks (status reports, consistency and completeness reports);
- consultation with Member States in order to clarify data and other information provided;
- preparation and circulation of the draft EU inventory and inventory report by 28 February based on Member States' submissions;
- preparation of the final EU inventory and inventory report by 15 April (to be submitted by the Commission to the UNFCCC Secretariat);
- assisting Member States in their reporting of GHG inventories by means of supplying software tools.

The tasks of the EEA and the ETC/ACM are facilitated by the European environmental information and observation network (Eionet), which consists of the EEA as central node (supported by European topic centres) and national institutions in the EEA member countries that supply and/or analyse national data on the environment (see http://eionet.eea.eu.int/). The Member States are encouraged to use the central data repository under the Eionet for making available their GHG submissions to the European Commission and the ETC/ACM (see http://cdr.eionet.eu.int/).

### *1.1.5 The European Topic Centre on Air Pollution and Climate Change Mitigation*

The European Topic Centre on Air and Climate Change Mitigation (ETC/ACM) was established by a contract between the lead organisation Institute for Public Health and the Environment (RIVM) in the Netherlands and EEA for the years 2011-2013. The ETC/ACM involves 10 organisations and institutions in eight European countries. The technical annex for the 2011 work plan for the ETC/ACM and an implementation plan specify the specific tasks of the ETC/ACM partner organisations with regard to the preparation of the EU inventory. Umweltbundesamt Austria is the task leader for the compilation of the EU annual inventory in the ETC/ACM, including all tasks mentioned above.

The ETC/ACM provides software tools for Member States to compile national GHG inventories and to convert their national inventory from Corinair-SNAP source category codes into the required CRF source categories. The main software tools are CollectER, for compiling and updating national emission inventories, and ReportER, for reporting the emissions in the required format, e.g. CRF. In addition, separate software tools are available to prepare estimates of emissions from agriculture and road transport. These tools are being used by several Member States. The ETC/ACM adapts the tools regularly to the latest changes in reporting requirements. The tools are available at http://acm.eionet.eu.int/.

### 1.1.6 Eurostat

Based on Eurostat energy balance data, Eurostat compiles annually by 31 March estimates of the EU $CO_2$ emissions from fossil fuels using the IPCC reference approach. Eurostat compares these estimates with national estimates of $CO_2$ emissions from fossil fuels prepared by Member States and provides information summarising and explaining these differences. In order to improve the consistency of Member State and Eurostat energy data, a project on harmonisation of energy balances has started between Eurostat and national statistical offices. In addition, Eurostat is leading an EU project aimed at improving estimates of GHG emissions from international aviation.

### 1.1.7 Joint Research Center

The Joint Research Centre (JRC) assists in the improvement of methodologies for the land-use, land-use change and forestry (LULUCF) sector. It does so (1) by inter-comparing methodologies used by the Member States for estimating emissions and removals with a focus on LULUCF and (2) by providing EU-wide estimates with various models/methods for emissions and removals with a focus on LULUCF. For this reason, methods using inverse modelling for $CH_4$ emissions are currently under development. In addition, the JRC is leading a project for improving the methodologies used for estimating GHG emissions from agriculture with a focus on the $N_2O$ emissions of agriculture soils, the source contributing most to the overall uncertainty of the EU inventory.

## 1.2 A description of the process of inventory preparation

The annual process of compilation of the EU inventory is summarised in Table 1.3. The Member States should submit their annual GHG inventory by 15 January each year to the European Commission's DG Climate Action. Then, the ETC/ACM, Eurostat and the JRC perform initial checks of the submitted data up to 28 February. The ETC/ACM transfers the nationally submitted data from the xml-files into the CRF aggregator database which was developped for aggregating the EU submission from member state (MS) submissions. From the CRF aggregator the aggregated EU inventory is transferred into the CRF reporter software for preparing the official EU GHG inventory submission.

**Table 1.3 Annual process of submission and review of Member States inventories and compilation of the EU inventory**

| Element | Who | When | What |
|---|---|---|---|
| 1. Submission of annual greenhouse gas inventories (complete common reporting format (CRF) submission and elements of the national inventory report) by Member States under Council Decision No 280/2004/EC | Member States | 15 January | Elements listed in Article 3(1) of Decision 280/2004/EC as elaborated in Articles 2 to7 in particular:<br>Greenhouse gas emissions by sources and removals by sinks, for the year n –2<br>And updated time series 1990- year n –3, depending on recalculations;<br>Core elements of the NIR<br>Steps taken to improve estimates in areas that were previously adjusted under Article 5.2 of the Kyoto Protocol (for reporting under the Kyoto Protocol) |
| 2. 'Initial check' of Member States' submissions | Commission (incl. Eurostat, the JRC), assisted by the EEA | As soon as possible after receipt of Member State data, at the latest by 1 April | Initial checks and consistency checks (by EEA). Comparison of energy data provided by Member States on the basis of the IPCC Reference Approach with Eurostat energy data (by Eurostat and Member States) and check of Member States' agriculture and land use, land-use change and forestry (LULUCF) inventories by DG JRC (in consultation with Member States). |
| 3. Compilation of draft EU inventory | Commission (incl. Eurostat, the JRC), assisted by the EEA | up to 28 February | Draft EU inventory (by EEA), based on Member States' inventories and additional information where needed. |

| Element | Who | When | What |
| --- | --- | --- | --- |
| 4. Circulation of draft EU inventory | Commission (DG Climate Action) assisted by the EEA | 28 February | Circulation of the draft EU inventory on 28 February to Member States. Member States check data. |
| 5. Submission of updated or additional inventory data and complete national inventory reports by Member States | Member States | 15 March | Updated or additional inventory data submitted by Member States (to remove inconsistencies or fill gaps) and complete final national inventory reports. |
| 6. Estimates for data missing from a national inventory | Commission (DG Climate Action) assisted by EEA | 31 March | The Commission prepares estimates for missing data by 31 March of the reporting year, following consultation with the Member State concerned, and communicate these to the Member States. |
| 7. Comments from Member States regarding the Commission estimates for missing data | Member States | 8 April | Member States provide comments on the Commission estimates for missing data, for consideration by the Commission. |
| 8. Final annual EU inventory (incl. EU inventory report) | Commission (DG Climate Action) assisted by EEA | 15 April | Submission to UNFCCC of the final annual EU inventory. This inventory will also be used to evaluate progress as part of the monitoring mechanism. |
| 9. Circulation of initial check results of the EU submission to Member States | Commission (DG Climate Action) assisted by EEA | As soon as possible after receipt of initial check results | Commission circulates the initial check results of the EU submission as soon as possible after their receipt to those Member States, which are affected by the initial checks. |
| 10. Response of relevant Member States to initial check results of the EU submission | Member States | Within one week from receipt of the findings | The Member States, for which the initial check indicated problems or inconsistencies provide their responses to the initial check to the Commission. |
| 11. Any resubmissions by Member States in response to the UNFCCC initial checks | Member States | For each Member State, same as under the UNFCCC initial checks phase Under the Kyoto Protocol: the resubmission should be provided to the Commission within five weeks of the submission due date. | Member States provide to the Commission the resubmissions which they submit to the UNFCCC Secretariat in response to the UNFCCC initial checks. The Member States should clearly specify which parts have been revised in order to facilitate the use for the EU resubmission.<br>As the EU resubmission also has to comply with the deadlines specified in the guidelines under Article 8 of the Kyoto Protocol, the resubmission has to be sent to the Commission earlier than the period foreseen in the guidelines under Article 8 of the Kyoto Protocol, provided that the resubmission correct data or information that is used for the compilation of the EU inventory. |
| 12. Submission of any other resubmission after the initial check phase | Member States | When additional resubmissions occur | Member States provide to the Commission any other resubmission (CRF or national inventory report) which they provide to the UNFCCC Secretariat after the initial check phase. |

On 28 February, the draft EU GHG inventory and inventory report are circulated to the Member States for review and comment. The Member States check their national data and information used in the EU inventory report and send updates, if necessary, and review the EU inventory report by 15 March. This procedure should assure the timely submission of the EU GHG inventory and inventory report to the UNFCCC Secretariat and it should guarantee that the EU submission to the UNFCCC Secretariat is consistent with the Member State UNFCCC submissions.

The final EU GHG inventory and inventory report is prepared by the ETC/ACM by 15 April for submission to the UNFCCC Secretariat. Resubmissions of the EU GHG inventory and inventory report are prepared by 27 May, if needed. By 15 May, Member States should provide to the Commission any resubmission in response to the UNFCCC initial checks which affects the EU inventory, in order to guarantee that the EU resubmission to the UNFCCC Secretariat is consistent with the Member States' resubmissions. In June the inventory and the inventory report are published on the EEA website (http://www.eea.europa.eu) and the data are made available through the EEA data warehouse (http://dataservice.eea.europa.eu/dataservice).

## 1.3 General description of methodologies and data sources used

### *1.3.1 The compilation of the EU GHG inventory*

The EU inventory is compiled in accordance with the recommendations for inventories set out in the 'UNFCCC guidelines for the preparation of national communications by parties included in Annex 1 to the Convention, Part 1: UNFCCC reporting guidelines on annual inventories' (FCCC/SBSTA/2004/8), to the extent possible. In addition, the *Revised IPCC 1996 guidelines for national greenhouse gas inventories* have been applied as well as the *IPCC Good practice guidance and uncertainty management in national greenhouse gas inventories*, where appropriate and feasible. In addition, for the compilation of the EU GHG inventory, Council Decision No 280/2004/EC and the Commission Decision 2005/166/EC.

The EU-15 GHG gas inventory is compiled on the basis of the inventories of the 15 Member States. The emissions of each source category are the sum of the emissions of the respective source and sink categories of the 15 Member States. This is also valid for the base year estimate of the EU-15 as fixed in the initial review report. Table 1.4 shows the base year emissions for EU-15 Member States and EU-15 as fixed in the respective initial review reports.

**Table 1.4 Base year emissions for EU-15 Member States and EU-15**

| EU-15 MS | $CO_2$, $CH_4$, $N_2O$ | HFC, PFC, $SF_6$ | Base year emissions 1) (Tonnes $CO_2$ equivalents) |
|---|---|---|---|
| Austria | 1990 | 1990 | 79,049,657 |
| Belgium | 1990 | 1995 | 145,728,763 |
| Denmark 2) | 1990 | 1995 | 69,323,336 |
| Finland | 1990 | 1995 | 71,003,509 |
| France | 1990 | 1990 | 563,925,328 |
| Germany | 1990 | 1995 | 1,232,429,543 |
| Greece | 1990 | 1995 | 106,987,169 |
| Ireland | 1990 | 1995 | 55,607,836 |
| Italy | 1990 | 1990 | 516,850,887 |
| Luxembourg | 1990 | 1995 | 13,167,499 |
| Netherlands | 1990 | 1995 | 213,034,498 |
| Portugal | 1990 | 1995 | 60,147,642 |
| Spain | 1990 | 1995 | 289,773,205 |
| Sweden | 1990 | 1995 | 72,151,646 |
| United Kingdom 2) | 1990 | 1995 | 776,337,201 |
| EU-15 | 1990 | 1990 (AT, FR, IT)<br>1995 (other MS) | 4,265,517,719 |

*Source: Initial review reports of the EU-15 Member States (www.unfccc.int)*
*Base-year emissions exclude emissions and removals from the LULUCF sector but include emissions due to deforestation in the case of Member States for which LULUCF constituted a net source of emissions in 1990.*
*The base year emissions relate to the EU territory of Denmark and the UK.*

Of the EU-15 Member States, 12 Member States have chosen 1995 as the base year for fluorinated gases while Austria, France and Italy have chosen 1990. Therefore, the EU-15 base year estimates for fluorinated gas emissions are the sum of 1995 emissions for 12 Member States and 1990 emissions for Austria, France and Italy. The EU-15 base year emissions also include emissions from deforestation for Ireland, the Netherlands, Portugal and the UK.

The reference approach is calculated for the EU-15 on the basis of Eurostat energy data (see Section 3.6) and the key category analysis (Section 1.5) is separately performed at EU-15 level (11).

Since Member States use different national methodologies, national activity data or country-specific emission factors in accordance with IPCC and UNFCCC guidelines, these methodologies are reflected in the EU GHG inventory data. The EU believes that it is consistent with the UNFCCC reporting guidelines and the IPCC good practice guidance to use different methodologies for one source category across the EU especially if this helps to reduce uncertainty and improve consistency of the emissions data provided that each methodology is consistent with the IPCC good practice guidance.

In general, no separate methodological information is provided at EU level except summaries of methodologies used by Member States. However, for some sectors quality improvement projects have been organised/are ongoing with the aim of further improving estimates at Member State level. These sectors include energy background data, emissions from international bunkers, emissions and removals from LULUCF, emissions from industrial processes, agriculture and waste.

The EU-15 CRF Table Summary 3 in Annex 1.2 provides information on methodologies and emission factors used by the Member States. These tables have been compiled on the basis of the information provided by the Member States in their CRF Table Summary 3. In addition, information on methods, activity data and emission factors was used which was provided by the Member States in accordance with Annex I of Commission Decision 2005/166/EC. The sector-specific chapters list the methodologies and emission factors used by the Member States for each EU key source.

Detailed information on methodologies used by the Member States is available in the Member States national inventory reports, which are included in Annex 1.12. Note that all Member States' submissions (CRF tables and national inventory reports), which are included in Annex 1.12 and made available at the EEA website, are considered to be part of the EU submission.

#### 1.3.1.1 Internal consistency of the EU CRF tables

In principle every single EU value is aggregated from the respective value of the EU Member States. However, sometimes there are consistency problems when compiling the EU CRF tables (i.e. the sum of sub-categories is not equal to the category total) in those categories where Member States have difficulties to allocate emissions to the sub-categories. Member States use notation keys like IE or C if they cannot provide an emission estimate for a certain sub-category. At Member State level, the use of the notation keys makes transparent the reason for not providing emission estimates. However, at EU-15 level, the sub-category emission value is the sum of Member States emission values and the information of the notation keys used by some Member States is lost in the EU-15 CRF submission. In order to make this more transparent, the CRF tables now include the values or notation keys reported by the MS as comments. In addition, Annexes 1.4-1.10 of this report include the CRF tables for the sectors for each EU-15 Member State. In order to address this problem, some source categories have been reallocated for the EU CRF tables.

A second problem is the reporting of Member States in "grey cells" which need to be included in the CRF reporter manually.

A third problem occurs where MS report potential fluorinated gas emissions but do not report actual emissions. In these cases the potential emissions are included in the national totals, but they are lost when aggregating the EU actual emissions. Therefore, the potential emissions are added manually into the CRF reporter for these Member States. Table 1.5 lists the procedures applied for the EU-15 Member States.

(11) However, the choice of the emission calculation methodology is made at Member State level and is based on the key category analysis of each individual Member State.

## Table 1.5 Manual changes in the CRF Reporter

| CRF Table | Member State | Year | Sector | Source category | Parameter | Manual changes/inclusion in the CRF reporter |
|---|---|---|---|---|---|---|
| Table1A(a) | MT | 1990-2009 | Energy | 1.A.2.F | AD, CO2 | Include MT 1A2F under 1A2F liquid fuels (no fuel split given) |
| Table1B2 | SE | 1990-2009 | Energy | 1.B.2.a.5 | N2O | Include SE emissions from 1.B.2.A.5 under 1.B.2.A.6 |
| Table1B2 | GB | 1990-2009 | Energy | 1.B.2.b.1 | N2O | Add pollutant N2O under 1B2b1 and include emissions from grey cells. |
| Table1 | DE | 1990-1997 | Energy | 1.B.2.b | CO | Include DE emissions from 1.B.2.b under 1.B.2.d 'Other non-specified' |
| | EU | 1990-2009 | Energy | 1.AB | all | CRF Reporter: Enter Reference Approach and delete MS comments |
| Table1B2 | RO | 1990-2009 | Energy | 1.B.2.a.ii, 1.B.2.a | CO2 | Include gap-filling |
| Table1B2 | RO | 1990-2009 | Energy | 1.B.2.c.i | CH4 | Include gap-filling |
| Table2(I)s1 | DE, SE, PL | 1990-2009 | Ind. Processes | 2.A.1 | NOx, NMVOC, C | Add new gases under 2A1 and include emissions |
| Table2(I)s1 | DE | 1990-2009 | Ind. Processes | 2.A.2 | NOx, NMVOC, S | Add new gases under 2A2 and include DE emissions |
| Table2(I)s1 | SE | 1990-2009 | Ind. Processes | 2.A.2 | SO2 | Add pollutant SO2 under 2A2 and include emissions from grey cells |
| Table2(I)s1 | PT | 1990-2009 | Ind. Processes | 2.A.6 | CH4 | Include PT CH4 emissions from grey cells |
| Table2(I)s1 | EU | 1990-2009 | Ind. Processes | 2.A.7 | CO2, NOx, CO, | Exclude glass production from other non-specified and delete MS comments |
| Table2(I)s1 | HU | 1990-2003 | Ind. Processes | 2.B.2 | CO2 | Add pollutant CO2 under 2B2 and include emissions from grey cells (EEA finding). |
| Table2(I)s1 | EU | 1990-2009 | Ind. Processes | 2.B.5 | CO2, CH4 | Exclude 2.B.5.1 - 2.B.5.5 from other non-specified and delete MS comments |
| Table2(1).A-Gs | DE | 1990-2009 | Ind. Processes | 2.C.1.1 | N2O | Add pollutant N2O under 2C1 and include emissions from grey cells. |
| Table2(1).A-Gs | ES | 1990-2009 | Ind. Processes | 2.C.1.5 | N2O | Add pollutant N2O under 2C1 and include emissions from grey cells. |
| Table2(1).A-Gs | GB | 1990-2009 | Ind. Processes | 2.C.1.5 | N2O | Add pollutant N2O under 2C1 and include emissions from grey cells. |
| Table2(1).A-Gs | PL | 2005-2009 | Ind. Processes | 2.C.1.5 | N2O | Add pollutant N2O under 2C1 and include emissions from grey cells. |
| Table2(1).A-Gs | NO | 1990-2009 | Ind. Processes | 2.C.1.5 | N2O | Add pollutant N2O under 2C1 and include emissions from grey cells. |
| Table2(1).A-Gs | SE | 1990-2009 | Ind. Processes | 2.D.1 | CH4, N2O | Add pollutants CH4, N2O under 2D1 and include emissions from grey cells. |
| Table2(1).A-Gs | PL, NO | 2005-2009 | Ind. Processes | 2.D.1 | CO2 | Add pollutant CO2 under 2D1 and include emissions from grey cells. |
| Table2(II) | FR | 1990-2009 | Ind. Processes | 2.E.2 | HFC-365mcf | Include FR emissions from HFC-365mcf in CO2 equivalents and delete MS comments |
| Table2(II).E | EU | 1990-2009 | Ind. Processes | 2.E.3 | PFC-A | Be sure that EUC notation keys are the sum of MS notation keys (EEA finding) |
| Table2(II).F | EU | 1990-2009 | Ind. Processes | 2.F | all | CRF Reporter: Enter emissions from CRF table 2(II).F |
| Table2.F | FR | 2003-2009 | Ind. Processes | 2.F.2.1 | HFC-365mcf | Include FR emissions from HFC-365mcf under Unspecified mix of HFCs and delete MS comments |
| Table2(II) | EE | 2004-2009 | Ind. Processes | 2.F.2 | HFC-365mcf | Include EE emissions from HFC-365mcf under Unspecified mix of HFCs and delete MS comments |
| Table2(I)s1 | BG, CY, MT | 1990-2009 | Ind. Processes | 2.F.9 | HFC-P, PFC-P | Make sure that potential emissions are accounted for (run CRF Aggregator report 'APE') and include them under 2.F.9 |
| Table4s1 | LU, NL | 1990-2009 | Agriculture | 4.A.1 | CH4 | Add LU, NL mature dairy cattle under dairy cattle and delete MS comments |
| Table4.A | EU | 1990-2009 | Agriculture | 4.A | all | Enter additional information from SBDT4A, JRC (not population, except for cattle) |
| Table 4.As2 | EU | 1990-2009 | Agriculture | 4.A | all | Enter additional information from SBDT4As2, JRC (not population) |
| Table4s1 | LU, NL | 1990-2009 | Agriculture | 4.B.1 | CH4 | Add LU, NL mature non-dairy, young cattle under non-dairy cattle and delete MS comme |
| Table4.B(a) | EU | 1990-2009 | Agriculture | 4.B | all | Enter additional information from SBDT 4B(a), JRC (not population, except for cattle) |
| Table4.B(a)s2 | EU | 1990-2009 | Agriculture | 4.B | all | Enter additional information from SBDT 4B(a)s2, JRC (not population) |
| Table4.B(b) | EU | 1990-2009 | Agriculture | 4.B | all | Enter additional information from SBDT 4B(b), JRC (not population) |
| Table4s2 | ES | 1990-2009 | Agriculture | 4.D | Nox | Add pollutant NOx under 4D4 and include emissions from grey cells. |
| Table4.D | EU | 1990-2009 | Agriculture | 4.D | all | Enter additional information from SBDT 4D, JRC (only additional information - fraction) |
| Table4.E | EU | 1990-2009 | Agriculture | 4.E.1 | CH4, N2O | Be sure that EUC notation keys are the sum of MS notation keys (EEA finding) |
| Summary1A | ES, PT | 1990-2009 | Agriculture | 4.F.5 | SO2 | Add pollutant SO2 under 4F5 and include emissions from grey cells. |
| Table4.F | EU | 1990-2009 | Agriculture | 4.F | all | Enter additional information from SBDT 4F, JRC (not crop production, not biomass burne |
| 5(IV) | IS | 2003-2009 | LULUCF | 5.B | CO2 | Include additional information from 5.B |
| Table5 | FI | 1990-2009 | LULUCF | 5.G | CO2 | Include additional information from 5.G |
| Table5 | GB | 1990-2009 | LULUCF | 5.G | CO2 | Include additional information from 5.G |
| Table5 | CY | 1990-2009 | LULUCF | 5.G | CO2 | Include additional information from 5.G |
| Summary1.A | FR | 1990-2009 | LULUCF | 5.G | NMVOC, SO2 | Include additional information from 5.G |
| Table5 | FR | 1994-2009 | LULUCF | 5.G | CO2, CH4 | Include additional information from 5.G |
| Summary1.A | IT | 1990-2009 | LULUCF | 5.G | SO2 | Include additional information from 5.G |
| 5(III) | DE | 1990-2009 | LULUCF | 5.G | N2O | Include additional information from 5.G |
| 5(III) | PT | 1990-2009 | LULUCF | 5.G | N2O | Include additional information from 5.G |
| 5(IV) | DE | 1990-2009 | LULUCF | 5.G | CO2 | Include additional information from 5.G |
| 5(IV) | NL | 1990-2009 | LULUCF | 5.G | CO2 | Include additional information from 5.G |
| 5(IV) | NO | 1990-2009 | LULUCF | 5.G | CO2 | Include additional information from 5.G |
| 5(I) | IS | 1990-2009 | LULUCF | 5.G | N2O | Include additional information from 5.G |
| 5(II) | IS | 1990-2009 | LULUCF | 5.G | N2O | Include additional information from 5.G |
| Table6 | ES | 1990-2009 | Waste | 6.A.1 | N2O | Add pollutant N2O under 6A1 and include emissions from grey cells. |
| Table6 | ES | 1990-2009 | Waste | 6.A.3 | N2O, SO2 | Add pollutants N2O, SO2 under 6A3 and include emissions from grey cells. |
| Table6.A,C | IS | 1990-2009 | Waste | 6.C | CO2, CH4, N2O | Include aggregated emissions from 6.C under 6.C.2 Other |

### 1.3.2 Use of data from EU ETS for the purposes of the national GHG inventories in EU Member States

#### 1.3.2.1 Overview

In January 2005 the European Union Greenhouse Gas Emission Trading System (EU ETS) commenced operation as the largest multi-country, multi-sector Greenhouse Gas Emission Trading System world-wide. The scheme is based on Directive 2003/87/EC, which entered into force on 25 October 2003.The European emissions trading system (ETS) covers around 10,500 installations across the 27 Member States of the European Union. Article 14 of the Emission Trading (ET) Directive requires Member States to ensure that emissions are monitored in accordance with specific monitoring and reporting guidelines (MRG)12, which are legally binding. Since 1 January 2005, all installations covered by the ETS have been required to estimate and report their emissions. Data for the installations covered by the ETS are reported by plant operators to competent authorities since 2005 based on a monitoring plan elaborated by the company and agreed by the competent authority in accordance with the methodologies established in the monitoring and reporting guidelines. The monitoring plan covers the following elements:

a) the description of the installation and activities carried out by the installation to be monitored;
b) information on responsibilities for monitoring and reporting within the installation;
c) a list of emissions sources and source streams to be monitored for each activity carried out within the installation;
d) a description of the calculation based methodology or measurement based methodology to be used;
e) a list and description of the tiers for activity data, emission factors, oxidation and conversion factors for each of the source streams to be monitored;
f) a description of the measurement systems, and the specification and exact location of the measurement instruments to be used for each of the source streams to be monitored;
g) evidence demonstrating compliance with the uncertainty thresholds for activity data and other parameters (where applicable) for the applied tiers for each source stream;
h) if applicable, a description of the approach to be used for the sampling of fuel and materials for the determination of net calorific value, carbon content, emission factors, oxidation and conversion factor and biomass content for each of the source streams;
i) a description of the intended sources or analytical approaches for the determination of the net calorific values, carbon content, emission factor, oxidation factor, conversion factor or biomass fraction for each of the source streams;
j) if applicable, a list and description of non-accredited laboratories and relevant analytical procedures including a list of all relevant quality assurance measures, e.g. inter-laboratory comparisons;
k) if applicable, a description of continuous emission measurement systems to be used for the monitoring of an emission source, i.e. the points of measurement, frequency of measurements, equipment used, calibration procedures, data collection and storage procedures and the approach for corroborating calculation and the reporting of activity data, emission factors and alike;
l) if applicable, a comprehensive description of the approach and the uncertainty analysis, if not already covered by items (a) to (k) of this list;
m) a description of the procedures for data acquisition, handling activities and control activities as well as a description of the activities (see Section 10.1-3);
n) where applicable, information on relevant links with activities undertaken under the EU eco-management and audit scheme (EMAS) and other environmental management systems (e.g. ISO14001:2004), in particular on procedures and controls with relevance to greenhouse gas emissions monitoring and reporting.

12 Comission Decision 2007/589/EC of 18 July 2007 establishing guidelines for the monitoring and reporting of greenhouse gas emissions pursuant to Directive 2003/87/EC of the European Parliament and of the Council. OJ L 229, 31.8.2007, p.1ff

Similar to the IPCC Good Practice Guidance, the ETS monitoring and reporting guidance is based on a tier system which defines a hierarchy of different ambition levels for activity data, emission factors and oxidation or conversion factors. The operator must, in principle, apply the highest tier level, unless he can demonstrate to the competent authority that this is technically not feasible or would lead to unreasonably high costs. The reported emissions of each installation are verified by independent verifiers for each plant in each reporting year.

Thus, the ETS generates an EU-27 data set on verified installation-specific $CO_2$ emissions for the sectors covered by the scheme. The ETS includes $CO_2$ emissions from energy industries and manufacturing industries, in particular combustion installations, mineral oil refineries, coke ovens, production and processing of ferrous metals, and mineral industries (cement, glass, lime, bricks and tiles, other ceramic materials) if the installations exceed certain capacity thresholds. In 2008 the scope of the EU ETS has been expanded to include petrochemical cracking installations, mineral wool production and carbon black production. At the moment, the greenhouse gases covered under the EU ETS are $CO_2$ (since 2005) and $N_2O$ (since 2010). However, other greenhouse gases and activities will be included in the scope of the EU ETS from 2013 onwards. In July 2006 the Climate Change Committee adopted unanimously revised Monitoring and Reporting Guidelines for the ETS. The revised Guidelines entered into force on 1st January 2008. For phase 3 of the ETS starting in 2013 another revision took place and a new version of the guidelines was recently adopted.

The plant-specific emissions data reported by operators under the EU ETS can be used in different ways for the purposes of the national GHG inventories:

1) Reported verified emissions can be directly used in the GHG inventory to report $CO_2$ emissions for a specific source category. This requires that the coverage of the respective ETS emissions is complete for the respective source category and that ETS activities and CRF source categories follow the same definitions. If ETS emissions are not complete, the emissions for the remaining part of the source category not covered by the EU ETS have to be calculated separately and added to the ETS emissions.
2) Emission factors (or other parameters such as oxidation factors) reported under the EU ETS can be compared with emission factors used in the inventory and they can be harmonised if the EU ETS provides improved information.
3) Activity data reported under the EU ETS can be used directly for the GHG inventory, in particular for source categories where energy statistics face difficulties in disaggregating fuel consumption to specific subcategories, e.g. to specific industrial sectors.
4) Data from EU ETS can be used for more general verification activities as part of national quality assurance (QA) activities without the direct use of emissions, activity data or emission factors.
5) Data from EU ETS can improve completeness of the estimation of IPCC source categories when additional data for source categories become available from EU ETS.
6) ETS data can improve the allocation of industrial combustion emissions to sub-categories under 1A2 Manufacturing Industries and Construction;
7) The comparison of the data sets can be used to improve the uncertainty estimation for the GHG inventories based on the ranges of data reported by installations.

Based on the information submitted in the national inventory reports (NIRs) in 2011 to the UNFCCC secretariat or the European Commission, 26 from 27 Member States indicated that they used ETS data at least for QA/QC purposes (see Table 1.6). This is a higher share of Member States than in 2010, where a similar analysis showed that 24 Member States had used ETS data for inventory purposes. 16 Member States indicated to directly use the verified emissions reported by installations under the ETS. 18 Member States used ETS data to improve country-specific emission factors. 12 Member States reported that they used activity data (e.g. fuel use) provided under the ETS in the national inventory.

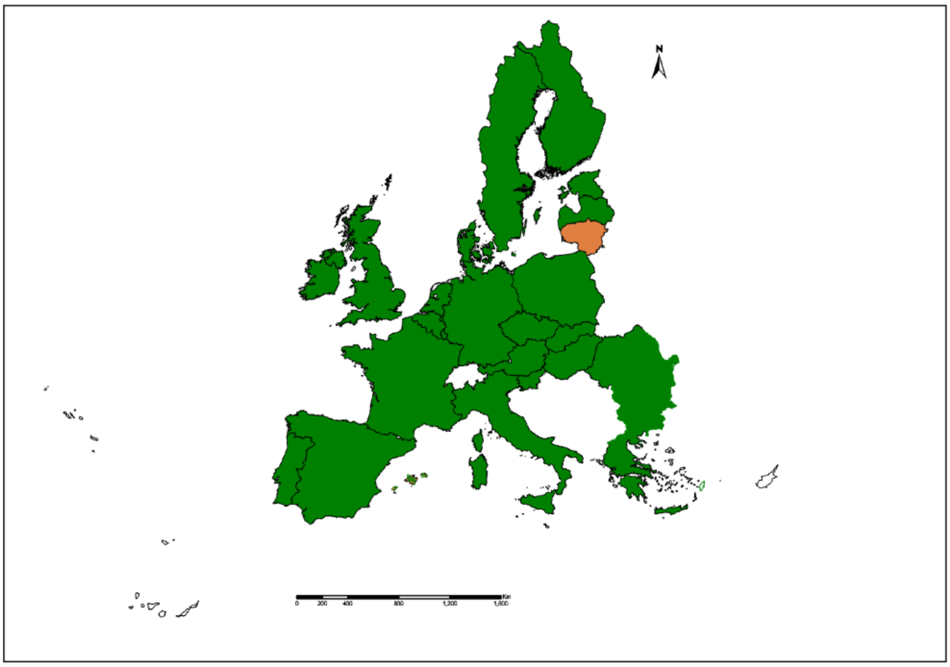
The NIR of Lithuania did not provide any information whether ETS data was used for inventory purposes. For Lithuania it is unclear whether they checked data consistency in a systematic way. Italy, Luxembourg and Spain did not provide an updated NIR 2011 during the preparation of this report.

**Table 1.6** **Use of ETS data for the purposes of the national GHG inventory**

| Member State | Status of use of ETS data | Use of emissions | Use of Activity data | Use of emission factors | Use for quality assurance |
|---|---|---|---|---|---|
| **Austria** | Used | ✓ | ✓ | ✓ | ✓ |
| **Belgium** | Used | ✓ | | ✓ | ✓ |
| **Bulgaria** | Used | ✓ | ✓ | ✓ | ✓ |
| **Cyprus** | Used | | | ✓ | ✓ |
| **Czech Republic** | Used | ✓ | ✓ | ✓ | ✓ |
| **Denmark** | Used | ✓ | | ✓ | ✓ |
| **Estonia** | Used | | | | ✓ |
| **France** | Used | ✓ | | | ✓ |
| **Finland** | Used | ✓ | ✓ | ✓ | ✓ |
| **Germany** | Used | | | ✓ | ✓ |
| **Greece** | Used | ✓ | ✓ | ✓ | |
| **Hungary** | Used | ✓ | ✓ | ✓ | ✓ |
| **Ireland** | Used | ✓ | | ✓ | ✓ |
| **Italy** | NIR 2011 not yet available | | ✓ | ✓ | ✓ |
| **Latvia** | Used | ✓ | ✓ | ✓ | ✓ |
| **Lithuania** | Not indicated | | | | |
| **Luxembourg** | NIR 2011 not yet available | | | | ✓ |
| **Malta** | Used | ✓ | | | ✓ |
| **Netherlands** | Used | | | | ✓ |
| **Poland** | Used | ✓ | | | ✓ |
| **Portugal** | Used | ✓ | ✓ | ✓ | ✓ |
| **Romania** | Used | | | | ✓ |
| **Slovakia** | Used | | ✓ | ✓ | ✓ |
| **Slovenia** | Used | | ✓ | ✓ | ✓ |
| **Spain** | NIR 2011 not yet available | | | | ✓ |
| **Sweden** | Used | ✓ | ✓ | ✓ | ✓ |
| **United Kingdom** | Used | ✓ | | ✓ | ✓ |

*Source: NIR submissions to UNFCCC 2011*

**Figure 1.2** **Use of ETS data for inventory purposes in the EU**



*Notes: Green = NIR provides information how ETS data was used for GHG inventory*
*Red = no information provided in NIR whether ETS data was used*

The following assessment provides a detailed overview of the use of ETS data in the EU-15 Member States. The information is mainly based on the NIR, as well as on the assessment conducted for this report.

### 1.3.2.2 Austria

#### General

About one third of total Austrian GHG emissions currently result from installations under the EU-ETS (~27 Tg $CO_2$ in 2009).

Verified emissions from EU ETS have complete coverage for

- refineries,
- iron and steel manufacturing industries,
- non metallic mineral industries (cement, glass, bricks and tiles, other ceramic materials),
- pulp and paper manufacturing industries and
- $CO_2$ emissions from coal combustion.

Combustion plants of other industrial branches (including power plants) are considered if their thermal plant capacity exceeds 20 MWth (excluding boilers < 3 MW, biomass-boilers and hazardous and municipal waste incineration boilers).

In Austria ETS data is submitted by means of a standard calculation sheets which includes numerical data about multiple fuels, processes and material flows. Additionally a written QA/QC report has to be submitted. For fuel combustion and industrial processes the following numerical data is reported:

- Activity data: mass or volume of fuel consumption/process input material.
- Net calorific value of fuel
- Oxidation factor of fuel/conversion factor of process material
- $CO_2$ emission factor of fuel or process material

- Share of non fossil $CO_2$ in case of "non-traded fuels"

For sites with complex material flows (e.g. refineries, iron and steel plants) carbon mass balance data is reported alternatively:

- Activity data: mass or volume of material flow
- Net calorific value of material
- Carbon content of material

Direct $CO_2$ measurements have not been submitted.

The ETS reports include data about "traded-fuels" (e.g. different types of coal and fuel oils, natural gas) as well as "non-traded fuels" (e.g. industrial wastes, biomass). For each of the "traded fuels" a national default NCV and a national default $CO_2$ emission factor may be selected for emission calculation. For "non-traded fuels" plant operators have to make their own estimate of carbon content and NCV.

The allocation of ETS emissions to CRF categories was based on NACE codes reported by installations. Furthermore the background data for the emission calculations under the ETS were used for further QA/QC checks.

**Energy**

ETS "bottom up" data 2005–2009 are used for the calculation of emission data in categories 1A1 Energy Industries, 1A2 Manufacturing Industries and Combustion and 1A4 a Commercial/Institutional. About 200 plants reported 800 fuel and material flows yearly which have been considered in the inventory. Austria uses activity data (mass and NCVs) from ETS data for the categories 1A1, 1A2 and 1A4a. ETS fuel masses/volumes and NCVs are used for activity data calculation. The remaining activity data is calculated by means of remaining fuel masses/volumes and averaged NCVs from the energy balance. ETS $CO_2$ emissions are considered by fuel. The remaining $CO_2$ emissions are calculated by remaining activity data and "national default" emission factors.

- 1A1a Public Electricity and Heat: For the years 2005–2009 $CO_2$ emissions from plants having a total boiler capacity of >= 20 MWth are taken from ETS reports and $CO_2$ emissions from plants < 20 MWth are calculated by means of national default emission factors and remaining fuel consumption of the energy balance. Coal consumption is fully covered by the ETS.
- 1A1b Petroleum refining: $CO_2$ emissions 2002 to 2005 are reported by the Austrian Association of Mineral Oil Industries which are consistent with ETS 2005 data. For the year 2006 on reported ETS data is used.
- 1A1c Manufacture of Solid Fuels and Other Energy Industries: For 2005 to 2009 $CO_2$ emissions and activity data of natural gas storage compressors are taken from ETS data.
- 1A2c Chemicals and 1A2d Pulp, Paper and Print as well as for 1A2e and f: For the years 2005 to 2009 $CO_2$ ETS data are considered with plant specific emissions and energy consumption and the remaining emissions are calculated based on the energy use. For Pulp, paper and print, in general ETS data shows slightly higher energy consumption (in terms of TJ) than current energy statistics, therefore ETS data is used from 2005 on.
- 1A2f Manufacturing Industries and Construction – Cement Clinker Production: $CO_2$ emissions 2004 to 2009 are taken from the ETS allocation plan survey and ETS data. Activity data is taken from the ETS for the years 2005-2009.
- 1A2f Manufacturing Industries and Construction – Other: For 2005 to 2009 ETS data is considered for glass, bricks & tiles and lime manufacturing plants.
- 2009 $CO_2$ implied emission factors for fuels calculated from ETS data are reported in a detailed way in the NIR in tables 28 and 29.

**Industrial processes**

Verified $CO_2$ emissions reported under the EU ETS were available for the years 2005-2009. These emissions have been incorporated in the inventory as far as possible (see respective sub-chapters for more information). The relevant sources are 2.A.1 Cement Production, 2.A.2 Lime Production, 2.A.3 Limestone and Dolomite Use, 2.A.7a Bricks production, 2.A.7b Magnesia Sinter Plants, 2.A.7c Glass production and 2.C.1 Iron and Steel.

- 2A1 Cement clinker production: $CO_2$ emissions are taken from ETS for the years 2005-2009. ETS data cover the whole cement industry in Austria.
- 2A2 Lime Production: $CO_2$ emissions are taken from ETS for the years 2005-2009. These data cover the whole lime producing industry in Austria. The ETS data are consistent with data from the association of the stone and ceramic industry and with statistical data.
- 2A3 Limestone and Dolomite Use: $CO_2$ emissions are taken from ETS for the years 2005-2009. ETS data cover limestone and dolomite use in the iron and steel and the chemical industry. Since 2005 ETS background data provided more detailed information on the actual carbon content of limestone and dolomite used. Therefore, the IEFs since 2005 are slightly different to the IPCC default values.
- 2A7 Glass production: $CO_2$ emissions reported under the ETS where used in the inventory. These data cover soda ash use in the glass industry. For 2005-2009 ETS background data provided more detailed information on the actual content of soda ash used. The ETS data in addition covers small amounts of other carbonates used in glass industry that have been included from 2005 onwards. Therefore, the IEF since 2005 is slightly different to IPCC default values. $CO_2$ emissions from limestone, dolomite and soda ash use in the glass production are reported under this category in contrast to previous reports, where these emissions were reported under the categories 2.A.3 Limestone and Dolomite Use and 2.A.4 Soda Ash Use.
- 2A7 Bricks and Tiles Production: For 2005-2009 verified $CO_2$ emissions, reported under the ETS, were used for the inventory. These data cover the whole brick industry in Austria.
- 2A7 Magnesia Sinter Production: $CO_2$ emissions reported under the ETS were used in the inventory. The operator reported total $CO_2$ emissions, which were compared with the ETS data and found to agree with the inventory estimations.
- 2C1 Iron and Steel: Verified $CO_2$ emissions reported under the ETS were used in the inventory. These data cover $CO_2$ emissions from pig iron, basic oxygen and electric arc furnace steel. For pig iron production the values for 2005-2009 correspond to the background data given in the ETS report. Since 2005 the IEF is quite stable, because background data reported under the ETS allowed accounting for reducing agents other than coke. For 2005-2009 detailed information on the carbon mass balance applied by the company to calculate total emissions from pig iron and Basic Oxygen Furnace (BOF) steel were available due to the ETS. Thus it was possible to validate $CO_2$ emission with this background data.

### 1.3.2.3 Belgium

**General**

The coverage of $CO_2$ emissions from ETS activities in relation to individual CRF source categories is not provided in the Belgian NIR.

ETS data are generally used for QA/QC purposes in all regions. Detailed information is provided on the detailed use of ETS data for inventory purposes for Flanders and Wallonia, but not for the Brussels region.

In the Flemish region reported sources in the ETS framework are compared with the reported sources in the greenhouse gas emission inventory and completed if necessary. Next to this, the emissions of $CO_2$ of the most important sources are also compared in these two datasets for the available years and tuned where possible and relevant. This means that, when major changes are detected in the reported emissions of $CO_2$ and/or energy data, the involved industry is contacted and data are optimized if necessary. As a result more accurate emissions and/or energy data can be obtained. Since the beginning of 2010, a study is conducted to examine the differences more in detail between energy and $CO_2$ data reported under the ETS and the data used in energy balances (energy use) and for emission reporting ($CO_2$). In the Flemish region, the emission reports under the ETS Directive are verified by a verification office, the Verification Office Benchmarking Flanders, VBBV. In Wallonia, data obtained from industrial companies concerned by the European Emission Trading process are systematically cross-checked with certified reports in the framework of that mechanism. Since 2005 ETS data are used directly in Flanders and Wallonia in several source categories.

**Energy**

- 1A1a Public electricity and heat production: In the Walloon region, some QC-tests are performed in the course of 2010. In particular in the category 1A1a, a recalculation with the emission trading data is performed.
- 1A1c Manufacture of Solid Fuels and Other Energy Industries: Since 2005, the $CO_2$ emissions have been giving directly by the plant under the emission trading scheme (Wallonia).
- 1A2 Manufacturing Industries and Construction: Wallonia uses EFs for solid fuels, blast furnace gas, coke oven gas and waste fuels from ETS reporting. Concerning natural gas, gas oil and residual fuel, the $CO_2$ emission factors are mainly originated from the IPCC 1996 Guidelines.
- 1A2a Iron and Steel: In the Flemish region the emissions of $CO_2$ for the biggest steel plant are revised for the complete time series during the 2011 submission mainly because of inconsistencies in emissions during the last years between the GHG inventory and the emissions reported under the emission trading directive. As a consequence some missing fuels were added in the inventory from (cokesgrid for the complete time series and anthracite from 2004 on).

**Industrial Processes**

Since 2005 EU-ETS-data are integrated in the Flemish greenhouse gas inventory in the sectors of glass and ceramic (category 2A). The emissions of these sectors were recalculated for the historical years with the same methodology as the one used for EU-ETS-purposes. Because of the small emissions of $CO_2$ in these sectors (below the threshold of 100 kton $CO_2$) no other reporting obligations than the ETS-reporting for these industries exist in the Flemish region.

- 2A7 Glass Production: In consultation with the federations and companies involved, an estimate is given of the emissions of $CO_2$ in the Flemish region. This estimation is calculated in Flanders with the methodology recorded in the monitoring protocol of the companies (emission trading scheme) and is based on production information and the evolution of the gamut of products. Wallonia uses plant-specific emission factors for glass production since 2003 which were verified with the data provided under the ETS.
- 2A7 Ceramics Production: Flanders and Wallonia use $CO_2$ emissions reported under the ETS.
- 2C1 Iron and Steel Production: During the 2011 submission the emissions of $CO_2$ in the iron and steel sector are completely revised in the Flemish region and based on the ETS-methodology instead of C-balance-approach in previous emissions. This revision took place mainly because of inconsistencies in emissions between the GHG emission inventory and the emissions reported from the emission trading directive. As a consequence the process emissions were revised as well.
  In the Walloon region $CO_2$ emissions (process and combustion emissions) have been obtained directly by the obliged reporting of the plants under the emission trading scheme since 2005.

### 1.3.2.4 Denmark

**General**

The EU ETS data for power plants account for 52 % of the $CO_2$ emission from stationary combustion.

EU ETS data are information on fuel consumption, heating values, carbon content of fuel, oxidation factor and $CO_2$ emissions. NERI receives the verified reports for all plants which utilises a detailed estimation methodology. NERI's QC of the received data consists of comparing to calculation using standard emission factors as well as comparing reported values with those for previous years. Outliers are checked.

In the Danish inventory plant or activity based $CO_2$ emission factors have been derived for power plants combusting coal and oil, refinery gas and flare gas in refineries, fuel gas and flare gas at off-shore installations, cement production, production of brick and tiles and lime production. For all these sources the EU ETS reports are only used in the Danish inventory for plants using high tier methods. The EU ETS data have been applied for the years 2006 - 2009.

**Energy**

**Fuel combustion**

The $CO_2$ emission factors for some large power plants and for combustion in the cement industry and refineries are plant specific and based on the reporting to the EU Emission Trading Scheme (EU ETS). In addition emission factors for off-shore gas turbines and refinery gas is based on EU ETS data. The EU ETS data have been applied for the years 2006 - 2009.

The EU ETS data for power plants include plant specific emission factors for coal, residual oil and gas oil.

- Power plants, coal: EU ETS data for 2009 were available from 17 coal fired power plant units. The plant specific information accounts for 97 % of the Danish coal consumption and 49 % of the total $CO_2$ emission from stationary combustion plants. The emission factor time-series for coal have been recalculated this year based on the EU ETS data that are now available for 4 years. In 2009, only 1 % of the $CO_2$ emission from coal consumption was based on the emission factor, whereas 99 % of the coal consumption was covered by EU ETS data (including EU ETS data for cement production).
- Power plants, residual oil: EU ETS data for 2009 based on higher tier methodologies were available from 24 units combusting residual oil. The EU ETS data accounts for 62 % of the residual oil consumption in stationary combustion. The $CO_2$ emission factors for residual oil have been recalculated based on the EU ETS data and an improved time-series has been implemented. EU ETS data have been utilised for the 2006 – 2009 emission inventories. In 2009, 27 % of the $CO_2$ emission from residual oil consumption was based on the emission factor, whereas 73 % of the residual oil consumption was covered by EU ETS data (Including EU ETS data for cement production). The emission factors for residual oil combustion in source category 1A1a Public electricity and heat in the years 2006-2009 refer to the implied emission factors of the EU ETS data estimated for each year. For the years 1990-2005, the emission factor for residual oil in source category 1A1a Public electricity and heat refer to the average IEF for 2006-2009.
- Power plants, gas oil: EU ETS data for 2009 based on higher tier methodologies were available from 2 plants combusting gas oil. The EU ETS data accounts for 9 % of the gas oil consumption in stationary combustion. Plant specific EU ETS data have been utilised for an increasing number of power plant units in the 2006 - 2009 emission inventories. In 2009 the implied emission factor for the power plants using gas oil was 75.1 kg per GJ. The EU ETS $CO_2$ emission factors for power plants were in the interval 74.9 - 75.2 kg per GJ. In 2009 9 % of the $CO_2$ emission from gas oil consumption was based on EU ETS data (Including EU ETS data for cement production).

- Industrial plants: Plant specific $CO_2$ emission factors have also been applied for the cement production plants, sugar production plants and vegetable oil production plants, that are part of source category 1A2 Industry. The EU ETS data includes $CO_2$ emission factors for coal, petroleum coke, residual oil and waste. The IEF for $CO_2$ in cement production fluctuates. For 2006-2009, detailed data are available from the EU ETS reporting and the fluctuations are a result of changing fuel types.
- Off-shore gas turbines: Individual EU ETS data are not applied for each of the off-shore gas turbines, but EU ETS data have been applied to estimate an average $CO_2$ emission factor for this source category. EU ETS data for the fuel consumption and $CO_2$ emission for off shore gas turbines are available for the years 2006-2009. Based on data for each oilfield implied emission factors have been estimated for 2006-2009. The average value has been applied for the years 1990-2005.
- Refinery gas: The emission factor applied for refinery gas refer to EU ETS data for the two refineries in operation in Denmark. Implied emission factors for Denmark have been estimated annually based on the EU ETS data since 2006.

**Fugitive emissions**

Reporting to the European Emission Trading Scheme are available in the annual EU ETS reports for refineries, offshore oil and gas extraction facilities and the natural gas treatment plant, concerning fugitive emissions. EU ETS data are only included in the national emission inventory if higher tier methodologies are applied. The EU ETS data are thereby a source of consistent data with low uncertainties. Unfortunately, corresponding data does not exist before the commencement of EU ETS in 2006 and therefore it is not possible to set up time-series based on EU ETS.

- Flaring: Emissions from flaring are estimated from the amount of gas flared offshore, in gas treatment/storage plants and in refineries and from the corresponding emission factors. From 2006 data on offshore flaring (flared amounts, calorific values and $CO_2$ emission factors) is given in the reports for the European Union Greenhouse Gas Emission Trading System (EU ETS) and thereby flaring can be split to the individual production units. Before 2006 only the summarized flared amount are available.
- Oil refining: The refineries deliver information on consumption of fuel gas and fuel oil. The calorific values are given by the refineries in the reporting for EU ETS from 2006. Before 2006 the calorific values given by the refineries were used when available. When not available standard calorific values given in the basic data tables from the Danish Energy Agency combined with the conversion factor between fuel gas and fuel oil given by the refinery were used for calculation.

**Industrial Processes**

- 2A1 Cement production: There is only one producer of cement in Denmark, Aalborg Portland Ltd. The activity data for the production of cement clinker is obtained from the company and the $CO_2$ emission is from the company report to EU ETS.
- 2A2: Limestone: Limestone is used for the refining of sugar as well as for wet flue gas cleaning at power plants and waste incineration plants. The emission factors are based on stoichiometric relations between consumption of CaCO3 and gypsum generation as well as consumption of lime for sugar refining and precipitation with $CO_2$. This information is supplemented with company reports to EU-ETS.
- Glass and Glass Wool: The reference for activity data for the production of glass and glass wool are obtained from the producers published in their environmental reports. Emission factors are based on stoichiometric relations between raw materials and $CO_2$ emissions. This information is supplemented with company reports to EU-ETS.
- 2A5: Bricks and Tiles: The production of lime and yellow bricks gives rise to $CO_2$ emissions. The emission factors are based on stoichiometric relations, assumption on CaCO3 content in clay as well as a default emission factor for expanded clay products. This information is supplemented with company reports to EU-ETS. For 2006-2009 emission factors have been de-

rived from $CO_2$ emissions reported by the brickworks to EU-ETS (confidential reports from approximately 20 brickworks) and production statistics (Statistics Denmark, 2010).

- 2A5: Yellow bricks and expanded clay products: For 2006-2009 emission factors for clay products have been derived from $CO_2$ emissions reported to EU-ETS (Damolin, 2010; Maxit, 2010) and production statistics (Statistics Denmark, 2010).
- 2D: Sugar production: from the year 2006-2009 the $CO_2$ emission compiled by the company for EU-ETS is used in the inventory (Danisco, 2010).

**Uncertainties**

The EU ETS data are thereby a source of consistent data with low uncertainties. Unfortunately, corresponding data does not exist before the commencement of EU ETS in 2006 and therefore it is not possible to set up time-series based on EU ETS.

### 1.3.2.5 Finland

**General**

At sectoral level verified emissions from EU ETS have complete coverage for

- Cement Production
- Lime production
- Iron and steel production

Finland also indicates how many of the total plants are included in the ETS in other sectors:

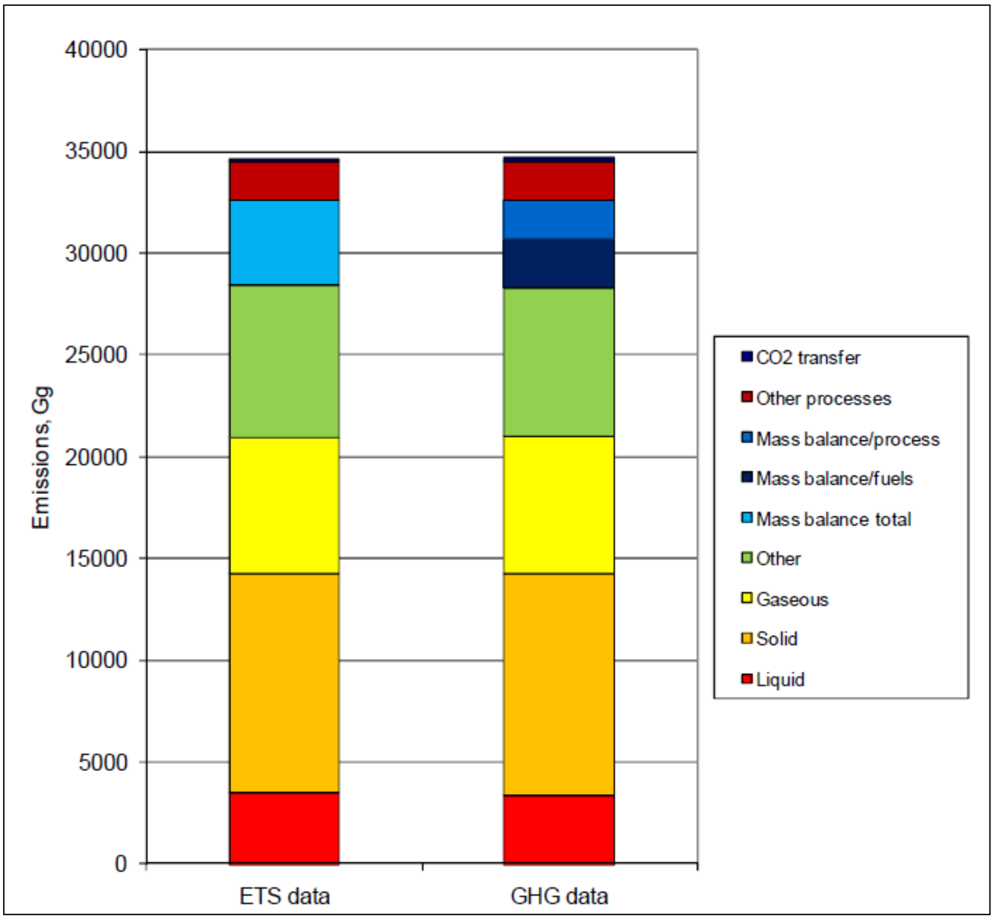
- Limestone and Dolomite Use: 19 plants out of 26 covered by ETS
- Glass Production: 4 plants out of 5
- Hydrogen Production: 2 plant out of 6

The EU ETS data obtained from the Energy Market Authority has become an increasingly important source of activity and emission data for the inventory. It has been used as prime source of activity data (especially for emissions in the Industrial process sector) and for comparison of fuel consumption and $CO_2$ emissions of specific installations (mainly energy emissions).

$CO_2$ emission data taken from the EU ETS (Emission Trading System, see Section 1.4) are annually compared with the calculated emission data in the ILMARI system. Both systems include point source (bottom-up) data. In the ILMARI system the plants included in the ETS are marked. Thus summaries of total ETS and non-ETS plants can be made easily. Total $CO_2$ emissions taken from the ETS data were 34.5 Tg in 2009. The corresponding amount taken from the GHG inventory data was 34.4 Tg. In the ETS data 166.8 Gg of $CO_2$ and in the GHG data 168.7 Gg of $CO_2$ was transferred out of the ETS plants. The reduced amount is slightly different because the storage factor in the inventory is based on annual data and in the ETS a predetermined average storage factor is used. The difference between the ETS and GHG data is 0.15 Tg, 0.4% of total ETS. There are more differences in the allocation of emissions to CRF categories, which can be seen in Figure 3.2-2.

The most important difference is in the Iron and steel sector, which is almost totally allocated to Industrial Processes in the ETS data. All iron and steel plants calculate and report their emissions according to the mass balance approach in the ETS. In the GHG inventory emissions are split between Energy and Industrial Processes. Another difference is the emissions of combustion of catalytic cracking coke in oil refineries, which is included in the Energy sector in the inventory and in Industrial Processes in the ETS.

**Figure 1.3** **$CO_2$ emissions of ETS plants compared with corresponding emissions reported in the GHG inventories 2009**




*Source: NIR of Finland, submission 2011, p.82, Figure 3.2-2*

From 2008 onwards ETS plants have been using mostly measured plant level calorific values and emission factors.

NCVs, $CO_2$ emission factors and fuel consumption data taken from the ETS plants were aggregated to the most detailed fuel code level and compared with the corresponding data in the ILMARI system. If there were significant differences, corrections were done in the ILMARI data (either plant-specific NCVs of emission factors or both). Concerning the most common and the most important fuels, the differences in aggregated NCVs and EFs were generally less than +-1%. For wood fuels the differences in NCVs were clearly larger (generally +-5%). This result was expected, mainly due to difficulties of plant operators in disaggregating different types of wood residues to existing fuel code system, but also due to variations in the moisture content of wood fuels. However, the difference in total amount of wood fuels in TJs was only 1% in 2009.

## Energy

Emissions from fuel combustion are by far the largest source of greenhouse gas emissions in Finland, and many point sources in this category are part of the EU Emission Trading Scheme. Monitored data for $CO_2$ emissions from these sources have become available from the emission trading system for the inventory years 2005 - 2009. In the Energy sector ETS data have been mainly used in:

- identifying missing point sources
- checking and verifying fuel consumption data
- verifying emission data
- verifying NVCs and $CO_2$ emission factors by fuel type.

The work to input the data from the ETS system in the GHG database system (ILMARI) has started during 2010. In 2011 more routines that are automatic will be planned to replace at least part of the manual checking and correction operations, but the continuation of this process depends on the resource situation. At the moment the ETS plants and data are included in the ILMARI for plant level verification.

The data have also been crosschecked with the amount of captured and transferred $CO_2$ reported under the EU ETS. These data exist for the years 2005-2009 and include the captured and transferred amount of $CO_2$ by plant. The differences in the PCC production data from the various sources have been very small. The amount calculated and reported by Statistics Finland in the greenhouse gas inventory has been approximately 97 per cent of the data reported to EU ETS 2005-2007. The difference is assumed to account for possible losses during transfer and production.

**Industrial Processes**

- 2A1 Cement Production: Data for Clinker production for the years 1990-2006 are received directly from the company and for years 2007-2009 from EU ETS data. The emissions calculated with site specific data of the most recent five years have been compared with EU ETS data. Differences between those figures have been less than 3%. For three years calculated emissions are higher than reported in EU ETS and for two years lower.
- 2A2 Lime Production: Emissions from 2005 onwards have been calculated using production data reported to the EU ETS data. The calculated emission data for years 2005-2009 of all plants have been verified with ETS data (all plants are included in EU Emission Trading Scheme) and differences in emissions have been found to be less than 9%. Higher emissions have been formed because in EU ETS companies calculate emissions using default emission factors and in the inventory emission factors are based on actual CaO and MgO content of lime.
- 2A3 Limestone and Dolomite Use: Activity data for 2009 are collected directly from individual companies also the EU ETS data have been used. Most of the data for the earlier years have been received from individual companies, EU ETS and a small part has been estimated using industrial statistics. The calculated emission data of 19 plants (out of 26) have been verified with ETS data and emissions have been found to be almost equal. Higher emissions have been formed because in EU ETS companies calculate emissions using default emission factors and in the inventory emission factors are based on assumption that not all limestone and dolomite are calcinated in the process.
- 2A4 Soda Ash Production and Use: The calculated emission data of a plant have been verified with ETS data and emissions have been found to be almost equal (+/-1%). Reason for this difference is that not all carbonate is assumed to be calcinated in the production process.
- 2A7 Glass Production: The consumption of limestone and dolomite has been used as activity data when calculating emissions from limestone and dolomite use. Activity data for 2009 are collected directly from individual companies and the EU ETS data. Most of the data for the earlier years have been received from individual companies, EU ETS and a smallish part has been estimated using industrial statistics. The calculated emission data of 4 plants (out of 5) have been verified with ETS data and emissions have been found to be almost equal (+/-2%). Reason for difference is that in the inventory calculation not all carbonate is assumed to be calcinated in the production process. In the verification it was also noticed that one company using dolomite reports their emissions miscalculated to Energy Market Authority for years 2006-2009, there seems to be an error in emission factor.
- 2B5: Hydrogen Production: The calculated emission data of two plants (out of 6) have been verified with ETS data and emissions have been found to be equal. These two plants are biggest emitters in this category, amount of their emissions represents more than 90% of category's emissions.
- 2C1: Iron and Stell Production: From 2005 on, all four iron and steel plants in Finland report to the EU ETS. Starting from 2007 submission (2005 data), the total $CO_2$ emissions for GHG inventory have been taken from the ETS data, although the split between process and fuel-

based emissions has been done in the same way as in the previous years' calculation. $CO_2$ emission data are available starting from 1996. ETS data are available from 2005 on.

#### 1.3.2.6 France

**General**

France indicates in a general way that $CO_2$ emissions in the inventory are consistent with ETS emissions because they are based on the same data sources. In France plant-specific data is collected by the same entities from the same installations for both the EU-ETS and the GHG inventory and energy statistics and data is therefore consistent. Small deviations occur for the following reasons:

- The $CO_2$ emissions from blast furnace gas are allocated to the producer and could also be allocated to the user in different systems
- Small installations with small emissions are not individually included in the estimation approach.
- The sectoral and source category definitions can be different.

Where all facilities in a given sector are covered by the ETS, consistency with the inventory is ensured by taking into account the information given by the installations that is audited by a recognized organization and by the French administration. If only some of the facilities in a sector are within the scope of the ETS, their statements under the ETS are also taken into account but the balance is accounted by other means to ensure consistency.

**Energy**

- 1A1 Energy industry: $CO_2$ emissions are determined by using emission factors for each fuel. National values are applied except when specific factors as justified by operators under the ETS are available (especially since 2005). Calculated emissions are compared with the emissions data reported under the ETS.
- 1A2f Combustion emissions from cement plants: Emissions data as reported under the ETS is used since 2004.
- 1A3a Pipeline compressors: The emission factor is determined based on data derived from the ETS since 2008.
- 1B2a Petroleum refining: $CO_2$ emissions are declared by the plants under the EU ETS.

**Industrial Processes**

- 2A1 Cement Production: France directly uses the emissions reported under the ETS since 2004.
- 2A2 Lime Production: ETS data are used for the inventory reporting since 2004.
- 2A7 Glass Production: ETS data are used for the inventory reporting. They are completed with the remaining glass production not covered by the ETS. For this part of the production national emission factors are used.
- 2A7 Bricks and Tiles Production: The emissions from ETS plants are taken directly from the ETS reports. These emissions are complemented based on the remaining national production and emission factors taken from ETS reports.

#### 1.3.2.7 Germany

**General**

The coverage of $CO_2$ emissions from ETS activities in relation to individual CRF source categories is not provided in the NIR.

In 2006 a research project compared ETS emissions and inventory emissions and developed allocation rules how the ETS emissions should be allocated to inventory categories. Then a formalized procedure was developed for the annual data exchange between ETS authority and the inventory system. ETS data are generally used for verification and QA purposes but not directly in the inventory. EFs from ETS data are also used. AD from ETS data are not used because these data are confidential and would decrease the transparency of the GHG inventory.

In the CRF table 1s1 (Energy) Germany reports additional source category that include the combustion emissions from source categories covered by the ETS (glass, cement and ceramics). This additional voluntary reporting considerably enhances the comparability of ETS emissions with inventory emissions at sectoral level.

**Energy**

The NIR generally indicates that ETS data are used for verification purposes. Both systems, the inventory and the ETS, refer to a list of "basic" $CO_2$ emission factors in the energy sector.

**Industrial Processes**

- 2A1 Cement Production: EFs between inventory and ETS are largely consistent, deviation of 1%.
- 2A3 Limestone and dolomite use: ETS data is used for verification and QA.
- 2A7: Glass Production: emissions were compared with ETS emissions and found to be in agreement.

### 1.3.2.8 Greece

**General**

The coverage of $CO_2$ emissions from ETS activities in relation to individual CRF source categories is not provided systematically, but it is indicated that all iron and steel plants are covered by the ETS.

Greece used AD and EF obtained from reporting under the ETS for the GHG inventory. In addition to the verified emissions provided for the period 2005-2009, data collected for the purposes of the national allocations plans for the ETS installations were collected for the period 2000-2006 and in some cases for the period 1990-2006 and this information was also used as a source for the inventory compilation. ETS data were used for 1A1, 1A2 and industrial processes.

The energy data used for the calculation of emissions derived from the national energy balance compiled by the Ministry of Development and the reports of installations under the EU ETS.

**Energy**

Emission factors: The determination of emission factors was based on data derived from verified ETS reports and IPCC guidelines.

- EF and AD were combined with remaining production and IPCC default EF to obtain complete emission estimates.
- 1A1a Public Electricity and Heat: For the public electricity and heat sector and for the years 2005-2009, a $CO_2$ EF of NG, based on plant specific data (ETS reports), was also calculated (plant specific EF).
- 1A1b Petroleum Refining: Tier 2 methodology was used with EFs calculated based on plant specific data (ETS reports) and IPCC default EFs for the whole time series. $CO_2$ and $N_2O$ emissions from catalytic cracking are included in this sub-source category, while $CH_4$ emissions are supposed to be included in Fugitive emissions from fuels.
- 1A1c Manufacture of Solid Fuels and Other Energy Industries: Data collected during the formulation of the NAP for the period 2005 – 2007 and verified ETS reports (for years 2005 -

2009) were used in this inventory, particular EFs. The allocation of the consumption into gas turbines and boilers as taken from ETS reports. The $CO_2$ EF of natural gas was estimated to comprise emissions from the processing of sour gas cleaning process among with the emissions from combustion. The EF for the processing of sour gas is based on ETS data.

- 1A2 Manufacturing Industries and Construction: Data collected (through questionnaires) during the formulation of the NAP for the period 2005 –2007 and verified installation ETS reports of 2005 - 2009 provided significant information regarding the structure of energy demand in industry per activity / technology. Energy consumption in activities not included in the EU emissions trading scheme (e.g. grey iron foundries) is estimated on the basis of the official data (national energy balance). For 2005 - 2009 activity data for steel production were available through the verified ETS reports. Also for primary aluminium production and ferroalloys production which are included under Non ferrous metals plant specific energy consumption data which was available through the verified ETS reports has been used fort he years 2005-2009.
- The activity data solid fuels was updated for the year 2008, based on plant specific data, derived from verified ETS reports.
- Energy consumption in Non metallic minerals is disaggregated into energy consumption for cement production (SNAP 030311), lime production (SNAP 030312), ceramics production (SNAP 030319) and glass production (SNAP 030105) according to verified ETS reports of years 2005 - 2009.
- Data on the non-energy consumption of fuels derive from the national energy balance. However, plant-specific data derived from verified ETS reports and information provided by specific Greek industries resulted to the improvement of reallocation of non-energy use fuels from the energy to the industrial processes sector: The non-energy use of natural gas for ammonia production has been reallocated in industrial processes sector, by using data from ETS reports and plant specific information.
- Solid fuels consumption in the ferroalloys production industry is included (in the national energy balance) in the solid fuels consumption of the non-ferrous metals sector. However, by using data from ETS reports and plant specific information, emissions from solid fuels for ferroalloys production are reallocated to the industrial processes sector, as from this submission.

**Industrial Processes**

$CO_2$ emissions from the majority of mineral and metal industries are estimated on the basis of country-specific emission factors. These emission factors derive of plant specific activity and emission data in the context of the EU ETS. Plant specific information has been collected through questionnaires for the formulation of the NAP (years 2005-2008) and verified reports under the EU ETS.

- 2A1 Cement Production: For the years 2005-2009 detailed data have been accessed via the verified ETS reports of the plants. These data refer to the quantities of carbonate raw material (CaCO3, MgCO3) used for the production of clinker.
- 2A2 Lime Production: The emissions are estimated making use of plant-specific data provided by the verified reports of the plants under the ETS.
- 2A3 Limestone and dolomite use: Steel production: Data are generally plant specific, deriving from the EU ETS verified reporting of the plants (for the years 2005-2009); Ceramics production: Carbonates consumption data (in the context of the ETS reports) have been used to estimate emissions in the years 2005-2009. Activity data refer to CaCO3 and MgCO3 consumption (emission factors 0.44 and 0.522 respectively). SO2 scrubbing: The operation of flue gas desulphurization systems in Greece started in 2000. The estimation of emissions is based on data collected during the formulation of the NAP for the period 2005 – 2007. For years 2005-2009 data from verified installation ETS reports were used. The emission factor used (0.44 t $CO_2$ / t limestone) derives from the stoichiometry of the reaction. Emissions have increased considerably in 2009 as a result of the inclusion of new operation plants in the system.
- 2A7 Glass Production: Activity data for the period 2001 – 2004 were collected (through questionnaires developed according to the guidelines described in the Commission Decision 2004/156/EC) in the framework of the formulation of the NAP for the period 2005 – 2007, ac-

cording to the EU Directive 2003/87/EC. Since February 2006 there is only one plant operating in Greece, whereas since 2005 this plant used to have two factories. Production data have been given for both factories for years 2005- 2006 and for the only plant left for the years 2007-2009. Also for the years 2005-2009 the reports in the EU ETS context have been extensively used.

- 2C1 Iron and Steel: Data are generally plant specific, deriving from the EU ETS verified reporting of the plants (for the years 2005-2009) and the reporting performed for the NAP formulation in the previous years. Activity data and EF for 2005-2009 are plant specific and are based on the verified reports under the EU ETS context. According to information received by the ElStat, all the iron and steel plants of the country are included in the EU ETS.
- 2C2 Ferroalloys Production and primary aluminium production: Activity data for 2005-2009 derive of the verified reports of the industry under the EU ETS.

**QA/QC**

Quality control of activity data include the comparison of the same or similar data from alternative data sources (e.g. Hellenic Statistical Authority and ETS reports) as well as time-series assessment in order to identify changes that cannot be explained. It should be noted that information and data collected (through questionnaires developed according to the guidelines described in the Commission Decision 2004/156/EC) in the framework of the formulation of the National Allocation Plan (NAP) for the period 2005 – 2007, according to the EU Directive 2003/87/EC (and its transposition to the national Law, JMD 2004) along with the data from the verified reports from installations under the EU ETS for years 2005-2009 constituted a significant source of information and an additional quality control check.

- Activity data comparison: Cross-checking between energy consumption data derived from national energy balance and plant specific energy consumption data of major industrial plants derived from verified ETS reports is performed.
- Emissions comparison: Verified ETS reports were used for the computation of plant specific $CO_2$ EFs and NCVs. For quality control purposes emissions calculated by applying PS EFs and NCVs are compared with the emissions calculated by using IPCC defaults EFs and NCVs derived from energy balance. By this way emission estimations were verified. The most appropriate EFs and NCVs per sector are selected and applied.

### 1.3.2.9 Ireland

**General**

Emissions trading covers approximately 100 installations in Ireland with combined $CO_2$ emissions of 17,215 Gg in 2009, accounting for 27.6 percent of total greenhouse gas emissions. The ETS data have a complete coverage for of $CO_2$ estimates for categories 1.A.1 Energy Industries, 2.A.1 Cement Production, 2.A.2 Lime Production, 2.A.3 Limestone and Dolomite Use, 2.A.4 Soda Ash Production and Use and 2.A.7 Bricks and Tiles.

The Emissions Trading Unit (ETU) forms part of OCLR and is a key component of the national system. Information submitted by participants in the European Union Emissions Trading Scheme (ETS) under Directive 2003/87/EC (EP and CEU, 2003) is managed by the ETU and is available to the inventory team in OCLR. The annual ETS compilation serves as an important source of activity-specific and company-specific data on $CO_2$ emissions, fuel use and emission factors for major combustion sources and industrial processes. The ETS returns to the Agencys Office of Climate, Licensing and Resource Use (OCLR) provide for the complete coverage of $CO_2$ estimates for in a number of sub-categories under 1.A.1 Energy Industries and 2.A. Mineral Products. When the allocation to these categories from the ETS raw data is completed, the output is returned to the ETS administrator in OCLR for final checking against the source data. This ensures the efficient and consistent transfer of the verified ETS emissions estimates into the national inventory. Inventory development continues to benefit from the internal review procedures that are ongoing with regard to the EU and its Member States.

**Energy**

The incorporation of the ETS data in the Energy sector for the last several submissions is again considered an important step towards improved reliability and accuracy of the estimates for categories 1.A.1 and 1.A.2. Thorough checking of this input is achieved in collaboration with colleagues in the Climate Change and Environmental Research Unit (CCERU) of the EPA, which acts as the competent authority for the ETS in Ireland. Following receipt of the raw ETS data from CCERU, the inventory experts allocate the $CO_2$ estimates and corresponding energy amounts to the appropriate sub-categories for CRF reporting and then return the compilation to the CCERU contact person for final checking and accounting of any amendments following the ETS verification process. This ensures that where ETS emissions estimates cover a category completely, such as in 1.A.1, the verified $CO_2$ values are transferred directly to the national inventory and consistency of results is guaranteed. In the case where the $CO_2$ estimates from ETS do not completely cover the category, as for 1.A.2, the benefit is realised as better information on fuels and more representative emission factors, which improves the top-down estimates of emissions obtained using the energy balance.

As for all years since 2005, $CO_2$ estimates reported under the ETS for 2009 are used to achieve complete bottom-up results in respect of some important sub-categories in this sector for the 2009 inventory. This is a significant advance in terms of accuracy as the ETS estimates are verified and they represent a large proportion of the total emissions from the Energy sector.

- 1A1 Energy Industries: The Annual Installation Emissions Reports (AIER) submitted by ETS participants in respect of their $CO_2$ emissions and fuel combustion in 2009 under Directive 2003/87/EC were used to report the complete inventory for category 1.A.1. The emissions data from a total of 22 individual installations – 19 electricity generating stations in 1.A.1(a), one oil refinery in 1.A.1(b) and two peat briquetting plants under 1.A.1(c) – are the basis for compiling the results in this important category. In each of the three sub-categories, the verified $CO_2$ estimates reported by the ETS participants were used directly and the corresponding fuel use as given in the national energy balance was used to estimate $CH_4$ and $N_2O$ emissions using the appropriate IPCC emission factors mentioned in the previous section.
- 1A1a Public Electricity and Heat Production: The $CO_2$ emissions for sub-category 1.A.1(a) obtained from AEIRs are estimated by ETS operators using tier 3 methodologies. The summarised $CO_2$ emissions compiled in the ETS database according to fuel type for all installations that constituted sub-category 1.A.1(a) in 2009 are aggregated to report the $CO_2$ emissions for this category. The $CO_2$ emissions estimates compiled through ETS for sub-category 1.A.1(a) are cross-checked with a separate long-standing data flow to the inventory agency covering plant-specific emissions for electricity generating stations that are used to report on the Large Combustion Plant Directive and the Convention on Long-Range Transboundary Air Pollution. The aggregated $CO_2$ emissions reported in the latter data-flow correspond to the compilation available under the ETS for all years since the ETS data became available.
- 1A1b Petroleum Refining: One small oil refinery accounts for the emissions reported under 1.A.1 (b) Petroleum Refining. The reported $CO_2$ emissions are those available from the ETS

database. These emissions are estimated using tier 2 methodologies. Because high-pressure gas, low-pressure gas and residual fuel oil account for the bulk of the emissions in 1.A.1 (b) in all years and the emission factors for these fuels do not fluctuate significantly, the emissions reported using ETS data are consistent with the annual estimates for historical years.

- 1A1c Manufacture of Solid Fuels and Other Energy Industries: Emissions for 1.A.1(c) Manufacture of Solid Fuels and Other Energy Industries were reported for the first time in the 2006 submission and refer to the production of peat briquettes from milled peat in two plants. The 2009 values for $CO_2$ are also taken from ETS returns which are based on tier 2 methodologies.
- 1A2 Manufacturing Industry and Construction: The combustion $CO_2$ emissions in a variety of installations across the CRF sub-categories 1.A.2(a) through 1.A.2(f) are covered by the ETS Directive 2003/87/EC but the total $CO_2$ emissions in any sub-category cannot be reported for Ireland using ETS data alone, as in the case of the sub-categories under 1.A.1. The ETS data are instead used to compare fuel quantities reported under ETS with corresponding amounts given in the preliminary national energy balance and to determine improved country-specific emission factors that can be applied for particular fuels and sub-categories. Information provide from the ETS on fuel data have been used to develop an annual country-specific $CO_2$ emission factor for petroleum coke since 2005. Petroleum coke is used in sub-categories 1.A.2.b, e and f. The average of the most recent five years of yearly specific emission factors is applied to years prior to 2005, as ETS data is only available from 2005 onwards.

**Industrial Processes**

The process $CO_2$ emissions for the relevant source categories under 2.A Mineral Products are largely covered by Directive 2003/87/EC (EP and CEU, 2003) on emissions trading in the EU and full use is made of this data source for the compilation of the national inventory. In general, the annual verified $CO_2$ emissions in respect of the installations concerned are used directly for the years covered by the ETS.

- 2A1 Cement Production: As the EU ETS subsequently became operational, plant specific $CO_2$ emissions and corresponding clinker production data are also available for all cement plants for the years 2004 through 2009 and these data are used directly to report emissions for category 2.A.1 in Ireland.
- 2A2 Lime Production: As in the case of cement production, lime producers provided their own estimates of $CO_2$ emissions from lime manufacture for the development of NAP1 under Directive 2003/87/EC on ETS. These were calculated in accordance with the methods described in the supporting Decision 2004/156/EC, thus providing detailed information on emission estimates and activity data for another important source of $CO_2$ emissions in Industrial Processes. The $CO_2$ estimates for lime production in 2009 have been obtained from the ETS returns to the CCRP of the EPA as for other recent years covered by the scheme and these have been used to confirm the estimates for previous years of the time-series.
- 2A3 Limestone and Dolomite Use: The $CO_2$ emissions reported under this category refer to those emissions associated with the use of limestone (CaCO3) for flue gas desulphurisation and limestone used in the manufacture of bricks and tiles. Limestone has been used to capture the sulphur emitted from peat burning in one electricity generating station since 2001 and in a second such plant since 2007. The $CO_2$ emissions estimates are taken from ETS returns. They are estimated on the basis of limestone quantity used by the companies and an emission factor of 0.44 t $CO_2$/t limestone, which is the stoichiometric ratio of $CO_2$ to CaCO3. A further minor use of limestone relevant to 2.A.3 Limestone and Dolomite Use in Ireland is its application in the purification of sugar produced from sugar beet. However, sugar production ceased in 2006 and the only information on emissions is that obtained under ETS in respect of 2005 and 2006.
- 2A4 Soda Ash Production and Use: The emissions associated with soda ash use by one company in Ireland are reported by the company under ETS for the years 2005-2009 and have been used directly in the inventory. Activity data for years prior to the ETS data were sourced by the inventory agency from the company. These data were combined with an emission factor of 0.41 t $CO_2$/t soda ash, indicated by the ETS data. This approach has allowed a full 1990-2009 time series of emissions to be included in the inventory.

- 2A7 Other Mineral Products: The emissions of $CO_2$ from glass production as well as the emissions arising from the use of clays and shale as a raw material in the manufacture of bricks and ceramics are reported under this CRF category. Similar to other categories under 2.A, information from individual plants that are participants in the Emissions Trading Scheme is utilised to report the emissions estimates in the national inventory. In the case of bricks and ceramics, the ETS data for the four companies concerned provide estimates of emissions for the years 2005-2009 along with the corresponding quantities of carbonate input materials and the relevant emission factors.
  Glass production is treated as a separate sub-category under 2.A.7. In the case of crystal glass, the $CO_2$ emissions are based on the use of potassium carbonate and sodium carbonate use (soda ash) as reported under ETS, using the emission factors of 0.415 t $CO_2$/t Na2CO3 and 0.267 t $CO_2$/t K2CO3, provided by the ETS monitoring and reporting guidelines.

**Uncertainties**

Low activity data uncertainties are justified in respect of $CO_2$ emissions sources in Industrial Processes, for which bottom-up data are applied in most cases and the major sources of emissions are covered by ETS.

### 1.3.2.10 Italy

**General**

The coverage of ETS emissions in relation to total $CO_2$ emissions (without LULUCF) is 46% in 2005, 47% in 2006 and 48% in 2007. The coverage of $CO_2$ emissions from ETS activities in relation to individual CRF source categories was analysed for the Italian inventory, but is not provided in a systematic way. The NIR indicates that Lime Production plants are completely covered under the ETS.

Data from the Italian Emissions Trading Scheme database are incorporated into the national inventory whenever the sectoral coverage is complete. ETS data are always used to develop country-specific emission factors and to check activity data levels.

The inventory agency ISPRA collects data from the industrial associations under the ETS and other European directives, Large Combustion Plant and EPER/E-PRTR, and makes use of these data in the preparation of the national inventory ensuring the consistency of time series. As an improvement and QA activity Italy is establishing a database where information collected in the framework of different European directives, Large Combustion Plant, EPER and Emissions Trading, are gathered together thus highlighting the main discrepancies in information and detecting potential errors. Even though the database is not completed yet all the figures are considered in an overall approach and used in the compilation of the inventory. Activity data and emissions reported under EU-ETS and EPER/EPRTR are compared to the information provided by the industrial associations. The general outcome of this verification step shows consistency among the information collected under different pieces of legislations and the information provided by the relevant industrial associations. In particular, comparisons can be carried out for cement, lime, limestone and dolomite, and glass sectors.

**Energy**

- 1B2 Oil and Gas: Fugitive $CO_2$ emissions reported in 1.B.2 refer to fugitive emissions in refineries during petroleum production processes, e.g. fluid catalytic cracking and flaring, and emissions from the production of oil and natural gas. Emissions in refineries have been estimated on the basis of activity data published in the National Energy Balance or supplied by industry and operators especially in the framework of the European emissions trading scheme.
- Coal $CO_2$ average emission factors have been revised from 2005 based on an analysis of the information collected by the plants in the framework of EU ETS and additional information on coals imported.
- The $CO_2$ emission factor of synthesis gas from heavy residual (syngas) used in refineries to produce energy and heat has been changed from 1999, on the basis of the information col-

lected in the framework of EU ETS. It has been calculated as the average value of syngas consumptions and emissions reported to the EU ETS.

- From 2008, the weighted average of $CO_2$ emission factor reported by operators in the framework of the EU ETS scheme is used for petroleum coke.
- Starting from 2008, the oxidation factors for petroleum coke and coal have been modified based on the data reported by operators under the EU ETS scheme. The reporting operators cover almost 100% of solid fuels used. Weighted average of oxidation factor reported for petroleum coke is 0.998 and for steam coal is 0.986.
- 1A1b Petroleum Refining: The consumption data used for refineries come from BEN (MSE, several years [a]); the same data are also reported by Unione Petrolifera, the industrial category association (UP, several years). From 2005 onwards, also the EU ETS “verifier’s reports” cover almost the entire sector, for energy consumptions, combustion emissions and process emissions.
- 1A1c Manufacture of solid fuels: Basic data to estimate emissions have been reported by national energy balance and the national grid administrator. Data collected by other surveys that include integrated iron and steel plants, such as EU ETS Directive, LCP and E-PRTR surveys, have been used to cross-check the energy balance data, fuels used and emission factors. Differences and problems have been analysed in details and solved together with Ministry of Economic Development experts, which are in charge to prepare the National Energy Balance. In particular, in the E-PRTR registry the integrated plants report every year the $CO_2$ emitted at each stage of the process, coke production, sinter production and iron and steel production, which result from separate carbon balances calculated in each phase of the production process. Moreover, total $CO_2$ emissions reported in the E-PRTR by the operators are equal to those reported under the EU ETS scheme.
- 1A2: Manufacturing industries: In general, in the industrial sector ETS data source is used for cross checking BEN data. Energy/emissions data from EU ETS survey of industrial sectors should be normally lower than the corresponding BEN data because only part of the installations / sources of a certain industrial sub sector are subject to EU ETS. In case of missing sources or lower figures in BEN than ETS, at fuel sector level, a verification procedure starts.
- 1A2a Iron and steel: For this sector, all main installations are included in EU ETS, but not all sources of emission. Only part of the processes of integrated steel making is subject to EU-ETS, in particular the manufacturing process after the production of row steel was excluded up to 2007 and only the lamination processes have been included from 2008 onwards. Moreover, the recovered coal gases used to produce electricity and steam are not included. So the EU ETS data is only of limited use for this subsector and the procedure set up starting from the total carbon input to the steel making process, is still the most comprehensive one to estimate the emissions to be reported in 1.A.2.a.

**Industrial Processes**

- 2A1 Cement Production: Emission factors have been estimated on the basis of detailed information supplied by plants in the ETS and checked with the industrial association. EFs are directly taken from ETS.
- 2A2 Lime Production: Emission factors have been estimated on the basis of detailed information supplied by plants in the ETS and checked with the industrial association.
- 2A3 Limestone and Dolomite Use: Detailed production activity data and emission factors have been supplied under the ETS and relevant data are annually provided by the Italian bricks and tiles industrial association and by the Italian ceramic industrial associations.
- 2A7 Glass Production: $CO_2$ emissions from glass production have been estimated by production activity data and emission factors estimated on the basis of information supplied by plants under the ETS.
- 2B5 Carbon Black: $CO_2$ emissions from carbon black production process have been estimated on the basis of information supplied by the Italian production plants in the framework of the national EPER/EPRTR registry and the ETS.

- 2C1 Iron and Steel: From 2000 $CO_2$ emission and production data have been supplied by all the plants in the framework of the ETS scheme, for the years 2000-2004 disaggregated for sinter, blast furnace and BOF plants, from 2005 specifying carbonates and fuels consumption and related $CO_2$ emissions. For 2002-2006 data have also been supplied by all the four integrated iron and steel plants in the framework of the European EPER registry not distinguished for combustion and processes. Emissions reported in the national EPER/E-PRTR registry and for the Emission Trading Scheme are compared and checked.

### 1.3.2.11 Luxembourg

**General**

The coverage of ETS emissions in relation to total $CO_2$ emissions (without LULUCF) is 22% in 2005-2007. No NIR 2010 had been provided during the preparation of this report.

Activity data obtained through the Emission Trading System (ETS) were used for QA/QC procedures by comparing this data to the data reported by the plant operators. Luxembourg's planned improvement for the future foresees to considerably extent the use of consumption and emission data provided by facilities either in the framework of the EU-ETS and of the E-PRTR in its inventories.

**Energy**

- NCVs from ETS data were used for other bituminous coal.
- 1A2f: Biomass: biogenic fraction in tires and other materials (fluff,…) used in cement production was revised according to EU-ETS data for the years 2006-2007.
- Industrial processes:
- 2A1 Cement Production: Recalculations since the last submission have been done for category 2A1 Clinker production. The methodology has been changed from IPCC GPG 2000 Tier 2 to ETS 2007 guidelines Tier 3. This results in new EF and hence new $CO_2$ emissions. The new EFs are based not only on the CaO content in the clinker but also on the MgO content in the clinker.
- Iron and steel production: Some default EF taken from ETS guidelines and carbon balance approach from 2004 ETS guidelines was used.

### 1.3.2.12 The Netherlands

**General**

In 2010 a quantitative assessment was made of the possible (in) consistencies in $CO_2$ emissions between data from ETS, NIR and National Energy Statistics. The figures that were analyzed concerned about 40% of the $CO_2$ emissions in the Netherlands in 2009. The differences could reasonably be explained (e.g. different scope) within the given time available for this action.

**Energy**

- 1A1c Manufacture of solid fuels and other Energy Industries: From 2002 onwards the data reported by the Dutch refineries are used to calculate plant specific emission factors for $CO_2$ which represent an improvement compared to the use of the standard EF. This procedure will be continued. Analysis of the ETS data revealed that the use of these data would not improve the inventory.

**Industrial Processes**

- Nitric Acid Production: From 2008 onwards, the $N_2O$ emissions of HNO3 production in the Netherlands were opted in in the European emission trading scheme (EU-ETS). For this purpose the companies developed monitoring plans that were approved by the Dutch Emissions authority (NEa), the government organization responsible for EU ETS in the Netherlands. In 2009 and 2010 the companies sent the verified emission reports to NEa (2008 /2009 emissions). The reported and verified (by an independent verifier) emissions (2008 and 2009) by the companies to NEa were checked against those as reported in the CRF tables (2008 and 2009). No differences were found between the emission figures in the CRF and the verified emissions in the emission reports under EU ETS.

#### 1.3.2.13 Portugal

**General**

The coverage of $CO_2$ emissions from ETS activities in relation to individual CRF source categories is not provided in the NIR.

According to the NIR 2011, Portugal still plans to better integrate data from ETS into the GHG inventory and to streamline the collection of data and emission estimates between the inventory and the ETS.

**Energy**

- Fuel consumption data for the islands Madeira and Azores were taken from reports under the ETS as well as from the Madeira and Azores Regional Environmental entities.
- Thermal electricity power plants: Since EU-ETS data is available for inventory use plant specific Carbon content was used in those cases where fuel analysis were made by the plant operator.
- Desulfurization in Large Point Source Energy Plants in Mainland Portugal: Since both these energy plants are included in the EU-ETS the $CO_2$ ratio reported under this scheme was used in the inventory – 0.44 ton $CO_2$/ton Ca.
- Large Point source energy plants: The EU-ETS as a data source has been gaining relevance since the last inventory, both in activity data and EF. For 2009 fuel consumption for all major power plants was obtainded from this source.
- 1A1b Refining of petroleum products: The quantities of fuel consumption from 1990 to 2004 in boilers and furnaces were collected directly from individual units under the Large Combustion Plants (LCP) directive and may be observed in the next figure for fuel oil and fuel gas. Since 2005 data source was EU-ETS. In a similar mode that was done for large power plants, and according to the explanations provided before, a comparison was done for total consumption in all refinery units between the data in INERPA (from EU-ETS) and the Energy Balance and graphs for residual fuel oil (FO) and fuel gas are presented in the next figure. There is an agreement between the two sources of information for the initial years of the period, although not so good for the last years. The differences between the two sources of information should be analized during next year. Fuel consumption for the period 2005-2009 was obtained directly from EU-ETS data. Refineries data have been revised for the period 2005-2009 based on EU-ETS.
- 1A2 Manufacturing Industries: Data on fuel consumption for LPS were obtained since 2009 inventory from EU-ETS. Iron and steel production data have been revised for the period 2005-2009 based on EU-ETS. Improvements made to Pulp and Paper sector primarily focused in the revision of fuel consumption data. There were two main information sourcer for this improvement: EU-ETS and Self-Control Program (Programa Autocontrolo) (1990-2008).

**Industrial Processes**

- 2A1 Cement Production: EU-ETS method A from Annex VII of Decision 2007/589/EC is used for the period 2005-2009. Data on consumption of raw materials, was obtained for the period 2005-2009 from EU-ETS.

- 2A2 Lime Production: EU-ETS method A from Annex VIII of Decision 2007/589/EC is used for the period 2005-2009. Data on consumption of raw materials, was obtained for the period 2005-2009 from EU-ETS.
- 2A3 Limestone, Dolimite and Carbonate Use: For this industry sector, although the consumption of carbonate bearing materials is not known for the whole period, a consumption factor was developed based on the information received under the European Emission Trading Scheme (EU-ETS), and production of construction ceramics and pavement ceramics, which is available from INE's industry surveys IAIT and IAPI, was used to obtain the full time series.
- 2A7 Glass Production: Country specific emission factors were calculated using data from 10 industrial plants in Portugal under the studies for the development of the Allocation Plan for the implementation of the ETS and under the efforts to streamline both inventories. These units reported annual production quantities together with consumption of carbonate materials: limestone, dolomite, sodium, barium and potassium carbonates, from where average emission factors could be estimated.
- 2C1 Iron and Steel: The $CO_2$ emission factors for Electric Arc Furnace were derived from the reporting of the two iron and steel plants that are included in the ETS. Emissions were determined from consumption of carbon bearing materials in these units: limestone, calcium carbide and coke for years 2002 and 2003. It was assumed that the same carbon content exists in both scrap and final steel produced in EAF furnaces and consequently no additional emissions are estimated apart from carbon in additives.

#### 1.3.2.14 Spain

**General**

ETS data have been used for verification purposes. An agreement with the departments of the environment ministry, the industry ministry and the Autonomous Regions has been signed for this purpose. To improve further the inventory, it is planned to continue updating the inventory by including information derived from the ETS. The agreement for harmonization (streamlining) is still valid.

**Energy**

- In the 2011 submission, $CO_2$ emissions from power plants in the inventory were compared with the verified reports from installations under the EU ETS for QA/QC purposes.
- For the iron and steel industry such comparison could not yet be performed due to the access to the information. For coke oven plants not located at integrated steel plants, it has been found that data could not be used directly due to a more aggregated level of information provided under the ETS (no differentiation of processes, thus allocation of combustion and emissions to coke oven plants only is difficult).

**Industrial processes**

- 2A1 Cement production: Data on consumption of raw materials, emission factors and $CO_2$ emissions were obtained for the period 2005-2009 from EU-ETS..
- 2A2 Lime Production: Emissions between the GHG inventory and ETS reports have also been compared for lime production

### 1.3.2.15 Sweden

**General**

The coverage of ETS emissions in relation to total $CO_2$ emissions (without LULUCF) is 31.6% in 2008 and 29.2% in 2009. For a number of plants in the Energy and Industrial Process sectors, data from the ETS is used in the GHG inventory. For those source categories where ETS data was applied, companies have been contacted and asked to verify and explain the estimations they have reported to the ETS. In case there has been a mismatch between ETS and previous data, the industries have been asked to provide supplementary data. Data for years before 2005 have been taken from the data collection for the preparation of the Swedish National Allocation Plans under the ETS.

**Energy**

- 1A1b Petroleum Refining: Data from the EU Emission Trading System (ETS) are used for four refinery plants for 2005 and later years. For the fifth plant data from environmental reports were used. In 2008 and later years, the quality of ETS data is considered to be very high for all five of the refineries, and thus this is the primary data source for the GHG inventory. For refinery gas, plant specific $CO_2$ emission factors reported to the ETS are used for 2008 and later, since they are considered to be more accurate then the older standard emission factor. For each of the five refineries, ETS data for the latest year are verified against the refineries legal environmental reports. The coherence between environmental reports and ETS data is checked when possible, and when differences occur, the facilities are contacted for verification. For a few plants that flare small amounts of gas, activity data as amount of flared gas is shown neither in the environmental reports, nor in the ETS data. Flaring at these plants was investigated in 2005, and the same values are used for later years. Every year, these facilities are asked to verify that the default value is still valid.
- 1A2c Chemicals: Generally, plants classified as ISIC Division 24 according to ISIC Rev.3 in the energy statistics are included in this sector, as recommended in IPCC 1996 Revised Guidelines. In submission 2011, it was decided to make an exception from this rule and include one major plastic manufacturing plant that is classified as ISIC 24 some years and ISIC 25 other years in CRF 1A2c all years to improve time series consistency in CRF 1A2c and 1A2f. For one of the largest facilities, including two plants, ETS data is the activity data source for 2008-2009. In 2005-2007, only parts of these plants were included in ETS and thus ETS data is not a suitable data source for those years. Hence, in 1990-2007, the data source for these two plants was energy statistics verified against the companies' environmental reports and when needed, the environmental reports were used as a complementary data source. For this facility, plant specific $CO_2$ emission factors from ETS are used for 2008-2009 for the methane-based gas mixtures.
- 1A2f Other Industries: Emissions from all companies with less than 10 employees are estimated and reported under CRF 1A2f. For 2008 and 2009, activity data for the three plants within the cement production industry is taken from the EU ETS system.
- 1B2A1 Hydrogen production plants at refineries: Both $CO_2$ and non-$CO_2$ emissions are estimated using the Tier 2 method. Activity data as consumed amount of fuels (butane gas and naphtha, respectively for the two plants) and $CO_2$ emissions are taken from the company's report to the EU ETS system.
- 1B2C2 Flaring: For the years 2005 and later, data from the EU ETS system has been used when possible. Data from the EU ETS system are verified against data from environmental reports and vice versa. In submission 2010 EU ETS data was analyzed carefully. It was concluded that the notation key for flaring of natural gas (NE in earlier sub-missions) could be changed, since no such flaring could be found in the EU ETS data and all plants that might be flaring are included in the EU ETS. The coherence between environmental reports and ETS data is checked when possible, and when differences occur, the facilities are contacted for verification. For a few plants that flare small amounts of gas, activity data as amount of flared gas is shown neither in the environmental reports, nor in the ETS data.

**Industrial Processes**

- 2A1 Cement production: Cement production occurs at three facilities in Sweden, with one being dominant. Emission data are obtained from environmental reports, EU ETS and by direct contacts with the facilities. Emissions have been estimated based on ETS data as well as direct information from the company. From 2005, data on clinker production and total $CO_2$ emissions is retrieved from the ETS. The ETS data lack information on emissions from dust.
- 2A3 Limestone and Dolomite Use: Data on the use of limestone and dolomite have been acquired from environmental reports, the ETS and through direct contacts with the companies.
- 2A4 Soda Ash Production and Use: Data on the use of soda ash have been acquired from the ETS and through direct contacts with the reporting companies.
- 2A7 Glass production: Activity data and emissions are mainly collected from the ETS or from the facilities yearly environmental reports.
- 2A7 Light expanded clay aggregates (LECA), roofing tile, brick and ceramic production: From 2005 and onwards, the equivalent data for LECA is acquired through the ETS and the Swedish LECA producer's annual report. For roofing tile, brick and ceramics production, activity and emission data from 2005 and onwards is acquired through the ETS. The data in the ETS does not always separate between emissions from limestone/dolomite use and $CO_2$ emissions from other carbon containing raw material (i.e. from the clay and other carbonates used) needed for the production. In order to as far as possible report an accurate total process-related $CO_2$ emission for the facilities included in this 2A7 sub-code, Sweden have chosen to report all $CO_2$ emissions in 2A7. One facility for ceramics production was added in submission 2011. $CO_2$ emissions from this facility for the years 2008 and 2009 are acquired through the ETS. As there is a lack of data before 2008, the reported emission for 2008 is extrapolated for the years 1990-2007.
- 2C1 Iron and Steel Production: Secondary Steel Production: In most cases, data from the Swedish enquiry for the Swedish national allocation plan (NAP) for the EU ETS could be used for the years 1998-2002. Data for 1990-1997 and 2003-2004 has been collected directly from the plants. From 2005, the equivalent data are acquired from the ETS, from the facilities environmental reports and through contacts with the companies. Data in the ETS includes information concerning carbon bound in products, slag, etc, but also other sources for process related $CO_2$ emissions. Prior to submission 2010, these other emissions were not included for all facilities. Estimates of these missing $CO_2$ emissions were performed using ETS data for 2005 – 2008 and production data for years before 2005. All $CO_2$ emissions presented for the facilities in ETS 2005 – 2009 are included in 2C1.1 in submission 2011. Reported $CO_2$ emissions until year 2008 are for all facilities, except the one which closed down in 2004, based on data in the ETS.
- Primary Iron and Steel Production: From 2005, ETS data is used and 1990-2004, information has been acquired from the plant. The emissions are verified using national statistics from Statistics Sweden on amounts of coke, anthracite and out-put material. Activity data (amount of pig iron produced) on integrated pig iron and steel production along with $CO_2$ emissions and consumed amounts of energy gases (coke oven gas, blast furnace gas and LD-gas) and other fuels, are reported by the plants in the environmental reports since 2003. Mass-carbon balances and associ-ated $CO_2$ emissions are also reported to the EU-ETS since 2005. For some years, $CO_2$ emissions to the EU-ETS did not include all plant stations (rolling mills), and additional information from the plants was obtained in order to ensure that no omissions occurred. Since 2008 annual $CO_2$ emissions reported by the plants in their environmental reports are equal to those reported to the EU ETS. For 2003 onwards, information on activity data and emissions for all plants (CRF 1A1c, 1A2a, 1B1c and 2C1.2) are taken from the environmental reports. For plants included in the EU-ETS the report data is scrutinized and compared to EU-ETS data. EU-ETS data is applied wherever it is judged to be appropriate in line with the Good Practice Guidance.
- 2C5 Other metal production: Both plants in this category report their emissions in yearly environmental reports. For the one plant included in the EU-ETS the reported activity data and emissions are analysed and compared to EU-ETS data. Where EU-ETS data is judged to be appropriate and in line with the Good Practice Guidance, it is applied.

#### 1.3.2.16 United Kingdom

**General**

The data reported under the EU ETS includes quantities of fuels consumed, carbon contents, calorific values and emissions of $CO_2$. Data for individual installations are treated as commercially confidential by the UK regulatory authorities and so only aggregated emissions data are presented here.

From the 2008 EU ETS dataset onwards, all of the major plant opt-outs will have ceased, and a more complete picture of fuel use and emissions across heavy industry in the UK is available. Note however, that emissions from smaller combustion devices in the industrial, commercial and public sectors will not be reported, since they are outside the scope of the EU ETS. This limitation will continue to restrict how much of the EU ETS data can be used to cross-check and directly inform the GHGI. However, from the 2008 dataset onwards, 100% of sector emissions should be covered for several major industrial sectors:

- Power stations;
- Oil refineries;
- Coke ovens;
- Integrated steelworks;
- Cement kilns; and
- Lime kilns.

In the case of coke ovens and integrated steelworks, the EU ETS reporting format does not provide a breakdown of emissions for the sectors reported within the GHGI: estimates of emissions from coke ovens, blast furnaces and sinter plants are not provided explicitly. In addition, the scope of reporting of EU ETS does not cover 100% of iron & steel sites or activities, as some secondary steel processes are excluded from the scope of EU ETS reporting. These two factors make the analysis and comparison of the EU ETS and the GHGI estimates much more uncertain for these sectors. The EU ETS data has, however, been useful as a quality check for the use of fuels within the iron and steel sector.

**Energy**

Carbon emission factors for coal, fuel oil, natural gas and sour gas use in power stations and fuel oil use in refineries are based on data reported to the EU Emissions Trading System (EU ETS) for the years 2005-2009. These data are of high quality, and available for all significant UK plants - some very small power stations, e.g. on remote islands, will not report to EU ETS but their fuel use will be trivial. Due to the use of site-specific data, carbon emission factors for these source categories are Tier 3. EU ETS data are not available before 2005, therefore emission factors for the earlier years must be calculated in a different way.

- 1A1b Petroleum refinery: Data from the EU ETS are also used to estimate carbon emissions from combustion of petroleum coke at refineries. This petroleum coke is in the form of carbon deposits that build up on catalysts used in cracking processes. For the years 2005-2008, carbon emissions from catalyst regeneration are available from the EU ETS. The emissions are quantified by site operators within EU ETS using either a mass balance approach or, increasingly, by monitoring carbon dioxide emitted in the flue gases from the catalyst regenerator. Data are available for all UK refineries. The carbon emissions available from the EU ETS are not consistent with estimates of petroleum coke consumption given in UK energy statistics, but are used because they are the best data available. This decision was agreed in close consultation with the UK energy statistics team in DECC, as it is a deviation from reported UK energy statistics on refinery petroleum coke use. Before 2005, emissions are calculated using the activity data given in UK energy statistics and the emission factor proposed in Baggott et al, 2004. Carbon factors for OPG (2008 and 2009) and fuel oil (2006 to 2009) use in refineries are now also based on EU ETS data. The EU ETS emission factor for OPG is also used for OPG use in other sectors. Emissions from petroleum coke consumption in refineries are based on DUKES data and an emission factor (UKPIA, 2010) from 1990 to 2004, and EU

ETS emissions data from 2005 onwards. The EU ETS emissions data imply that the DUKES data are not consistent with the data presented in DUKES for this sector. The time series of fuel consumption presented in DUKES has been compared with the estimates derived from the EU ETS data and the UKPIA emission factor.

- 1A1c: For the 2011 inventory, EU ETS data have been used for the years 2008 and 2009, emissions for 2003 to 2007 have been interpolated.
- 1A2: Emission factors for coal use by autogenerators for 2005 to 2009 are now based on EU ETS data. Emission factors for lime kilns are also based on EU ETS data.
- 1B2 Oil and Natural gas: In recent years, these EU ETS data have been used by operators to update their EEMS emission estimates for combustion processes, ensuring consistency between EEMS and EU ETS, and by the Inventory Agency as a useful Quality Check on time-series consistency of carbon emission factors. Oil and Gas UK provides emission estimation guidance for all operators to assist in the completion of EEMS and EU-ETS returns to the UK environmental regulators, including the provision of appropriate default emission factors for specific activities, where installation-specific factors are not available.

**Industrial Processes**

The EU ETS has, for 2005 onwards, provided a source of high quality data on emissions from some industrial processes, especially cement production. In other cases, the data is limited due to opt-outs for processes that were already part of other schemes. The GHGI has made use of EU ETS data wherever possible to improve emission estimates.

- 2A2 Lime Production: Uncertainty in the activity data for 2009 is particularly high, since EU ETS fuel consumption data show a large decrease between 2008 and 2009 and this will presumably reflect a lowering in production. The current inventory methodology involves using the 2008 activity data as a temporary measure until data for 2009 become available but in this case this almost certainly leads to an overestimate in the activity data.

Use of EU ETS data may help to reduce uncertainties in the future by providing an alternative source of activity data.

### *1.3.3 Comparability and completeness of emissions reported under the EU-ETS and in annual GHG inventories*

As explained in the previous section reported verified emissions under the EU-ETS can only be directly used in the GHG inventory to report $CO_2$ emissions for a specific source category if the ETS data cover all installations that occur in a source category. Besides the completeness in scope of emission sources, there are however also differences in greenhouse gas emissions due to the completeness and comparability of the emission calculations for different source categories. There are a number of detailed technical provisions that are different in the monitoring and reporting guidelines for the EU ETS and the IPCC guidelines. These differences can lead to different reported $CO_2$ emissions under the EU ETS and in the GHG inventory. Some of these issues prevent inventory compilers from using verified emissions reported under the ETS directly for the national GHG inventory or limit the number of reports they can use. Some of these differences have been removed after the first phase of the EU ETS when the 2004 ETS monitoring and reporting guidelines (2004 MRG) were replaced by the 2007 ETS Monitoring and reporting (2007 MRG), however some new differences have been introduced in the second phase of the ETS from 2008-2012.

### 1.3.3.1 Determination of tiers

Both reporting guidelines, the IPCC guidelines and the ETS MRG, are based on methodological tiers that require higher levels of accuracy for emission sources contributing to a significant extent to the total emissions in a country. However, in the inventory reporting, the key category analysis determines which methodological tier should be used which is based on the contribution of a source category to the total emission level and the emission trend. If a source category is determined as key, all emissions from this source/sector have to be estimated based the same minimum tier methodology.

In the ETS reporting tiers apply at installation level based on the emission level (< 50 kt, ≥ 50 kt and ≤ 500 kt and > 500 kt $CO_2$) of each installation. At sectoral level, e.g. for power generation, verified emissions could result from small, medium and large emitters and are therefore based on different ETS tiers. For inventory key categories, it is therefore possible that not all verified emissions reported (in particular those estimates that are based on default parameters) under the EU ETS fulfil the tier-level required for the GHG inventory.

### 1.3.3.2 Fuel emission factors and net calorific values

The 2004 ETS MRG used default fuel emission factors from 1996 IPCC reporting guidelines13 and net calorific values and from 2000 IPCC Good Practice guidance which is consistent with the UNFCCC reporting guidelines under the Convention and the Kyoto Protocol. The revised 2007 ETS MRG use default fuel emission factors and net calorific values from 2006 IPCC guidelines for national GHG inventories which have not yet been adopted for reporting under the UNFCCC and will not be made mandatory before the reporting year 2015. Thus, starting from 2008 the reporting under the ETS, emissions may have been estimated with fuel-specific default EF that are not acknowledged under the UNFCCC. However, this may not affect the reporting practice substantially as both IPCC and the ETS guidelines require countries and installations to use measured/ installation-specific or country-specific EF and NCVs.

### 1.3.3.3 Oxidation factor

The Tier 1 method for combustion installations 2004 ETS MRG assumed an oxidation factor of 0.99 for conversion of C to $CO_2$ for all solid fuels and of 0.995 for all other fuels. IPCC 1996 Guidelines recommend 0.98 for coal, 0.99 for oil and oil products, 0.995 for gas and 0.99 for peat and electricity generation.14

**Table 1.7 Comparison of default oxidation factors used for GHG inventories and for ETS reporting**

| | **Fraction of carbon oxidised, default parameters for tier 1** | | |
|---|---|---|---|
| **Fuel type** | **1996 IPCC Guidelines valid for GHG inventories until 2014** | **2004 ETS MRG** | **2007 ETS MRG** |
| Coal | 0.98 | 0.99 | 1 |
| Oil and oil products | 0.99 | 0.995 | 1 |
| Gas | 0.995 | 0.995 | 1 |
| Peat for electricity generation | 0.99 | 0.99 | 1 |

The impact of these differences in the default assumptions for the oxidation factors on the emission estimation depends on the extent to which Member States and installations use tier 1 and the default parameters in their reporting.

13 With few exceptions such as shale oil for which IPCC guidelines don't provide a value

14 Table 1-6 Revised 1996 IPCC Guidelines for national GHG Inventories, Reference manual, chapter energy

#### 1.3.3.4 Transferred $CO_2$

The 2004 version of the ETS MRG included a specific provision for "transferred $CO_2$" which allowed to subtract $CO_2$ which is not emitted from the installation but transferred out of the installation as a pure substance, as a component of fuels or directly used as a feedstock in the chemical or paper industry, from the calculated level of emissions for an installation.15 $CO_2$ that is transferred out of the installation for the following uses could be considered as transferred $CO_2$:

- pure $CO_2$ used for the carbonation of beverages,
- pure $CO_2$ used as dry ice for cooling purposes,
- pure $CO_2$ used as fire extinguishing agent, refrigerant or as laboratory gas,
- pure $CO_2$ used for grains disinfestations,
- pure $CO_2$ used as solvent in the food or chemical industry,
- $CO_2$ used as feedstock in the chemical and pulp industry (e.g. for urea or carbonates).

In the reporting under the UNFCCC such subtraction is not allowed if the carbon is only stored for a short time (such as for beverages or dry ice) and consequently the intermediate binding of $CO_2$ in downstream manufacturing processes and products should not be subtracted from $CO_2$ emissions.

Thus, for Member States applying the provisions for transferred $CO_2$ in the first phase of the ETS, this provision introduced some differences in accounting of $CO_2$ emissions. In quantitative terms this was not very relevant as the quantities deducted for transferred $CO_2$ under the EU ETS were rather small as indicated in the responses to the questionnaires provided by Member States in relation of Article 21 of the ETS Directive.

In the revised version of the ETS MRG from 2007, the application of the provision requires approval by the competent authority and is only applicable if "*the subtraction is mirrored by a respective reduction for the activity and installation which the respective Member State reports in its national inventory submission to the UNFCCC.*" Thus, the revision of the 2007 ETS MRG made the reporting of transferred $CO_2$ more consistent with the GHG inventory.

#### 1.3.3.5 Cement production

For process emissions from cement production, the first version of the 2004 ETS MRG included a calculation method based on carbonate content of the process input that did not take into account emissions from cement kiln dust and emissions from non-carbonate content of raw materials while the other method based on clinker production took CKD into account. Both methods (input and output based) in 2007 ETS MRG estimate emissions from calcination of carbonates in the raw materials, from calcination of cement kiln dust as well as from non-carbonate content of raw materials for the higher tiers and are therefore fully consistent with IPCC Guidelines.

## 1.4 Description of key categories

A key category analysis has been carried out according to the Tier 1 method (quantitative approach) described in IPCC (2000). A key category is defined as an emission source that has a significant influence on a country's GHG inventory in terms of the absolute level of emissions, the trend in emissions, or both.

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15 Decision 2004/156/EC, p. 7ff

In addition to the key category analysis at EU-15 level, every Member State provides a national key category analysis which is independent from the assessment at EU-15 level16. The EU-15 key category analysis is not intended to replace the key category analysis by Member States. The key category analysis at EU-15 level is carried out to identify those categories for which overviews of Member States' methodologies, emission factors, quality estimates and emission trends are provided in this report. In addition, the EU-15 key category analysis helps identifying those categories that should receive special attention with regard to QA/QC at EU level. The Member States use their key category analysis for improving the quality of emission estimates at Member State level.

To identify key categories of the EU-15, the following procedure was applied:

- Starting point for the key category identification for this report were the CRF sectoral report tables and sectoral background data tables (for energy), i.e. CRF Tables 1A(a), 2(I), 3, 4, 5, 6 of the EU-15 GHG inventory. All categories where GHG emissions/removals occur were listed, at the most disaggregated level available at EU-15 level and split by gas.
- A level assessment was carried out for the years 1990 and 2009 and a trend assessment was performed for 1990 to 2009. The assessment was carried out for emissions excluding LULUCF and including LULUCF.
- The key category analysis excluding LULUCF resulted in the identification of 76 key categories for the EU-15 and cover 96 % of total EU-15 GHG emissions in 2009. The key category analysis including LULUCF resulted in 82 key categories (see Annex 1.1).

The results of the EU-15 key category analysis excluding LULUCF is presented in Table 1.8. In addition, the table also shows for each key category the share of emissions estimated with higher tier methods. It shows that for most key categories more than 75 % of EU-15 emissions are calculated with higher methods.

More details related to the key category analysis are included in Annex 1.1. In Chapters 3 to 9 for each key category overview tables are presented which include the Member States' contributions to the EU-15 key source in terms of level and trend. Annex 1.1 also includes the results of the Tier 2 key category. It shows that source category $N_2O$ emissions from 4D agricultural soils is by far the largest key category if uncertainties are included (both for level and trend).

**Table 1.8 Key categories for the EU-15 (Gg $CO_2$ equivalents)**

| Source category gas | Gg $CO_2$ equ. | | Trend | Level | | Share of higher Tier in Category |
|---|---|---|---|---|---|---|
| | 1990 | 2009 | | 1990 | 2009 | |
| 1 A 1 a Public Electricity and Heat Production: Gaseous Fuels ($CO_2$) | 60,419 | 255,377 | T | L | L | 95% |
| 1 A 1 a Public Electricity and Heat Production: Liquid Fuels ($CO_2$) | 123,501 | 43,678 | T | L | L | 97% |
| 1 A 1 a Public Electricity and Heat Production: Other Fuels ($CO_2$) | 12,660 | 32,295 | T | L | L | 94% |
| 1 A 1 a Public Electricity and Heat Production: Solid Fuels ($CO_2$) | 752,396 | 556,020 | T | L | L | 96% |
| 1 A 1 b Petroleum refining: Gaseous Fuels ($CO_2$) | 3,846 | 12,098 | T | | L | 100% |
| 1 A 1 b Petroleum refining: Liquid Fuels ($CO_2$) | 97,195 | 102,064 | T | L | L | 99% |
| 1 A 1 b Petroleum refining: Solid Fuels ($CO_2$) | 3,581 | 455 | T | | | 100% |
| 1 A 1 c Manufacture of Solid fuels and Other Energy Industries: Gaseous Fuels ($CO_2$) | 16,968 | 20,408 | T | L | L | 100% |
| 1 A 1 c Manufacture of Solid fuels and Other Energy Industries: Solid Fuels ($CO_2$) | 82,793 | 24,680 | T | L | L | 100% |

16 A comparison of the EC key category analysis with the key category analysis of the Member States (without LULUCF) in 2006 showed that most EC key categories are also key categories in the Member States. The Member States' key categories covered 92 % of the emissions of the 78 EC key categories in 2006.

| Source category gas | Gg $CO_2$ equ. | | Trend | Level | | Share of higher Tier in Category |
|---|---|---|---|---|---|---|
| | 1990 | 2009 | | 1990 | 2009 | |
| 1 A 2 a Iron and Steel: Gaseous Fuels ($CO_2$) | 17,446 | 13,925 | | L | L | 100% |
| 1 A 2 a Iron and Steel: Liquid Fuels ($CO_2$) | 7,520 | 3,996 | T | L | | 100% |
| 1 A 2 a Iron and Steel: Solid Fuels ($CO_2$) | 93,103 | 50,542 | T | L | L | 100% |
| 1 A 2 b Non-Ferous Metals: Solid Fuels ($CO_2$) | 3,351 | 367 | T | | | 76% |
| 1 A 2 c Chemicals: Gaseous Fuels ($CO_2$) | 27,778 | 28,216 | T | L | L | 91% |
| 1 A 2 c Chemicals: Liquid Fuels ($CO_2$) | 36,797 | 19,479 | T | L | L | 99% |
| 1 A 2 c Chemicals: Other Fuels ($CO_2$) | 3,603 | 5,815 | T | | L | 100% |
| 1 A 2 c Chemicals: Solid Fuels ($CO_2$) | 7,523 | 3,424 | T | L | | 98% |
| 1 A 2 d Pulp, Paper and Print: Gaseous Fuels ($CO_2$) | 10,580 | 15,392 | T | L | L | 97% |
| 1 A 2 d Pulp, Paper and Print: Liquid Fuels ($CO_2$) | 9,549 | 3,916 | T | L | | 92% |
| 1 A 2 e Food Processing, Beverages and Tobacco: Gaseous Fuels ($CO_2$) | 12,682 | 20,240 | T | L | L | 96% |
| 1 A 2 e Food Processing, Beverages and Tobacco: Liquid Fuels ($CO_2$) | 13,947 | 6,662 | T | L | L | 84% |
| 1 A 2 e Food Processing, Beverages and Tobacco: Solid Fuels ($CO_2$) | 4,841 | 1,338 | T | | | 98% |
| 1 A 2 f Other: Gaseous Fuels ($CO_2$) | 103,558 | 118,850 | T | L | L | 96% |
| 1 A 2 f Other: Liquid Fuels ($CO_2$) | 122,484 | 87,773 | T | L | L | 96% |
| 1 A 2 f Other: Other Fuels ($CO_2$) | 3,277 | 12,250 | T | | L | 96% |
| 1 A 2 f Other: Solid Fuels ($CO_2$) | 138,805 | 45,234 | T | L | L | 78% |
| 1 A 3 a Civil Aviation: Jet Kerosene ($CO_2$) | 13,237 | 16,804 | T | L | L | 98% |
| 1 A 3 b Road Transportation: Diesel oil ($CO_2$) | 266,862 | 494,535 | T | L | L | 100% |
| 1 A 3 b Road Transportation: Diesel oil ($N_2O$) | 1,647 | 4,626 | T | | | 100% |
| 1 A 3 b Road Transportation: Gasoline ($CH_4$) | 4,098 | 836 | T | | | 93% |
| 1 A 3 b Road Transportation: Gasoline ($CO_2$) | 362,786 | 249,481 | T | L | L | 99% |
| 1 A 3 b Road Transportation: LPG ($CO_2$) | 7,283 | 6,498 | | L | L | 89% |
| 1 A 3 c Railways: Liquid Fuels ($CO_2$) | 7,783 | 4,998 | | L | | 87% |
| 1 A 3 d Navigation: Gas/Diesel Oil ($CO_2$) | 9,323 | 10,000 | | L | L | 72% |
| 1 A 3 d Navigation: Residual Oil ($CO_2$) | 6,698 | 7,445 | | L | L | 96% |
| 1 A 4 a Commercial/Institutional: Gaseous Fuels ($CO_2$) | 60,114 | 99,224 | T | L | L | 95% |
| 1 A 4 a Commercial/Institutional: Liquid Fuels ($CO_2$) | 75,892 | 43,881 | T | L | L | 100% |
| 1 A 4 a Commercial/Institutional: Solid Fuels ($CO_2$) | 27,789 | 2,099 | T | L | | 96% |
| 1 A 4 b Residential: Gaseous Fuels ($CO_2$) | 161,940 | 230,837 | T | L | L | 90% |
| 1 A 4 b Residential: Liquid Fuels ($CO_2$) | 169,468 | 130,201 | T | L | L | 95% |
| 1 A 4 b Residential: Solid Fuels ($CO_2$) | 74,513 | 10,858 | T | L | L | 95% |
| 1 A 4 c Agriculture/Forestry/Fisheries: Gaseous Fuels ($CO_2$) | 8,716 | 10,073 | | L | L | 93% |
| 1 A 4 c Agriculture/Forestry/Fisheries: Liquid Fuels ($CO_2$) | 56,758 | 49,680 | | L | L | 38% |
| 1 A 4 c Agriculture/Forestry/Fisheries: Solid Fuels ($CO_2$) | 3,712 | 435 | T | | | 100% |
| 1 A 5 a Stationary: Solid Fuels ($CO_2$) | 4,667 | 10 | T | | | 97% |
| 1 A 5 b Mobile: Liquid Fuels ($CO_2$) | 13,672 | 5,062 | T | L | | 82% |
| 1 B 1 a Coal Mining: ($CH_4$) | 44,022 | 7,619 | T | L | L | 54% |
| 1 B 2 a Oil: ($CO_2$) | 8,514 | 9,439 | | L | L | 69% |

| Source category gas | Gg $CO_2$ equ. | | Trend | Level | | Share of higher Tier in Category |
|---|---|---|---|---|---|---|
| | 1990 | 2009 | | 1990 | 2009 | |
| 1 B 2 b Natural gas: ($CH_4$) | 25,379 | 19,122 | T | L | L | 100% |
| 2 A 1 Cement Production: ($CO_2$) | 80,174 | 65,523 | T | L | L | 72% |
| 2 A 2 Lime Production: ($CO_2$) | 17,194 | 13,784 | | L | L | 36% |
| 2 A 3 Limestone and Dolomite Use: ($CO_2$) | 7,444 | 5,598 | | L | | 72% |
| 2 B 1 Ammonia Production: ($CO_2$) | 19,450 | 15,381 | | L | L | 96% |
| 2 B 2 Nitric Acid Production: ($N_2O$) | 35,772 | 11,357 | T | L | L | 100% |
| 2 B 3 Adipic Acid Production: ($N_2O$) | 58,927 | 10,804 | T | L | L | 28% |
| 2 B 5 Other: ($CO_2$) | 10,406 | 13,881 | T | L | L | 100% |
| 2 C 1 Iron and Steel Production: ($CO_2$) | 47,287 | 27,608 | T | L | L | 90% |
| 2 C 3 Aluminium production: (PFC) | 13,347 | 677 | T | L | | 100% |
| 2 E 1 By-product Emissions: (HFC) | 21,158 | 697 | T | L | | 100% |
| 2 E 1 By-product Emissions: ($SF_6$) | 1,559 | - | T | | | |
| 2 E 2 Fugitive Emissions: (HFC) | 6,301 | 1,035 | T | | | 100% |
| 2 F 1 Refrigeration and Air Conditioning Equipment : (HFC) | 166 | 50,122 | T | | L | 89% |
| 2 F 3 Fire Extinguishers: (HFC) | 1 | 2,564 | T | | | |
| 2 F 4 Aerosols/ Metered Dose Inhalers: (HFC) | 76 | 7,657 | T | | L | 92% |
| 4 A 1 Cattle: ($CH_4$) | 117,434 | 103,800 | | L | L | 100% |
| 4 A 3 Sheep: ($CH_4$) | 16,671 | 13,456 | | L | L | 73% |
| 4 B 1 Cattle: ($CH_4$) | 22,346 | 20,011 | | L | L | 78% dairy cattle, 48% non-dairy cattle |
| 4 B 13 Solid Storage and Dry Lot: ($N_2O$) | 20,189 | 16,682 | | L | L | 63% |
| 4 B 8 Swine: ($CH_4$) | 17,134 | 19,013 | T | L | L | 65% |
| 4 D 1 Direct Soil Emissions: ($N_2O$) | 117,233 | 96,332 | T | L | L | 35% |
| 4 D 2 Pasture, Range and Paddock Manure: ($N_2O$) | 30,292 | 25,551 | | L | L | 55% |
| 4 D 3 Indirect Emissions: ($N_2O$) | 81,939 | 65,135 | T | L | L | 31% |
| 6 A 1 Managed Waste disposal on Land: ($CH_4$) | 138,429 | 76,701 | T | L | L | 98% |
| 6 A 2 Unmanaged Waste Disposal Sites: ($CH_4$) | 13,578 | 5,997 | T | L | L | 100% |
| 6 B 2 Domestic and Commercial Wastewater: ($CH_4$) | 8,999 | 6,609 | | L | L | 25% |
| 6 B 2 Domestic and Commercial Wastewater: ($N_2O$) | 9,589 | 10,038 | | L | L | 15% |

## 1.5 Information on the quality assurance and quality control plan

### *1.5.1 Quality assurance and quality control of the European Union inventory*

The European Union GHG inventory is based on the annual inventories of the Member States. Therefore, the quality of the European Union inventory depends on the quality of the Member States' inventories, the QA/QC procedures of the Member States and the quality of the compilation process of the European Union inventory. The Member States and also the European Union as a whole implemented QA/QC procedures in order to comply with the IPCC good practice guidance.

The EU QA/QC programme describes the quality objectives and the inventory quality assurance and quality control plan for the EU GHG inventory including responsibilities and the time schedule for the performance of the QA/QC procedures: Definitions of quality assurance, quality control and related terms used are those provided in IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories and Guidelines for National Systems under the Kyoto Protocol. The EU QA/QC programme will be reviewed annually and modified or updated as appropriate.

The European Commission (Directorate General Climate Action) is responsible for coordinating QA/QC activities for the EU inventory and ensures that the objectives of the QA/QC programme are implemented and the QA/QC plan is developed. The European Environment Agency (EEA) is responsible for the annual implementation of QA/QC procedures for the EU inventory.

The overall objectives of the EU QA/QC programme are:

- to provide an EU inventory of greenhouse gas emissions and removals consistent with the sum of Member States' inventories of greenhouse gas emissions and removals,
- to establish appropriate QA/QC procedures at EU level in order to comply with requirements under the UNFCCC and the Kyoto Protocol,
- to contribute to the improvement of quality of Member States' inventories and
- to provide assistance for the implementation of national QA/QC programmes.

A number of specific objectives have been elaborated in order to ensure that the EU GHG inventory complies with the UNFCCC inventory principles of transparency, completeness, consistency, comparability, accuracy and timeliness.

In the QA/QC plan quality control procedures before and during the compilation of the EU GHG inventory are listed. In addition, QA procedures, procedures for documentation and archiving, the time schedules for QA/QC procedures and the provisions related to the inventory improvement plan are included.

QC procedures are performed at several different stages during the preparation of the European Union inventory. Firstly, a range of checks are used to determine the consistency and completeness of Member States' data so that they may be compiled in a transparent manner at EU level. Secondly, checks are carried out to ensure that the data are compiled correctly at EU level to meet the overall reporting requirements. Thirdly, a number of checks are conducted with regard to data archiving and documentation to meet various other data quality objectives.

Based on the EU QA/QC programme a quality management manual was developed which includes all specific details of the QA/QC procedures (in particular checklists and forms). The structure of the EU quality management manual has been developed on the basis of the Austrian quality management manual. The reason for using the Austrian manual as a template for the EU manual is that the EU GHG inventory is compiled by Umweltbundesamt Austria and the implementation of the annual QA/QC procedures are coordinated by Umweltbundesamt Austria. By using the Austrian quality manual as a template for the EU quality manual the EU can benefit from the experience made during the set-up of the Austrian quality management system which is accredited under ISO 1720; procedures and documents from the Austrian system have been taken and adapted according to the need of the EU quality management system.

The EU quality management manual is structured along three main processes (management processes, inventory compilation processes, supporting processes) of the quality management system (Table 1.9).

**Table 1.9 Structure of the EU quality management manual**

| Chapter | | Chapter description |
|---|---|---|
| **Management processes** | | |
| ETC 01 | EU inventory system | Describes the organisation and responsibilities within the EU GHG inventory system |
| ETC 02 | QA/QC programme | Describes the preparation and evaluation of the EU QA/QC programme by the |

| Chapter | | Chapter description |
|---|---|---|
| | | European Commission |
| ETC 03 | Quality management system | Describes the responsibilities and the structure of the quality management system and gives an overview of the forms and checklists used |
| ETC 04 | Quality management evaluation | Describes the evaluation of the status and effectiveness of the quality management system |
| ETC 05 | Correction and prevention | Describes the procedures for the correction and prevention of mistakes that occur in the EU inventory |
| ETC 06 | Information technology systems | Describes the information technology systems used such as CIRCA, Reportnet and the systems set up at Umweltbundesamt Austria |
| ETC 07 | External communication | Describes the communication with Member States and other persons and institutions |
| **Inventory compilation processes** | | |
| ETC 08 | QC MS submissions | Describes the quality control activities performed on the GHG inventories submitted by the EU Member States |
| ETC 09 | QC EU inventory compilation | Describes the quality control activities performed during the compilation of the EU GHG inventory including checks of database integrity |
| ETC 10 | QC EU inventory report | Describes the checks carried out during and after the compilation of the EU GHG inventory report |
| **Supporting processes** | | |
| ETC 11 | Documents | Describes the production, change, proofreading, release and archiving of quality management documents |
| ETC 12 | Documentation and archiving | Describes the procedure for preparing documentation and archiving |

The quality checks performed during inventory compilation process are the central part of the quality manual. Quality checks are made at three levels:

#### 1.5.1.1 Quality control MS submissions

The QC activities of MS submissions include two elements; checking the completeness of the Member States CRF tables and checking the consistency of Member States GHG data. The com-pleteness checks of Member States' submissions are carried out by EEA/ETC-ACM by using a similar status report form as used by the UNFCCC Secretariat. The completed status reports are sent to Member States by 28 February; then Member States can check the status reports and update information, if needed. The status reports of the Member States' submissions are included in Annex 1.3 of this report.

The consistency checks of Member States data primarily aim at identifying main problems in time series of emissions and implied emissions factors, implied emissions factors across Member States and sub-category sums. For the time series checks the algorithms of the UNFCCC secretariat are used. In addition, the ETC/ACM identifies potential problems by comparison with the previous year's inventory submission of the Member States and checks the availability of the CRF tables needed for the compilation of the EU inventory. The results of these checks are documented in the consistency reports and are also sent to the Member States by 28 February, in order to obtain, if needed, revised emission estimates or additional information.

For the sectors energy, industrial processes, agriculture, LULUCF and waste sector-specific checks are performed by the sector experts and documented in sector-specific forms/checklists. In addition, the EU sector experts receive the results of checks with the UNFCCC outlier tool before they are sent to the Member States. The main findings of the sector specific checklists are transferred to/also documented in the consistency reports.

For every updated inventory submission provided by the MS by 15 March follow-up checks are performed and the status reports are completed; for new submissions a consistency report is prepared. In addition it is checked if issues identified in the status reports and in the consistency reports (initial checks), which are relevant for the EU inventory (report) have been clarified by the MS. If this is not the case MS are contacted for clarification.

### 1.5.1.2 Quality control EU inventory compilation

After the initial checks of the emission data, the ETC/ACM transfers the national data from the xml-files into the ETC/ACM CRF aggregator database. The version of the data received by ETC/ACM are numbered, in order to be traced back to their source. The ETC/ACM CRF aggregator database is maintained and managed by Umweltbundesamt Austria.

As the EU GHG inventory is compiled on the basis of the inventories of the EU Member States, the focus of the quality control checks performed during the compilation of the EU GHG inventory lays on checking if the correct MS data are used, if the data can be summed-up (same units are used) and that the summing-up is correct. Finally, the consistency and the completeness of the EU GHG inventory is checked. All the checks are carried out for the original submission by 15 April each year and for any resubmission. Two checklists are used for this purpose: ‘Inventory preparation/consistency’ and ‘Data file integrity’.

### 1.5.1.3 Quality checks EU inventory report

The checks carried out during and after the compilation of the EU GHG inventory report are specified in the checklist ‘EU inventory report’. They cover a.o. checks of data consistency between the inventory and the inventory report, data consistency between the tables and the text, but also checks of the layout.

The circulation of the draft EU inventory and inventory report on 28 February to the EU Member States for reviewing and commenting also aims to improve the quality of the EU inventory and inventory report. The Member States check their national data and information used in the EU inventory report and send updates, if necessary, and review the EU inventory report. This procedure should assure the timely submission of the EU GHG inventory and inventory report to the UNFCCC secretariat and it should guarantee that the EU submission to the UNFCCC secretariat is consistent with the Member States UNFCCC submissions.

Finally, also the detailed analysis of GHG emission trends of the EU and each EU Member State after the submission of the EU inventory to the UNFCCC also contributes to improving the quality of the EU GHG inventory. This analysis is carried out in the annual EU GHG trend and projections report (see EEA, 2009b); the report identifies sectoral indicators, for socio-economic driving forces of greenhouse gas emissions, by using Member States indicator submissions under Council decision 280/2004 or data from Eurostat and from Member States’ detailed inventories. In addition, it compares and analyses Member States’ emission trends in the EU key sources and provides main explanations, either socio-economic developments or policies and measures, for these trends in some Member States.

### 1.5.1.4 EU internal review

A collaborative internal review mechanism is established within the European Union so that all participants (MS, EEA, Eurostat, and JRC) may contribute to the identification of shortcomings and propose amendments to existing procedures. The review activities with experts from Member States are coordinated by the ETC/ACM under Working Group I and take place during the period from April through September each year. The synthesised findings of collaborative reviews provide a basis for the planned progressive development of inventories both at Member state and at EU level.

The EU internal reviews 2010 and 2009 focussed on potential under-estimations of the MS inventories as identified in the UNFCCC review reports 2008 and on the use of EU-ETS data in the GHG inventories. In 2008, the internal review was a follow-up of the EU initial review assessed the completeness and comparability (consistent allocation) of Member States' emissions in the sector Industrial Processes. In addition, $N_2O$ emissions from road transport were reviewed. In 2007, the internal review focused on the uncertainty estimates by identifying potential outliers of MS uncertainty estimates. In 2006 the following source categories have been reviewed by Member States experts: 1A1 'Energy industries', 1A2a 'Iron and steel production', 1.B 'Fugitive emissions from fuels', 2.A 'Mineral products', 2B 'Chemical industry', 2C 'Iron and steel production' and fluorinated gases, 2.E 'Production of halocarbons and $SF_6$' and 2.F 'Consumption of halocarbons and $SF_6$'. In 2005, the EU internal review was carried out for the first time. In this pilot exercise two Member States experts reviewed the source categories 1A2 'Manufacturing industries' and 1A3 'Transport'.

#### 1.5.1.5 UNFCCC reviews

In addition, European Union QA procedures aim to build on the issues identified during the independent UNFCCC inventory review of Member States' inventories. Quality assurance procedures based on outcomes of the UNFCCC inventory review consist of the:

- Annual compilation of issues identified during the UNFCCC inventory review related to sectors, key source categories and the major inventory principles transparency, consistency, completeness, comparability and accuracy for all Member States;
- Identification of major issues from the compilation and discussion of ways to resolve them in Working Group 1 under the Climate Change Committee, including identification and documentation of follow-up actions that are considered as necessary within Working Group 1;
- Reviews of the extent to which issues identified through this procedure in previous years have been addressed by Member States;
- Ongoing investigations of ways to produce a more transparent inventory for the unique circumstances of the European Union.

#### 1.5.1.6 Improvement plan

Based on the findings of the UNFCCC reviews, the EU internal review and other recommendations the improvement plan for the EU GHG inventory is compiled before the annual compilation process starts. After the finalisation of the annual EU GHG inventory it is evaluated if the improvements planned have been implemented.

### *1.5.2 Overview of quality assurance and quality control procedures in place at Member State level*

As the EU GHG inventory is based on the annual inventories of the EU Member States, the quality of the EU inventory depends on the quality of the Member States' inventories and their QA/QC procedures. Table 1.10 gives an overview of QA/QC procedures in place for the EU-15 Member States. The information is taken from the Member State national inventory reports 2008, 2009 and 2010.

**Table 1.10 Overview of quality assurance and quality control procedures in place for EU-15 MS at Member State level (NIR descriptions)**

| MS | Description of the national QA/QC activities | Source |
| --- | --- | --- |

| MS | Description of the national QA/QC activities | Source |
|---|---|---|
| **Austria** | A quality management system (QMS) has been designed to achieve to the objectives of good practice guidance, namely to improve transparency, consistency, comparability, completeness and confidence in national inventories of emissions estimates. The QMS is based on the Inter-national Standard ISO/IEC 17020 General Criteria for the operation of various types of bodies performing inspections. The QMS ensures that all requirements of a type A inspection body as stipulated in ISO/IEC 17020 are met, which include strict independence, impartiality and integrity. Since December 2005 the Umweltbundesamt has been accredited as inspection body (Id.No.241) in accordance with the Austrian Accreditation Law.<br>The implementation of QA/QC procedures as required by the IPCC-GPG support the development of national greenhouse gas inventories that can be readily assessed in terms of quality and completeness. The QMS as implemented in the Austrian inventory includes all elements of the QA/QC system outlined in IPCC-GPG Chapter 8 "Quality Assurance and Quality Control", and goes beyond. It also comprises supporting and management processes in addition to the QA/QC procedures in inventory compilation and thus ensures agreed standards not only within (i) the inventory compilation process and (ii) supporting processes (e.g. archiving), but also for (iii) management processes (e.g. annual management reviews, internal audits, regular training of personnel, error prevention).<br>The Austrian Quality Management System is described in detail in Austria's NIR 2010).<br>**Changes to the QMS since the last submission**<br>In 2010 the following QA/QC activities and improvements have been made:<br>• In response to an external audit by the accreditation body (2009), excel files used for emissions calculations have to be validated before use additionally to the validation of the results. This has fairly been implemented in 2010.<br>• In 2010 new experts joined the "Inspection Body for Emission Inventories". They have been integrated successfully enabling a smoothly maintenance of inventory work.<br>• In case of a resubmission of the Austrian Inventory – as required 2010 in response to the UNFCCC Review 2010 („Saturday Paper") – an additional QAQC check has been introduced resp. formalized in the QMS. It provides for an accurate checking of data and calculation, fol-lowing the four-eye principle.<br>• In response to an external system audit of the QMS, the responsibilities of the CEO (Chief Executive Officer) and the Head of the Inspection Body has been reorganized.<br>On the 13th and 14th January 2011 a comprehensive external audit by the accreditation body took place at the Umweltbundesamt. This „Re-Accreditation" is obligatory every 5 years and aims at examining the "Inspection Body for Emission Inventories" respectively its QM-System in detail. The result of this audit and measures to be implemented will be described in the National Inventory Report 2011. | Austria's Annual Greenhouse Gas Inventory 1990–2009<br>Jan 2011<br>p. 31f |
| **Belgium** | Belgium did submit a full QA/QC plan of the Belgian national system for the estimation of anthropogenic greenhouse gas emissions by sources and removals by sinks under Article 5, paragraph 1, of the Kyoto Protocol on the 20th of October 2008 to the UNFCCC-experts as a demand of the UNFCCC-centralized review carried out from the 1st to the 6th of September 2008. In the final Annual Review Report of UNFCCC (Report of the individual review of greenhouse gas inventories of Belgium submitted in 2007 and 2008) the ERT concluded that the QA/QC plan has been prepared and implemented in accordance with the IPCC good practice guidance. This plan is revised during the 2010 submission to the UNFCCC-secretariat.<br>The overall QA/QC responsibilities on the Belgian GHG inventory are carried out at IRCEL/CELINE, the interregional cell for the environment which is the national inventory agency responsible for international obligations related to air emissions reporting.<br>As a consequence, the quality and assurance controls already carried out within the responsible regions, are supplemented by the QA/QC performed to the national Belgian inventory. After completion of the Belgian greenhouse gas emission inventory by IRCEL/CELINE, the regions and IRCEL/CELINE carry out further quality control checks of the national inventory before the official submission takes place. IRCEL/CELINE is the final responsible for the national inventory, and any change at this stage is conducted only by IRCEL/CELINE, after co-ordination with the relevant regional contacts. The QC checks are described in section 1.6.1.5. of the BE NIR.<br>Independent audits of the greenhouse gas inventories of the regions and the national inventory have started in the course of 2002 and results became available in 2003. The purpose of these audits was to analyse the difficulties encountered while compiling the regional emission inventories into the national inventory in order to improve the quality and completeness of the Belgian national emission inventory and to evaluate the differences between the process at that time and the obligations in the framework of the UNFCCC & IPCC Guidelines and the Kyoto Protocol.<br>The results of these audits of greenhouse gases inventories showed clearly that the Belgian national inventory is of qualitative good value. The difference between the situation in Belgium at that time and the fulfilling of the IPCC Guidelines was mainly the absence of the complete implementation of the IPCC Good Practice Guidance for the Belgian emission inventory with respect to setting up a quality system.<br>Technical working groups are set up since the beginning of 2003 to investigate in detail the implementation of the Good Practice Guidance for the different sectors in Belgium and to harmonise the 3 regional emission inventories in Belgium as much as possible. The overall conclusion in the different technical working groups was that appropriate methods are used for all sectors and in accordance with the IPCC Good Practice Guidance.<br>All three regions perform their own QC procedures. Below, the state of the art in the three regions is briefly described. The Tier 1 QC checks conducted at the regional and the national level are also included in the BE NIR. | Belgium's GHG Inventory (1990-2009)<br>Jan 2011<br>pp. 13-15 |

| MS | Description of the national QA/QC activities | Source |
|---|---|---|
| **Denmark** | The Quality Control (QC) and Quality Assurance (QA) plan for greenhouse gas emission inventories performed by the Danish National Environmental Research Institute is in accordance with the guidelines provided by the UNFCCC (IPCC, 1997), and the Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000). The ISO 9000 standards are also used as important input for the plan.<br>The quality planning is based on the following definitions as outlined by the ISO 9000 standards as well as the Good Practice Guidance (IPCC, 2000):<br>• Quality management (QM) Coordinates activity to direct and control with regard to quality.<br>• Quality Planning (QP) Defines quality objectives including specification of necessary operational processes and resources to fulfil the quality objectives.<br>• Quality Control (QC) Fulfils quality requirements.<br>• Quality Assurance (QA) Provides confidence that quality requirements will be fulfilled.<br>• Quality Improvement (QI) Increases the ability to fulfil quality requirements.<br>The QA/QC work is supported by an inventory file system, where all data, models and QA/QC procedures and checks are stored.<br>The QA/QC plan will continuously improve these activities in the future.<br>The Danish Quality Concept foresees quality management, quality planning, quality control, quality assurance and quality improvement. The strategy for process-oriented QC is based on setting up a system for the process of the inventory work. In the Danish Annual EC Greenhouse Gas Report 2010: Inventories 1990-2008 it is stated that the QA/QC programme has not been changed. | Danish Annual EC GHG report 2010: Inventories 1990-2008 Jan 2010, p. 2<br>No change since 2010 submission |
| **Finland** | The quality management system is an integrated part of the national system. It ensures that the greenhouse gas inventories and reporting are of high quality and meet the criteria of transparency, consistency, comparability, completeness, accuracy and timeliness set for the annual inventories of greenhouse gases.<br>Statistics Finland has the overall responsibility for the GHG inventory in Finland including the responsibility for co-ordinating the quality management measures at the national level. Statistics Finland compiles and approves the inventory and submits it to the UNFCCC Secretariat and to the European Commission. As a national statistical office Statistics Finland and its Greenhouse gas inventory unit are committed to quality. The quality framework based on the European Statistics Code of Practice and Statistics Finland's Guidelines on Professional Ethics supports the GHG inventory quality management. The expert organisations contributing to the production of emission or removal estimates are responsible for the quality of their own inventory calculations.<br>The quality co-ordinator steers and facilitates the quality assurance and quality control (QA/QC) process, and experts of all calculation sectors implement and document the QA/QC procedures. The inventory working group that consists of participants from all institutes involved in the inventory preparation has been established to advance communication between the inventory unit and the expert organisations in charge of the different sectors. Issues related to QA/QC are discussed in the meetings of the inventory working group and in the bilateral quality meetings between the inventory unit and the expert organisations.<br>An electronic quality manual including e.g. guidelines, plans, templates and checklists is in place and available to all parties of the national inventory system via the Internet.<br>Statistics Finland bears the responsibility for archiving the quality manual and for submissions of annual inventories (CRF tables and NIR). Expert organisations contributing to the sectoral calculation archive the primary data used, internal documentation of calculations and sectoral CRF tables.<br>Statistics Finland co-ordinates the participation of the partners of the national system in the reviews, as well as responses to issues raised by the reviews of the UNFCCC Secretariat.<br>The quality objectives and the planned QC and QA procedures are recorded as the QA/QC plan. The QA/QC plan is a checklist that specifies the QC and QA actions, the schedules for the actions and the responsibilities.The QA/QC plans are written in Finnish. The QA/QC plans are part of the electronic quality manual of the inventory and archived according to the inventory unit's archive formation plan. Quality objectives and QA/QC plans are updated yearly in the spirit of continuous improvement.<br>The QC procedures in use in the Finland´s GHG inventory comply with the IPCC good practice guidance. General inventory QC checks (IPCC GPG 2000, table 8.1 and IPCC GPG LULUCF 2003, table 5.5.1) include routine checks of the integrity, correctness and completeness of data, identification of errors and deficiencies and documentation and archiving of inventory data and quality control actions. In addition to general QC checks, category-specific QC checks including technical reviews of the source categories, activity data, emission factors and methods are applied on a case-by-case basis focusing on key categories and on categories where significant methodological and data revisions have taken place. Results of the QC checks are recorded in internal documents for the calculation and archived in the expert organisations. The quality assurance (QA) activities recorded in the QA/QC plan are performed at the inventory evaluation stage. QA reviews are performed after the implementation of QC procedures to the finalised inventory. The inventory QA system comprises reviews and audits to assess the quality of the inventory and the inventory preparation and reporting process, to determine the conformity of the procedures taken and to identify areas where improvements could be made<br>ISO 9001 certification of the inventory quality management system is under consideration. | GHG Emissions in Finland 1990-2009<br>Draft,<br>Jan 2011 pp.28-33 |

| MS | Description of the national QA/QC activities | Source |
|---|---|---|
| France | The national emissions inventory system is set up, by incorporating the usual criteria applicable to Quality Management Systems (QMS). CITEPA, in charge of preparing the national emissions inventories from a technical viewpoint, has put in place a system for quality assurance and quality control based on the ISO 9001 standard . This approach has been confirmed by the fact that CITEPA was awarded a certificate issued by the French Quality Management Body (AFAQ) in 2004. This was renewed in 2007 and in 2010 and follow-up audits were conducted in between. The task of preparing the national emissions inventories is covered by the QMS via several specific processes (see Quality Manual – confidential in-house document). In this framework, several processes for quality assurance and quality control of the inventories are incorporated into the different processes and procedures implemented, corresponding to the different phases and actions.<br>The overall objective of the quality assurance and quality control programme focuses on the production of national emissions and sinks inventories in line with requirements issued in the different national and international frameworks covered by the SNIEPA. These requirements concern the definition, implementation and application of procedures and methods aimed at meeting the criteria on traceability, exhaustiveness, consistency, comparability and punctuality required by international and EU institutions, as part of the commitments France has signed up to.<br>Quality control is incorporated into the different phases of the processes and procedures developed by the bodies involved in the national system in order to achieve the objectives and targets set. The CITEPA, the body responsible for the technical coordination and compilation of the inventories is in charge of monitoring quality control and issues recommendations aimed at improving, completing and developing the necessary processes and procedures. These procedures can be automatic or manual, take the form of a check-list, feasibility, consistency, exhaustiveness, trend analysis and simulation tests, etc. They are implemented at several stages in the process of conducting the inventory.<br>Quality assurance is provided through several measures designed to subject the inventories to reviews for the purpose of obtaining comments and assessments from stakeholders, generally with expert knowledge. | direct communication, March 2011 |
| Germany | The quality system "Qualitässystem Emissionsinventare" (QSE) is built on the requirements of the IPCC Good Practise Guidance (defined in chapter 8), the national requirements in Germany and the internal Structure within Umweltbundesamt (the national Coordination Centre for GHG inventory compilation). QSE covers all steps of the inventory preparation. It was made bindig within Umweltbundesamt by means of the UBA-Hausanordnung 11/2005 (a regulatory framework).<br>QSE regulates responsibilities within the QA/QC system. The quality control checks for Tier 1 (pursuant paragraph 14 (g) of the Guidelines for National Systems) were carried out for 2006 reporting the first time. They were sent as QC check lists to the experts together with the request for data.The minimum requirements according to the QA/QC system for implementation, description and documentation of the QA/QC measures are carried out together with the respective contribution to the inventory. A general description of quality aims is given in the QSE-Handbook (derived from the IPCC Good Practise Guidance).<br>According to the requirements for the IPCC GPG and Paragraph 12 (d) of the Guidelines for National Systems the necessary QA/QC activities should be summarised in a QA/QC plan. The QA/QC plan is combined with the checklist for QA/QC. For 2008, 2009 and 2010 reporting the checklists for sectoral experts were improved. Thus, both the QA/QC plans and QA/QC checklists are an instrument for the inspection of the fulfilment of the international requirements and allow for control over the quality of the inventory.<br>In the quality improvement plan potential for improvement and findings from the independent inventory review are documented.<br>Data are documented in a central archive. Either data are stored in the central archive directly or if for a given reason (e.g. confidentiality of the data) data is not stored in the central archive reference is given to place were the data is stored. | Nationaler Inventarbericht Zum Deutschen Treibhausgasinventar 1990 - 2009<br>Jan 2010 pp. 82ff<br>(submitted in German, translated) |

<table>
<tr><th>MS</th><th>Description of the national QA/QC activities</th><th>Source</th></tr>
<tr><td>Greece</td><td>A QA/QC system is being implemented since April 2004. It has been developed by the previous technical consultant (NOA) and is still being used by the National Technical University of Athens. A revision of the system was performed in May 2008, according to the experience gained from 2008 and 2009 submission, resulting in the current version 1.2. The supervision of QA/QC system is performed by the Ministry of Environment, Energy and Climate Change. The system is based on the ISO 9001:2000 standard and its quality objectives, as stated in the quality management handbook, are the following:
<ul>
<li>Compliance with the IPCC guidelines and the UNFCCC reporting guidelines while estimating and reporting emissions/removals.</li>
<li>Continuous improvement of GHG emissions/removals estimates.</li>
<li>Timely submission of necessary information in compliance with relevant requirements defined in international conventions, protocols and agreements.</li>
<li>The accomplishment of the above-mentioned objectives can only be ensured by the implementation of the QA/QC procedures included in the plan for:</li>
<li>data collection and processing</li>
<li>applying methods consistent with IPCC Good Practice Guidance and LULUCF Good Practice Guidance for calculating / recalculating emissions or removals,</li>
<li>making quantitative estimates of inventory uncertainty,</li>
<li>archiving information and record keeping and</li>
<li>compiling national inventory reports</li>
</ul>
The QA/QC system developed covers the following processes:<br><br>
QA/QC system management, comprising all activities that are necessary for the management and control of the inventory agency in order to ensure the accomplishment of the quality objectives.<br><br>
Quality control that is directly related to the estimation of emissions. The process includes activities related to (a) data inquiry, collection and documentation, (b) methodological choice in accordance with IPCC Good Practice Guidance, (c) quality control checks for data from secondary sources and (d) record keeping.<br><br>
Archiving inventory information, comprising activities related to centralised archiving of inventory information and the compilation of the national inventory report.<br><br>
Quality assurance, comprising activities related to the different levels of review processes including the review of input data from experts, if necessary, and comments from the public<br><br>
Estimation of uncertainties, defining procedures for estimating and documenting uncertainty estimates per source / sink category and for the whole inventory<br><br>
Inventory improvement, that is related to the preparation and the justification of any recalculations made.<br><br>
The implementation of the plan started in April 2004 and the first internal review was carried out in June 2004, following procedures and manuals (available only in Greek) developed by in house staff and outside consultants. The current in use version of the QA/QC manual was revised in May 2008.<br><br>
All the procedures described there, are followed by both the MEECC and the NTUA staff members. Furthermore, annual internal audits take place by MEECC/NTUA between September and November of each year and audits by independent local experts are planned and implemented.</td><td>Climate Change Emissions Inventory,<br><br>Information under Article 3(1) of the Decision 280/2004/ EC,<br><br>Jan 2011, pp.10-11</td></tr>
<tr><td>Ireland</td><td>In early 2005, the inventory agency in Ireland commissioned a project with UK consultants to establish formal QA/QC procedures in emission inventories that would meet the needs of the UNFCCC reporting requirements. The project developed a QA/QC system including a documented QA/QC plan and procedures along with a QA/QC manual. The manual provides a general overview to the QA/QC system and guidance on the application of the plan and procedures. The QA/QC plan identifies the specific data quality objectives related to the principles of transparency, consistency, completeness, comparability and accuracy required for Ireland's national inventory and provides specific guidance and documentation forms and templates for the practical implementation of QA/QC procedures. The QA/QC procedures cover such elements as data selection and acquisition, data processing and reporting so that the international requirements under the Kyoto Protocol and Decision 280/2004/EC are met. The manual provides guidance and templates for appropriate quality checking, documentation and traceability, the selection of source data and calculation methodologies and peer review and expert review of inventory data and outlines the annual requirements for continuous improvement for the inventory.<br><br>
The inventory agency used the 2006 reporting cycle to begin implementation of the basic elements of the new approach to QA/QC and its application was substantially completed in delivering the 2007 submission. The system facilitates record keeping related to the chain of activities from data capture, through emissions calculations and checking, to archiving and the identification of improvements.<br><br>
Ireland’s calculation spreadsheets in all sectors have been restructured and reorganised to facilitate the QA/QC process and to facilitate more efficient analysis and to ensure ease of transfer of the outputs to the CRF Reporter Tool. This facilitates rapid year-on-year extension of the time-series and efficient updating and recalculation, where appropriate, in the annual reporting cycle. Internal aggregation to various levels corresponding to the CRF tables provides immediate and complete checks on the results.<br><br>
External reviews of the agriculture sector and of the entire ETS results for 2005 were conducted as important new components of quality assurance at the beginning of 2007.<br><br>
Inventory development continues to benefit from the internal review procedures that are ongoing with regard to the EU and its Member States.</td><td>Ireland National Inventory Report 2009,GHG emissions 1990-2007 reported to the UNFCCC Mar 2009<br><br>pp.16</td></tr>
</table>

| MS | Description of the national QA/QC activities | Source |
|---|---|---|
| **Italy** | ISPRA has elaborated an inventory QA/QC plan which describes specific QC procedures to be implemented during the inventory development process, facilitates the overall QA procedures to be conducted, to the extent possible, on the entire inventory and establishes quality objectives.<br>Particularly, an inventory QA/QC procedures manual has been drawn up which describes QA/QC procedures and verification activities to be followed during the inventory compilation and helps in the inventory improvement. Quality control checks and quality assurance procedures together with some verification activities are applied both to the national inventory as a whole and at sectoral level. Future planned improvements are prepared for each sector, by the relevant inventory compiler. Each expert identifies areas for sectoral improvement based on his own knowledge and in response to inventory UNFCCC reviews and other kind of processes.<br>Checklists are compiled annually by the inventory experts and collected by the QA/QC coordinator. These lists are also registred in the 'reference' database.<br>General QC procedures also include data and documentation gathering. Specifically, the inventory analyst for a source category maintains a complete and separate project archive for that source category; the archive includes all the materials needed to develop the inventory for that year and is kept in a transparent manner. All the information used for the inventory compilation is traceable back to its source. The inventory is composed by spreadsheets to calculate emission estimates; activity data and emission factors. Particular attention is paid to the archiving and storing of all inventory data, supporting information, inventory records as well as all the reference documents. After each reporting cycle, all database files, spreadsheets and official submissions are archived as 'read-only' mode in a master computer.<br>Quality assurance procedures regard some verification activities of the inventory as a whole and at sectoral level. The inventory is presented to a Technical Committee on Emissions (CTE), coordinated by the Ministry for the Environment, Land and Sea, where all the relevant Ministries and local authorities are represented; within this task emission figures and results are shared and discussed.<br>Moreover, at European level, voluntary reviews of the European inventory are undertaken by experts from different Member States for critical sectoral categories. The only official review, apart from those by the UNFCCC, was performed by Ecofys, in 2000, in order to verify the effectiveness of policies and measures undertaken by Italy to reduce GHG emissions to the levels established by the Kyoto Protocol. In this framework an independent review and checks on emission levels were carried out as well as controls on the transparency and consistency of methodological approaches.<br>Comparisons between national activity data and data from international databases are usually carried out in order to find out the main differences and to find explanations to the differences Comparisons between emission estimates from industrial sectors and those published by the industry itself in the Environmental reports are carried out annually in order to assess the quality and the uncertainty of the estimates. | Italian Greenhouse Gas Inventory 1990-2007<br>National Inventory Report 2009, April 2009, pp.31-35 |
| **Luxembourg** | Luxembourg's Quality Management System (QMS) follows a Plan-Do-Check-Act-Cycle (PDCA-cycle), which is an accepted model for pursuing a continual improvement of performance according to international standards and is in line with procedures described in decision 19/CMP.1 and in the IPCC Good Practice Guidance.<br>Due to Luxembourg's clear extent, its QMS deals with a manageable quantity of documents. Fol-lowing are the specifications of Luxembourg's Quality Management System:<br>• firm build-up with a quality manual consisting of a chart with all relevant documents, handling instructions and deadlines for check;<br>• good manageability (instead of a complex system);<br>• usable and effective quality control procedures (user-friendly, clearly arranged).<br>Since the QMS has been implemented in the year 2008, further developments and improvements have been implemented.<br>The QMS ensures and continuously improves the quality (measured by transparency, accuracy consistency, comparability, completeness (TACCC) and timeliness) of Luxembourg's GHG Inventory in order to fulfil the party's obligations according to articles 3, 5 and 7 of the Kyoto Protocol.<br>Luxembourg's Quality Management System (QMS) of the GHG Inventory is organised in three layers:<br>a) Performance processes which directly concern the compilation of the GHG Inventory. They comprise input data, data acquisition, calculations, and generation of CRF tables and NIR as well as quality control checks and the outcomes of the NIR and CRF-tables.<br>b) Management processes which control the system's performance by defining quality objectives, responsibilities, quality assurance procedures, improvement plans and the personnel's qualifications and obligations.<br>c) Supporting processes which assist the system's performance by providing technical requirements and standards.<br>Further details on Luxembourg's QMS and relating QA/QC procedures are described in detail in Luxembourg's NIR 2010. | National Inventory Report 1990-2008, May 2010<br>p.51-60 |

| MS | Description of the national QA/QC activities | Source |
|---|---|---|
| **Netherlands** | As part of its National System, the Netherlands has developed and implemented a QA/QC programme. This programme is yearly assessed and updated, if needed.<br>Monitoring protocols were elaborated and implemented in order to improve the transparency of the inventory (including methodologies, procedures, tasks, roles and responsibilities with regard to inventories of greenhouse gases). Transparent descriptions and procedures of these different aspects are described in the protocols for each gas and sector and in process descriptions for other relevant tasks in the National System. The protocols are assessed annually and updated if needed.<br>**Various QC issues:**<br>Inconsistencies in the key category analysis between CRF and NIR were analyzed and removed<br>In response to review findings the Netherlands has updated the protocols and provided more specific information on sector specific QC activities<br>The Netherlands continues its efforts to include the correct notation keys in the CRF files.<br>**Quality control includes the following activities:**<br>General QC checks were performed. To facilitate these general QC checks, a checklist was developed and implemented. A number of general QC checks have been introduced as part of the annual work plan of the PRTR and are also mentioned in the monitoring protocols.<br>The QC checks included in the work plan, aim at covering issues as consistency, completeness and correctness of the CRF data, among others.<br>The general QC for the present inventory is largely performed in the PRTR, as an integrated part of the working processes. The PRTR task forces fill in a standard-format database with emission data for 1990–2007. After a first check of the emission files by PBL and TNO for completeness, the (corrected) data are available for the specific task force for checking consistency checks and trend analysis (comparability, accuracy). The task forces have access to information about the relevant emissions in the database.<br>Several weeks before the dataset was fixed, a trend verification workshop was organized by PBL (December 2009) (see Box 1.1). The result of this workshop including actions for the taskforces to resolve the identified clarification issues are documented at PBL. Required changes to the database are then made by the taskforces.<br>Quality Assurance for the current NIR includes the following activities:<br>• A peer and public review on the basis of the draft NIR in January/February 2009.<br>• In preparing this NIR, the results of former UNFCCC reviews, including the results of the initial review in 2007 and the review of the NIR 2007 and NIR 2008 in September 2008 have been taken into account to the extent possible<br>• As part of the evaluation process of the previous cycle, internal audits were performed through SenterNovem on the use of the protocols and the implementation of QC checks. This year the NIR process was given special attention. The audit resulted in some recommendations on transparency of the processes (e.g. improvement by drawing up manuals for key source analysis and data conversion from the central database to the CRF) and on tasks and responsibilities (e.g. capacity building, improvement of planning and communication).<br>The QA/QC activities generally aim at a high-quality output of the emissions inventory and the National System; these are in line with international QA/QC requirements (IPCC Good Practice Guidance). | Greenhouse Gas Emissions in the Netherlands 1990-2009<br>Jan 2019<br>Introduction |
| **Portugal** | The APA has the overall responsibility for the GHG inventory in Portugal, including the competence for the coordination of the Quality Assurance and Quality Control System. The conceptualization of the system has however been done under an external consultancy with Ecoprogresso. Each public organization contributing with data to the inventory is responsible for the quality of their own data. The inventory staff is responsible for the implementation of QA/QC procedures.<br>The QA/QC system is an integral part of the SNIERPA, which was created by the March, 17th Resolution of the Council of Ministers nr. 68/2005.<br>The QA/QC system is composed of two main elements: a Quality Control and Quality Assurance Programme and a Procedures Manual. The first schedules the application of the general (QC1) and specific (QC2) Quality Control as well as Quality Assurance (QA) procedures, described in detail in a Manual. The procedures were defined according to Good Practice and Uncertainty Management Guide (IPCC, 2000) and adapted to the specific National Inventory (INERPA) characteristics.<br>Quality Control tier 1 (QC1) procedures defined in the QA/QC Manual include a series of checklists, which consider basic checks on the accuracy of data acquisition processes (including, e.g, transcription errors) and checks on calculation procedures, data and parameters.<br>It includes also cross-checking among subcategories in terms of data consistency, verification of NIR and CRF tables. Documentation and archiving procedures include checks on information handling which should enable the recalculation of the inventory. QC tier 2 (QC2) procedures, on the other hand, include technical verifications of emission factors, activity data, comparison of results among different approaches.<br>Both QC1 and QC2 procedures have been applied by the inventory team during the inventory calculation and compilation following the QA/QC plan.<br>An important tool for data checking is the implied emissions factor (IEF) graph of the CRF Reporter. This utility enables the visual verification of time series. When inconsistent trends are detected the underlying data are analised and corrected if necessary.<br>The results of quality control of national submissions under the EC GHG Monitoring Mechanism (e.g. completeness checks, consistency checks), and the issues raised during the annual review process of the UNFCCC, constitute additional processes of technical verification and represent valuable sources of error detection. | Short Portuguese National Inventory Report on Greenhouse Gases, 1990-2009<br>Jan 2010, pp. 15-16 |

| MS | Description of the national QA/QC activities | Source |
|---|---|---|
| **Spain** | The QA/QC plan is an internal document with the aim to improve the inventory. It is revised periodically and adapted to changes in the procedures of inventory preparation. The objectives of the QA/QC plan are:<br>Timeliness: to reach this target a time schedule for specific tasks and respective check points are established<br>**Completeness**<br>*Consisitency*: A parameter or variable is only introduced once in the data base. This assures that a parameter that is used several times in the inventory is always the same. Consistency of time series is achieved by subjecting primary data to quality control. Outliers in the time series are identified and checked.<br>*Comparability*: The Spanish Inventory should be comparable with inventories from other countries. To achieve this goal definitions and nomenclature are based on SNAP and CRF.<br>*Accuracy*: Priority for the use of methods of higher tier is given to key categories<br>*Transparency*: The reproducibility of the inventory should be granted. For this aim processes that generate emissions, the variables of activities and their origins, the algorithms and emission factors and the estimated emissions are documented in SNAP format.<br>**Improvement of the inventory.**<br>DGCEA as single national entity of the NIS is responsible for the quality control and quality assurance system. For this task DGCEA receives technical assistance from AED. | Inventario de Emisiones de gases de efecto inver-nadero de España, años<br>1990-2009<br>Jan 2011, pp. 1.39ff<br>(submitted in Span-ish, trans-lated) |
| **Sweden** | The Swedish Environmental Protection Agency (Swedish EPA) is responsible for the QA/QC plan for the inventory. The national GHG emissions are compiled by the Swedish Environmental Emission Data (SMED). Other contractors are also involved in the inventory preparations process.<br>The QA/QC plan consists of quality procedures and checklists specified for each reporting CRF-code (or group of codes). The plan is updated annually and lists all quality control steps that must be undertaken during inventory work (Tier 1 and where appropriate Tier 2). The QA/QC plan also includes descriptions of roles and responsibilities, of data-bases and models and documented procedures for uncertainty and key source analysis, as well as procedures for handling and responding to UNFCCC´s review of the Swedish inventory. The QA/QC plan handles follow-up and improvement by collection of improvement needs from all stages of the annual inventory cycle. This results in a planning document, which is used as a basis for planning and selecting further actions to improve the inventory.<br>**Quality control:** In this inventory, general Tier 1 QC measures, according to Table 8.1 in IPCC Guidelines, and source specific Tier 2 QC measures have been carried out. All QC measures performed are documented in QC checklists for each CRF code or group of codes. After completion of the initial compilation of the inventory, a QC-team reviews all QC checklists.<br>*Verification*: Key categories should be subject to external peer review according to the Tier 2 of the Good Practice Guid-ance. The Swedish QA/QC system includes national peer reviews by sectoral authorities. The procedures are described in Annex 6:2. The peer reviews include methodology and emissions factors used, as well as compari-sons of activity and emission data with other national statistics. The reviewers also identify areas of improvement, which consolidates the ba-sis for improvements in coming submissions.<br>QC for the overall inventory: When the reporting tables and the NIR are completed, a quality coordinator performs a fi-nal quality control before delivery of the inventory to the Swedish EPA. | National Inventory Report 2011 Sweden<br>Jan 2011<br>pp.44ff |

| MS | Description of the national QA/QC activities | Source |
|---|---|---|
| United Kingdom | The National Atmospheric Emissions Inventory and the UK Greenhouse Gas Inventory are compiled and maintained by AEA, part of AEA Technology plc. The data compilation and reporting for some source sectors of the UK inventory are performed by other contractors (i.e. North Wyke compile the agriculture sector, CEH compile the land use, land use change and forestry sector), but AEA Energy and Environment is responsible for co-ordinating inventory-wide QA/QC activities.<br>UK emission estimates are prepared via a central database of activity data and emission factors. Numerous QA/QC procedures are built into the data processing system. These include checks before data are entered into the national database of GHG emissions, and when data are extracted from the database. The database contains activity data and emission factors for all the sources necessary to construct the UK GHG inventory.<br>The Inventory has been subject to ISO 9000 since 1994 and is now subject to BS EN ISO 9001:2008. It is audited by Lloyds and the AEA Technology internal QA auditors. The NAEI has been audited favourably by Lloyds on three occasions in the last ten years. The emphasis of these audits was on authorisation of personnel to work on inventories, document control, data tracking and spreadsheet checking, and project management. As part of the Inventory management structure there is a nominated officer responsible for the QA/QC system – the QA/QC Co-ordinator. AEA is currently accredited to BS EN ISO 9001:2008, and was last audited in October 2009 by Lloyds.<br>*Documentation*: Source data received by AEA are logged, numbered and are traceable back to their source from anywhere in the system, using a contacts database, spreadsheet notes and automated system of data referencing within the main NAEI database of activity data and emission factors;<br>*Checking*: AEA's QA/QC system requires that spreadsheet calculations are checked and the checks applied are described. Also the data sources used for calculations must be referenced on the spreadsheet. All spreadsheets are subject to second-person checking prior to data uploading to the NAEI database. Mass balance checks are made to ensure that the total fuel consumptions in the GHG inventory are in accordance with those published in the official UK Energy Statistics from DECC. Database output comparisons between different inventory cycles enable the investigation of the effects of recalculations and help identify any data processing errors. A final check is made on the inventory comparing the emissions of the latest year with those of the previous year (within the same version), and a complete time-series check is also conducted for selected key sources.<br>*Recalculations:* Where changes are made to inventory estimation methodologies, or where source data are revised or errors in previous inventories identified, then the full time-series of emissions are recalculated.<br>*Archiving:* At the end of each reporting cycle, all the database files, spreadsheets, on-line manual, electronic source data, paper source data, output files are in effect frozen and archived. An annual report outlining the methodology of the inventory and data sources is produced. Electronic information is stored on hard disks that are regularly backed up. Paper information is also archived. | UK Greenhouse gas Inventory 1990-2009: Short NIR, Jan 2011 pp. 21ff |

### 1.5.3 Further improvement of the QA/QC procedures

One of the most important activities for improving the quality of national and EU GHG inventories is the organisation of workshops and expert meetings under the EU GHG Monitoring Mechanism. In September 2004 a 'Workshop on quality control and quality assurance of greenhouse gas inventories and the establishment of national inventory systems' was organised. The Workshop facilitated the exchange of experience of Member States in the implementation of Quality Control (QC) and –Assurance (QA) procedures and the implementation of the National Inventory System. The workshop brought together experts from 17 Member States, the European Commission (DG ENV, JRC), EEA, ETC/ACM and an observer from the UNFCCC secretariat. For details of the workshop see the workshop report available on the website of the ETA/ACC:
http://air-climate.eionet.eu.int/docs/meetings/040902_GHG_MM_QAQC_WS/meeting040902.html

A number of other workshops and expert meetings have been organised in recent years with a focus on sector-specific quality improvements.

Table 1.11 lists the most important workshops.

**Table 1.11** **Overview of workshops and expert meetings organised under the EU GHG Monitoring Mechanism**

| Workshop/expert meeting | Date and venue |
|---|---|
| Reporting on supplementary information under the Kyoto Protocol starting in 2010 | 2 March 2009, Berlin, Germany |
| Technical workshop on LULUCF reporting issues under the Kyoto Protocol | 13-14 November 2008, JRC, Ispra, Italy |
| Workshop on the implications of the implementation of the 2006 IPCC Guidelines for national GHG inventories | 30 - 31 October 2008, EEA, Copenhagen, Denmark |
| 2nd workshop on data consistency between National GHG inventories and reporting under the EU ETS | 13-14 September 2007, EEA, Copenhagen, Denmark |
| Expert meeting on the estimation of $CH_4$ emissions from solid waste disposal sites with the First Order Decay method | 8-9 March 2006, EEA, Copenhagen, Den-mark |
| Workshop on data consistency between National GHG inventories and reporting under the EU ETS | 9-10 February 2006, EEA, Copenhagen, Denmark |
| Training workshop on the use of CRF Reporter for the experts of the European Union | 12-13 September 2005, EEA, Copenhagen, Denmark |
| EU workshop on uncertainties in greenhouse gas inventories | 5-6 September 2005, Helsinki, Finland |
| Workshop on Inventories and projections of greenhouse gas emissions from waste | 2-3 May 2005, EEA, Copenhagen, Denmark |
| Expert meeting on improving the quality of. greenhouse gas emission inventories for category 4D | 21-22 October 2004, JRC, Ispra, Italy |
| Workshop on quality control and quality assurance of greenhouse gas inventories and the es-tablishment of national inventory systems | 2-3 September 2004, EEA, Copenhagen, Denmark |
| Workshop on emissions of greenhouse gases from aviation and navigation | 17-18 May 2004, EEA, Copenhagen, Den-mark |
| Enlargement Training Workshop on Emission Inventory Improvement and Uncertainty As-sessment | 27-28 November 2003, JRC, Ispra, Italy |
| 2003/06/24 Workshop on energy balances and energy related GHG emision inventories | 24-25 June 2003, EEA, Copenhagen, Den-mark |
| Workshop on Inventories and Projections of GHG and Ammonia Emissions from Agriculture | 27-28 February 2003, EEA, Copenhagen, Denmark |

All the workshop reports are available at the website of the EEA/ETC-ACM: http://air-climate.eionet.eu.int/meetings/past_html

## 1.6 Uncertainty evaluation

The EU-15 Tier 1 uncertainty analysis was made on basis of the Tier 1 uncertainty estimates of the Member States. Uncertainties were estimated for seven sectors ‘Stationary fuel combustion’, ‘Trans-port’, ‘Fugitive emissions’, Industrial processes’, ‘Agriculture’, ‘LULUCF’ and ‘Waste’. Within these sectors the available MS uncertainty estimates were grouped by source categories. Then for each source category a range of uncertainty estimates was calculated: the lower bound of the range was cal-culated by assuming that all uncertainty estimates within a source category are uncorrelated; the upper bound of estimates was calculated by assuming that all uncertainty estimates within a source category are correlated. Then a single uncertainty estimate was calculated for each source category based on the assumption that MS uncertainty estimates are correlated if they use Tier 1 methods and/or default emission factors. After having calculated the uncertainty estimates for each source category, the uncer-tainty estimates for the sectors and for total GHG emissions were calculated.

**Estimation of trend uncertainty:** The EU uncertainty estimate is rather complicated due to potential correlations between MS uncertainties. Therefore, an analytical method, which allows more flexibility than IPCC Tier 1, was compiled.

Trend in MS n category x was defined as

$$\mathbf{Trendn,x = En,x(t)-En,x(0)} \qquad \mathbf{(1)}$$

Where E(t) denotes emissions in the latest inventory year and E(0) emissions in the base year.

Variance for each MS and source category was calculated by using the perceptual uncertainty estimates reported by MS, and assuming normal distributions. Uncertainties in trends of different MS and source categories were then calculated using first order approximation of error propagation.

The assumptions of correlation between years (0 and t) and between different MS are important for the estimation of trend uncertainty. However, there is not enough information about strengths of different correlations. Effect of correlation was tested both with the analytical method developed, and by using MC simulation, where Normal distribution was used in all the cases to ensure comparability with analytical estimates. Table 1.12 presents an example of such comparison made in 2006. The source category chosen for the example is 4D, $N_2O$ emissions from agricultural soils, as this category has a major effect on inventory uncertainty in most MS. Both the effects of correlations between years and between Member States were tested.

**Table 1.12 Trend uncertainty for EU-15 emissions of $N_2O$ from agricultural soils by using different assumptions of correlation estimated using Monte Carlo simulation**

| Years correlate | MS correlate | Trend uncertainty |
|---|---|---|
| YES | YES | -27 to +26 |
| YES | NO | ±13 |
| NO | YES | -294 to +292 |
| NO | NO | -116 to +115 |

*Note: "YES" denotes full correlation between years or Member States. Trend uncertainty is presented as percentage points.*

The results of the comparison revealed that assumption on correlation between years has much larger effect on trend uncertainty than the assumption on correlation between MS. In the IPCC GPG 2000, it is suggested to assume that emission factors between years are fully correlated, and activity data are independent. However, in the EU uncertainty estimate, it is assumed that activity data uncertainties also correlate to some extent between years, because typically the same data collection methods are used each year. Therefore, for simplicity, in EU uncertainty estimate it was decided to assume that emissions between years are fully correlated, even though this may underestimate trend uncertainty to some extent.

In the example in

Table 1.13, uncertainty decreased when correlation between MS was added to the correlation between years. However, this is not always the case; in another example considering EU-15 MS estimates for 1A1a $CO_2$, uncertainty was ±0.2% when it was assumed that years correlate and MS estimates are independent. When a correlation between MS was added, the uncertainty decreased to ±0.1%.

Correlation between MS is difficult to quantify, especially in case of trend uncertainty, where correlation between different MS in different years should also be quantified. Furthermore, effect of correlation on uncertainty (increasing or decreasing) depends on the direction and magnitude of trend for each MS and each source category. Therefore, a simple conservative assumption cannot be made. Therefore, for simplicity, it was assumed in trend uncertainty estimate that MS are independent17.

In general, the caveats of the method used are the same as in IPCC Tier 1, i.e. the result gives the most reliable results when uncertainties are small, and it assumes normal distributions even though this cannot actually be the case when uncertainties are >100%. However, these issues do not seem to have any major effect on the results, as can be seen from

17 When the correlation assumptions were simplified, IPCC Tier 1 method could also have been used

Table 1.13, where waste sector uncertainties are presented both with analytical method and Monte Carlo simulation. When uncertainty increases, also the difference between the two methods increases.

**Table 1.13** **Comparison of trend uncertainty estimates for EU-15 Waste Sector using the modified Tier 1 method and Monte Carlo simulation (Tier 2). Trend uncertainty is presented as percentage points**

| Sector | GHG | Tier 1 | Tier 2 |
|---|---|---|---|
| 6A. Landfills | $CH_4$ | ±12 | ±12 |
| 6B. Wastewater | $CH_4$ | ±27 | -28 to +27 |
| 6B. Wastewater | $N_2O$ | ±9 | ±9 |
| 6C. Waste incineration | $CO_2$ | ±7 | ±7 |
| 6C. Waste incineration | $CH_4$ | ±23 | -23 to +24 |
| 6C. Waste incineration | $N_2O$ | ±18 | ±18 |
| Waste Other | $CH_4$ | ±990 | -976 to +993 |
| Total Waste Sector | | ±11 | ±11 |

*Note: Trend uncertainty is presented as percentage points.*

Furthermore, trend uncertainty was calculated as in Equation 1, and the resulting confidence intervals were divided by base year estimate (best estimate) to obtain the relative change. The results would have been somewhat different, if trend uncertainty were calculated as in Equation 2:

$$\mathbf{Trendn,x = [En,x(t)\text{-}En,x(0)]/\ En,x(0) \qquad (2)}$$

However, the effect of the choice between Eq 1 and 2 depends also on the direction and magnitude of trend in different MS, and without further consideration it cannot be stated whether choice of Eq 1 yielded a conservative estimate or not.

Lack of knowledge of different correlations, and many assumptions make the interpretation of EU trend uncertainty difficult, and therefore it should not be compared with uncertainty estimates of other countries. However, trend uncertainty calculations are internally consistent, and therefore the results can be used e.g. to assess which categories are the most important sources of trend uncertainty in the EU inventory.

Table 1.14 shows the main results of the uncertainty analysis for the EU-15. The lowest level uncertainty estimates are for stationary fuel combustion (1.1 %) and transport (3 %), the highest estimates are for agriculture (41.4 % - 91.3 %). For agriculture a range of level uncertainties is provided depending on the assumption on $N_2O$ emissions from soils. The lower bound assumes that all MS uncertainty estimates of $N_2O$ from agricultural soils are uncorrelated, the upper bound assumes that all uncertainty estimates are correlated. Overall level uncertainty estimates including LULUCF of all EU-15 GHG emissions is calculated to be between 4.9 % and 9.6 %, and excluding LULUCF slightly lower between 4.6 % and 9.4 %.

With regard to trend uncertainty estimates the lowest uncertainty estimates are for stationary fuel combustion (+/- 0.5 percentage points), the highest estimates are for fugitive emissions (21.3 percentage points). Overall trend uncertainty (excluding LULUCF) of all EU-15 GHG emissions is estimated to be 1.6 percentage points.

More detailed uncertainty estimates for the source categories are provided in Chapters 3-8.

**Table 1.14 Tier 1 uncertainty estimates of EU-15 GHG emissions**

| Source category | Gas | Emissions 1990 | Emissions 2009 | Emission trends 1990-2009 | Level uncertainty estimates based on MS uncertainty estimates | Trend uncertainty estimates based on MS uncertainty estimates |
|---|---|---|---|---|---|---|
| Fuel combustion stationary | all | 2,483,294 | 2,350,995 | -5% | 1.1% | 0.5 |
| Transport | all | 693,740 | 855,786 | 23% | 3% | 1.1 |
| Fugitive emissions | all | 96,617 | 49,841 | -48% | 21% | 21.3 |
| Industrial processes | all | 352,882 | 306,369 | -13% | 5% | 13.6 |
| Agriculture | all | 441,171 | 386,833 | -12% | 67.2% (41.4%-91.3%) | 8.4 |
| LULUCF | all | -212,334 | -251,002 | 18% | 33% | 15.0 |
| Waste | all | 183,670 | 117,439 | -36% | 24% | 13.5 |
| **Total (incl LULUCF)** | **all** | **4,039,040** | **3,816,262** | **-6%** | **7.3% (4.9%-9.6%)** | **-** |
| **Total (excl LULUCF)** | **all** | **4,251,374** | **4,067,264** | **-4%** | **7.0% (4.6%-9.4%)** | **1.6** |

*Note: Emissions are in Gg $CO_2$ equivalents; trend uncertainty is presented as percentage points;*
*Uncertainty estimates for Agriculture are taken from 2007.*
*Uncertainty estimates for Portugal are not included.*

In September 2005 a workshop on uncertainties in greenhouse gas inventories was organised in Helsinki (Finland). The aim of the workshop was to share information and experience on uncertainty assessment, to discuss needs for further guidance, and to improve comparability of uncertainty estimates across different Member States. The main objectives were to help Member States to compile/improve uncertainty estimates and to help develop the uncertainty assessment of the EU inventory. The workshop brought together experts from 16 Member States, the European Commission (DG ENV, JRC), ETC-ACM, as well as from Norway and Russia. UNFCCC secretariat sent their statement in a written form to the workshop. The workshop produced recommendations on the following topics: a) EU Uncertainty assessment and implications on Member State uncertainty assessment and b) Uncertainty assessment at Member State level (see workshop report http://air-climate.eionet.eu.int/meetings/past_html).

Table 1.15 gives an overview of information provided by EU-15 Member States on uncertainty estimates in their national inventory reports 2010 and presents summarised results of these estimates. For some Member States, either a national inventory report was available, which did not include quantitative uncertainty analysis, or no national inventory report was available at all.

**Table 1.15 Overview of uncertainty estimates available from EU-15 Member States**

| Member State | Austria | Belgium | Denmark | Finland | France | Germany | Greece | |
|---|---|---|---|---|---|---|---|---|
| Citation | NIR Mar 2011, pp.42-49 | NIR Mar 2011, pp. 25-27 | NIR Mar 2011, pp.67-81 | NIR Mar 2011, pp. 37-38 | NIR, Mar 2011, p. 43 | NIR Mar 2011 , pp. 110-115 | NIR, Jan 2011, pp. 40-43 | |
| Method used | Tier 1 | Tier 1 | Tier 1 | Tier 1 | Tier 1 | Tier 1 | Tier 1 | |
| Documentation in NIR (according to Table 6.1/6.2 of GPG) | Yes | Yes (Annex 2) | Yes | Yes (Annex 6) | Yes (Annex 7) | Yes (Annex 7) | Yes (Annex IV) | |
| Years and sectors included | emissions: 2009; trends: 1990-2009; excluding LULUCF | emissions: 2009; trends: 1990-2009; inclusing LULUCF | emissions: 2009; trend:1990 -2009; including LULUCF | emissions: 2009; trends: 1990-2009; including LULUCF | emissions: 2009; trends: 1990-2009; including LULUCF | emissions: 2008; trends: 1990-2008; including LULUCF | emissions: 2009; trends: 1990-2009; including LULUCF | |
| **Uncertainty (%)** | Tier 1 | Tier 1 | Tier 1 | Tier 1 | Tier 1 | Tier 1 | Tier 1 (i. L.) | Tier 1 (e. L.) |
| $CO_2$ | | | 3.8% | | | | 3.8% | 3.6% |
| $CH_4$ | | | 24% | | | | 51.6% | 51.7% |
| $N_2O$ | | | 42% | | | | 88.4% | 88.4% |
| F-gases | | | 48% | | | | 246.1% | 246.4% |
| Total | 4.63% | 7.94% | 5.7% | i. L.: 59%<br>e. L.: 12% | i. L.: 22.5%<br>e. L.: 18.3% | 3.8% | 8.92% | 8.67% |
| **Uncertainty in trend (%)** | Tier 1 | Tier 1 | Tier 1 | Tier 1 | Tier 1 | Tier 1 | Tier 1 | Tier 1 |
| $CO_2$ | | | ±2.7% points | | | | | |
| $CH_4$ | | | ±4.8% points | | | | | |
| $N_2O$ | | | ±12% points | | | | | |
| F-gases | | | ±62% points | | | | | |
| Total | ±1.88% points | ±2.83% points | ±3.0% points | i. L.: ±39% points<br>e. L.: ±7% points | i. L.: ±4.0% points<br>e. L.: ±2.5% points | 4.1% | ±11.53 % points | ±11.25 % points |

| Member State | Ireland | Italy | Luxembourg | Netherlands | Portugal | Spain | Sweden | United Kingdom |
|---|---|---|---|---|---|---|---|---|
| Citation | Uncertainty Table 2011 | Uncertainty Table 2011 | Uncertainty Table 2011 | Uncertainty Table 2011 | NIR Mar 2011, pp.16-18 | Uncertainty Table 2011 | NIR Mar 2011, pp. 44-47 | Uncertainty Table 2011 |
| Method used | Tier 1 | Tier 1 | Tier 1 | Tier 1 | Tier 1 | Tier 1 | Tier 1 | Tier 1 |
| Documentation in NIR (according to Table 6.1/6.2 of GPG) | Yes | - | - | Yes (Annex 7) | Yes (Annex B) | Yes (Annex 7) | Yes (Annex 7) | Yes (Annex 7) |
| Years and sectors included | emissions: 2009; trend: 1990-2009; all categories (i.L.) | emissions: 2009; trend: 1990 -2009; all categories (i.L.) | emissions: 2009, trend: 1990-2009; all categories (e.L.) | emissions: 2009; trend: 1990-2009; all categories (e.L.) | emissions: 2009, trend: 1990-2009; all categories (e.L.) | emissions: 2009; trend: BY-2009; excluding LULUCF | emissions: 1990 and 2008; trend: 1990-2008; including LULUCF | emissions: 1990, 2009; trend: BY - 2009, including LULUCF |
| **Uncertainty (%)** | Tier 1 | Tier 1 | Tier 1 | Tier 1 | Tier 1 | Tier 1 | Tier 1 | Tier 1 |
| $CO_2$ | 4.5% | | | 2% | 4.4% | - | | |
| $CH_4$ | 1.8% | | | 17% | 25.2% | - | | |
| $N_2O$ | 6.1% | | | 44% | 128.0% | - | | |
| F-gases | 0.2% | | | 50% | 67.4% | | | |
| Total | 7.8% | 10.0% | 2.8% | 3% | 9.2% | 10.5% | 61,5% (i.L.)<br>6,1% (e.L.) | i. L.: 19,0%<br>e. L.: 18.8% |
| **Uncertainty in trend (%)** | Tier1 | Tier 1 | Tier 1 | Tier 1 | Tier 1 | Tier 1 | Tier 1 | Tier 1 |
| $CO_2$ | ±1,2% points | | | ±3 % points | | | | |
| $CH_4$ | ±1,09% points | | | ±9 % points | | | | |
| $N_2O$ | ±2,08% points | | | ±8 % points | | | | |
| F-gases | ±0,28% points | | | ±11 % points | | | | |
| Total | ±4,45% points | ±8.0% points | ±1,79% points | ±3 % points | ±14,4% points | ±11,7% points | i.L.: ±14,1% points<br>e.L.: ±2,2% points | i. L.: ±2.5% points<br>e. L.: ±2.4% points |

## 1.7 General assessment of the completeness

### 1.7.1 Completeness of Member States' submissions

The EU GHG inventory is compiled on the basis of the inventories of the EU Member States. Therefore, the completeness of the EU inventory depends on the completeness of the Member States' submissions. Table 1.16 summarises timeliness and completeness of the EU-15 Member States' submissions in 2011. It shows that GHG inventories for 2009 were submitted by all EU-15 Member States by 15 April 2011; some Member States provided resubmissions by 15 May (cut-off date for the 27 May resubmission of the EU). The completeness of national submissions with regard to individual CRF tables can be found in the status reports in Annex 1.3.

**Table 1.16 Date, mode and content of submissions of EU-15 Member States in 2010 (status 15 May 2011)**

| MS | Date | Submission mode | XML | SEF | CRF | KP LULUCF | NIR |
|---|---|---|---|---|---|---|---|
| AT | 14/01/2011 | CDR | AUT-2011-v1.2 | 2010 | 1990-2009 | 2008, 2009 | short NIR |
| AT | 15/03/2011 | CDR | AUT-2011-v1.3 | 2010 | 1990-2009 | 2008, 2009 | yes |
| AT | 15/04/2011 | CDR | AUT-2011-v1.5 | 2010 | 1990-2009 | 2008, 2009 | yes |
| BE | 17/01/2011 | CDR | BEL-2011-v1.1 | 2010 | 1990-2009 | 2008, 2009 | yes |
| BE | 15/03/2011 | CDR | BEL-2011-v1.2 | 2010 | 1990-2009 | 2008, 2009 | yes |
| BE | 15/04/2011 | CDR | BEL-2011-v1.3 | 2010 | 1990-2009 | 2008, 2009 | yes |
| DK | 14/01/2011 | CDR | - | 2010 | - | - | - |
| DK | 14/01/2011 | CDR | DNM-2011-v1.1 | - | 1990-2009 | 1990, 2008, 2009 | short NIR |
| DK | 15/03/2011 | CDR | DNM-2011-v1.2 | - | 1990-2009 | 1990, 2008, 2009 | yes |
| DK | 15/04/2011 | CDR | - | - | - | - | yes |
| DK | 15/04/2011 | CDR | DNM-2011-v1.4 | - | 1990-2009 | 1990, 2008, 2009 | - |
| FI | 15/01/2011 | CDR | FIN-2011-v1.1 | 2010 | 1990-2009 | 2008, 2009 | yes |
| FI | 15/03/2011 | CDR | FIN-2011-v1.3 | 2010 | 1990-2009 | 2008, 2009 | yes |
| FI | 15/04/2011 | CDR | FIN-2011-v1.6 | 2010 | 1990-2009 | 2008, 2009 | yes |
| FR | 14/01/2011 | CDR | FRK-2011-v1.1 | 2010 | 1990-2009 | 2008, 2009 | short NIR (fr) |
| FR | 28/01/2011 | CDR | FRK-2011-v1.2 | - | 1990-2009 | 2008, 2009 | - |
| FR | 14/03/2011 | CDR | FRK-2011-v1.3 | - | 1990-2009 | 2008, 2009 | yes (fr) |
| FR | 15/04/2011 | CDR | - | - | - | - | yes (fr) |
| FR | 11/05/2011 | CDR | FRK-2011-v2.1 | | 1990-2009 | 2008, 2009 | |
| DE | 14/01/2011 | CDR | DEU-2011-v1.1 | 2010 | 1990-2009 | 2008, 2009 | yes (de) |
| DE | 23/02/2011 | CDR | DEU-2011-v1.2 | - | 1990-2009 | 2008, 2009 | - |
| DE | 15/04/2011 | CDR | DEU-2011-v1.3 | 2010 | 1990-2009 | 2008, 2009 | yes (de+en) |
| GR | 15/01/2011 | CDR | GRC-2011-v1.1 | - | 1990-2009 | 2008, 2009 | - |
| GR | 19/01/2011 | CDR | - | - | - | - | short NIR |
| GR | 30/01/2011 | CDR | - | 2010 | - | - | - |
| GR | 15/03/2011 | CDR | GRC-2011-v1.2 | - | 1990-2009 | 2008, 2009 | - |
| GR | 24/03/2011 | CDR | - | - | - | - | yes |
| GR | 13/05/2011 | CDR | GRC-2011-v2.1 | | 1990-2009 | 2008, 2009 | |
| IE | 13/01/2011 | CDR | IRL-2011-v1.1 | - | 1990-2009 | 2008, 2009 | partly |

| MS | Date | Submission mode | XML | SEF | CRF | KP LULUCF | NIR |
|---|---|---|---|---|---|---|---|
| IE | 15/03/2011 | CDR | IRL-2011-v1.3 | 2010 | 1990-2009 | 2008, 2009 | yes |
| IE | 15/04/2011 | CDR | IRL-2011-v1.4 | - | 1990-2009 | 2008, 2009 | yes |
| IT | 17/01/2011 | CIRCA IT | - | 2010 | - | - | - |
| IT | 13/02/2011 | CIRCA IT | ITA-2011-v1.1 | - | 1990-2009 | 2008, 2009 | - |
| IT | 16/03/2011 | CIRCA IT | ITA-2011-v1.2 | - | 1990-2009 | 2008, 2009 | - |
| IT | 16/04/2011 | CIRCA IT | ITA-2011-v1.3 | | 1990-2009 | 2008, 2009 | yes |
| LU | 10/02/2011 | CDR | LUX-2011-v1.1 | - | 1990-2009 | 2008, 2009 | - |
| LU | 25/02/2011 | CDR | LUX-2011-v1.2 | - | 1990-2009 | 2008, 2009 | - |
| LU | 15/04/2011 | CDR | LUX-2011-v1.3 | - | 1990-2009 | 2008, 2009 | yes |
| NL | 14/01/2011 | CDR | NLD-2011-v1.1 | 2010 | 1990-2009 | 2008, 2009 | yes |
| NL | 15/03/2011 | CDR | NLD-2011-v1.2 | - | 1990-2009 | 2008, 2009 | yes |
| NL | 15/04/2011 | CDR | NLD-2011-v1.3 | 2010 | 1990-2009 | 2008, 2009 | yes |
| PT | 15/01/2011 | CDR | PRT-2011-v1.1 | 2010 | 1990-2009 | 1990, 2008, 2009 | - |
| PT | 21/01/2011 | CDR | - | - | - | - | short NIR |
| PT | 15/03/2011 | CDR | PRT-2011-v1.2 | - | 1990-2009 | 1990, 2008, 2009 | yes |
| PT | 18/03/2011 | CDR | - | - | - | - | yes |
| PT | 25/03/2011 | CDR | PRT-2011-v1.3 | - | 1990-2009 | 1990, 2008, 2009 | - |
| PT | 15/05/2011 | CDR | PRT-2001-v1.6 | | 1990-2009 | 1990, 2008, 2009 | |
| PT | 16/05/2011 | CDR | | | | | yes |
| ES | 14/01/2011 | CDR | ESP-2011-v1.1 | 2010 | 1990-2009 | 1990, 2008, 2009 | yes (es) |
| ES | 15/03/2011 | CDR | ESP-2011-v1.3 | 2010 | 1990-2009 | 1990, 2008, 2009 | - |
| ES | 28/03/2011 | CDR | ESP-2011-v1.5 | - | 1990-2009 | 1990, 2008, 2009 | - |
| ES | 06/04/2011 | CDR | - | - | - | - | yes (es) |
| ES | 15/04/2011 | CDR | - | - | - | - | - |
| SE | 12/01/2011 | CDR | SWE-2011-v1.1 | - | 1990-2009 | 2008, 2009 | yes |
| SE | 15/03/2011 | CDR | SWE-2011-v1.1 (08-03-2011) | 2010 | 1990-2009 | 2008, 2009 | yes |
| SE | 31/03/2011 | CDR | | | | | yes |
| GB | 14/01/2011 | CDR | GBE-2011-v1.1 | 2010 | 1990-2009 | 2008, 2009 | short NIR |
| GB | 15/03/2011 | CDR | GBE-2011-v1.1 | 2010 | 1990-2009 | 2008, 2009 | partly |
| GB | 25/03/2011 | CDR | GBE-2011-v1.2 | - | 1990-2009 | 2008, 2009 | - |
| GB | 15/04/2011 | CDR | GBE-2011-v1.4 | - | 1990-2009 | 2008, 2009 | - |
| GB | 15/04/2011 | CDR | - | 2010 | - | - | yes |

*The grey xml files have been used for the EU-15 inventory*

In response to the Saturday paper 2010 the EU mobilized the mechanisms of its national system to further enhance its QA/QC programme and develop an appropriate action plan, in consultation with the MS, geared in particular towards complementing the existing procedures and improving the completeness regarding NEs of the EU greenhouse gas inventory in 2011 and beyond (see description in Chapter 13). During February and March intensive consultation between the EU inventory team and the Member States took place. In some cases the EU inventory team recommended Member States to provide estimates and/or change the use of notation keys. After this consultation the number of NEs in the Member States' GHG inventories could be reduced significantly. As a result of this consultation and the improvements in response to the UNFCCC review cycle 2010 the number of NEs at EU-15 level could be reduced by about 40% in the 2011 submission compared to the 2010 submission. Annex 1.4 provides a list of all NEs and IEs and includes explanations taken from the Member States' CRF Tables 9. This information is equivalent to CRF Table 9 which cannot be filled-in automatically for the EU-15 due to the amount of information from the Member States.

The following table provides an overview of the general completeness sections of the Member States' National Inventory Reports.

**Table 1.17 Description of completeness taken from EU-15 Member States submissions 2011**

| MS | Description of the completeness | Source |
|---|---|---|
| **Austria** | Where "NE" is used in an inventory for emissions or removals, both the NIR and the CRF completeness table indicate why emissions or removals have not been estimated. For emissions by sources and removals by sinks of greenhouse gases marked by "NE" check-ups are in progress to establish if they actually are "NO" (not occurring). As part of the improvement programme of the inventory, it is planned that these source or sink categories are either estimated or allocated to "NO". | Austria's Annual Greenhouse Gas Inventory 1990–2009<br>Mar 2011<br>p. 50 |
| **Belgium** | All sources and sinks included in the IPCC Guidelines are covered with the exception of the following (very) minor sources: $CO_2$ from asphalt roofing (2A5), due to missing activity data; - $CO_2$ from road paving (2A6), due to missing activity data; Emissions from Industrial wastewater (6B1), due to missing data (see also chapter 8 for more information).<br>Emissions from the agricultural sector in the Brussels region were estimated for the first time during the 2011 submission as a result of the centralized review carried out by the expert review team of UNFCCC in September 2010 (Saturday paper).<br>Some other 'NE' sources, mainly small missing emissions from $CH_4$ and $N_2O$ from combustion activities of 'other fuels' in the Flemish region were added during the 2011 submission. | Belgium's Greenhouse Gas Inventory (1990–2009)<br>Mar 2011<br>p. 27 |
| **Germany** | If source-specific emissions and sinks are not quantified, they are quantitatively not relevant or the necessary data for an estimate are not available (NE-not estimated). The still reported "Not estimated" (NE) concern mostly not quantified emissions, which according to IPCC GPG (2003, p.1.11), do not have to be reported, as these emissions are listed in the appendices 3a.2, 3a.3 und 3a.4.<br>Some of the emission data, which are available to UBA, cannot be published because of confidentiality. These data are complete, but can only be reported on an aggregate level. | Nationaler Inventarbericht zum deutschen Treibhausgasinventar 1990-2009<br>Jan. 2011<br>p. 114-115 |
| **Denmark** | Some very minor sources have not been estimated due to lack of methodology, activity data or emission factors, i.e.: In the Solvent and other product use sector currently only $N_2O$ emissions from anaesthesia are included in CRF category 3D, Denmark will try to obtain activity data for other uses of $N_2O$. $N_2O$ emissions from anaesthesia are only included from 2005 onwards. Methane and nitrous oxide emissions from manure management have not been estimated for ostriches and pheasants. There is no default factors provided in the revised 1996 IPCC Guidelines or IPCC GPG. Direct and indirect $CH_4$ emissions from agricultural soils are not estimated. Direct and indirect soil emissions are considered of minor importance for $CH_4$. No methodology is recommended in IPCC-GPG. In the LULUCF sector emissions/removals from living biomass in settlements remaining settlements and emissions/removals from living biomass and soils in partly water covered wetlands are currently not estimated due to the lack of available data.<br>The lack of data availability is also an issue for other aspects of LULUCF, e.g. harvested wood products. For more detail please see chapter 7. In the Waste sector $CO_2$ emissions from managed waste disposal on land are not estimated. According to the 1996 IPCC Guidelines: "Decomposition of organic material derived from biomass sources (e.g., crops, forests), which are regrown on an annual basis is the primary source of $CO_2$ released from waste. Hence, these $CO_2$ emissions are not treated as net emissions from waste in the IPCC Methodology." Emissions of $N_2O$ from accidental fires are reported as not estimated due to lack of emission factors. | Denmark's National Inventory Report 2011<br>Mar 2011<br>Annex 5 |
| **Finland** | Sources which are not estimated are listed in Annex 5.<br>$CH_4$ emissions from 4A9 (Poultry), $CH_4$ emissions from 4D1 and 4D3 is not estimated, as there is no methodology available. $N_2O$ emissions from 6B1 and 6B2 are not estimated, as there is no IPCC methodology for $N_2O$ available. The sink 5D1, 5E1, 5E2, 5F1, 5F2 is not estimated as there is no need to report according to the appendices in GPG LULCF 2003. | National Inventory Report under the UNFCCC and the Kyoto Protocol<br>Mar 2011<br>Annex 5 |

| MS | Description of the completeness | Source |
|---|---|---|
| **France** | There is only the memo item 1C2, which is not estimated, because data are not available. | Rapport National d'inventaire pour la France au titre de la convention cadre des nations unies sur les changements climatiques et du protocole de Kyoto<br>CRF table 9<br>Mar 2001 |
| **Greece** | $CO_2$ emissions from a number of minor sources (organic chemicals, asphalt roofing, road paving with asphalt) included in Industrial processes are not estimated due to the lack of emission factors in the IPCC guidelines.<br>Potential emissions of f-gases are not estimated, as, for the time being, imports/exports of the relative chemical compounds are not recorded separately. $CH_4$ emissions from Agricultural soils. There is no method for the estimation of $CH_4$ emissions from this source. $N_2O$ emissions from wastewater handling, due to lack of methodological approach. | Climate Change Emissions inventory<br>Jan 2011<br>p.12-13 |
| **Ireland** | The work done for the current reporting cycle serves to maintain a complete and consistent emissions time-series by improving the inventories for the years 1990-2008 to bring them fully into line with that for 2009, which features important methodological changes in the Agriculture and Waste sectors. The opportunity has also been taken in this current cycle to improve, wherever possible, the estimates of emissions and removals for all years for LULUCF reported under the Convention in accordance with the requirements of Decision 13/CP.9 in order to achieve consistency with the reporting on Article 3.3 activities under the Kyoto Protocol. $CO_2$ emissions from 2D are not estimated, $N_2O$ emissions from 3, $CH_4$ from 4D, $CH_4$ from 5D, $CH_4$ and $N_2O$ from 5F and $CO_2$, $CH_4$ and $N_2O$ from 6C are not estimated. | National Inventory Report 2011<br>Mar 2011<br>p.25 and 32 |
| **Italy** | The inventory covers all major sources and sinks, as well as direct and indirect gases, included in the IPCC guidelines. Details are reported in CRF table 9. Sectoral and background tables of CRF sheets are complete as far as details of basic information are available. For instance, multilateral operations emissions are not estimated because no activity data are available. With respect to the last year submission, improvements concerned the estimation of emissions from the combustion of biomass in the pulp and paper industry and emissions from the use of $N_2O$ in explosives also in response to the recommendations of the last UNFCCC review. | National Inventory Report 2011<br>Apr 2011<br>p.43 |
| **Luyembourg** | All sources and sinks included in the IPCC Guidelines are covered. With regards to LULUCF, this submission contains new estimations for LULUCF, the three main sub-categories now being covered as well as the sub-categories wetlands, settlements and other lands, which were not estimated in the previous submission. Both direct GHGs as well as precursor gases are covered by Luxembourg's inventory. However, indirect GHG – NOx, CO, NMVOCs – and SO2 need to be re-evaluated in the light of the revision of the inventories Luxembourg is compiling for the UNECE CLRTAP. Generating better emission estimates for these gases are part of our planned improvements. The notation key NE is used for existing emissions by sources and removals by sinks of GHG which have not been estimated. Where NE is used in an inventory for emissions or removals, CRF table 9 indicates why emissions or removals have not been estimated. For emissions by sources and removals by sinks of GHG marked by NE, check-ups are in progress to establish if they actually are NO (not occurring). As part of the improvement programme of the inventory, it is planned that these source or sink categories are either estimated or allocated to NO. | National Inventory Report 2011<br>Apr 2011<br>p.84-85 |
| **Netherlands** | At present, the greenhouse gas emission inventory for the Netherlands includes all of the sources identified by the Revised IPCC Guidelines (IPCC, 1997). Except for a number of (very) minor sources:<br>Charcoal production (1B2) due to missing activity data; Charcoal use (1A4), due to missing activity data; $CO_2$ from asphalt roofing (2A5) and $CO_2$ from road paving (2A6), due to missing activity data; $CH_4$ from Enteric fermentation poultry (4A9), due to missing emission factors; $N_2O$ from Industrial wastewater (6B1), due to negligible amounts. Part of $CH_4$ from industrial waste water (6B1b Sludge), due to negligible amounts;<br>The Netherlands emissions inventory focuses on completeness and improving accuracy in the most relevant sources. This means that for all 'NE' sources, it is investigated what information is available and whether it could be assumed that a source is a really (very) small/negligible. For those sources that were not small, during the improvement programme, methods for estimating the emissions were developed.<br>As a result of this process, it was decided to keep only for very few sources as 'NE', since data for estimating emissions are not available and the source is very small. Of course, on regular basis it is being checked/re-assessed whether there are developments in NE sources that indicate (major) increase in emissions or new data sources for estimating emissions. For all except biofuels, this is the case for the 'NE' sources the ERT is referring to. For biofuels we are planning to incorporate activity data and emissions. | Greenhouse gas emissions in the Netherlands 1990-2009<br>Mar 2011<br>Annex 5 |
| **Portugal** | See CRF Table 9 (a)<br>Despite the efforts done, it was still not possible to collect the necessary background information to quantify $CO_2$ emissions from agricultural lime application. | Portuguese National Inventory Report on Greenhouse Gases, 1990-2009<br>Mar 2011 |
| **Spain** | See CRF table 9(a) | Inventario de emisiones de gases de efecto invernadero des Espana anos 1990-2009<br>Jan 2011 |

| MS | Description of the completeness | Source |
|---|---|---|
| Sweden | All relevant emissions and sources are estimated and reported in the inventory. Details on sectoral completeness is given below:<br>Energy: Emissions of $CH_4$ and $N_2O$ from liquid biofuels used in road transportation and military transportation are however not estimated. There might also still be some lack in completeness as regards in-house generated fuels in the chemical industry and in smaller companies.<br>Industrial Processes: Data is complete for all greenhouse gases, possibly with the exception of $CH_4$ for a few sources, e.g. within the chemical industry.<br>Agriculture: There are, how-ever, some marginal animal groups, which are not included, such as fur-bearing animals (minks, foxes and chinchillas). These groups are very small and there is no methodology developed for estimating their GHG emissions.<br>LULUCF: All land areas are inventoried in the field except high mountains, military impediments and urban land. We believe that their relative importance for the Swedish GHG inventory is small. The inventory of the LULUCF-sector is complete in the sense that all carbon pools and other sources, defined based on the IPCC GPG for LULCUF, are reported for land use categories that are considered managed. The reporting of woody biomass stocks refers to above and below ground parts of trees taller than 1.3 m. Other vegetation such as shrubs and herbs are not reported. Emissions/removals from below ground biomass of dead stump systems are from this submission included in the dead organic matter pool.<br>Waste: The effects of possible leakage of methane and nitrous oxide from the wastewater treatment processes have not been estimated. All other data are complete. | National Inventory Report 2011 Sweden<br>Mar 2011<br>p. 47-48 |
| United Kingdom | See CRF table 9(a) | UK Greenhouse Gas Inventory, 1990 to 2009<br>Apr 2011<br>Annex 5 |

### 1.7.2 Data gaps and gap-filling

The EU GHG inventory is compiled by using the inventory submissions of the EU Member States. If a Member State does not submit all data required for the compilation of the EU inventory by 15 March of a reporting year, the Commission prepares estimates for data missing for that Member State. In the following cases gap filling is made:

- To complete specific years in the GHG inventory time-series for a specific Member State
- for the most recent inventory year(s);
- for the base year;
- for some years of the time series from 1990 to the most recent year.
- To complete individual source categories for individual Member States that did not estimate specific source categories for any year of the inventory time series and reported 'NE'. Gap filling methods are used for major gaps when it is highly certain that emissions from these source categories exist in the Member States concerned;
- To provide complete CRF background data tables for the European Union when some Member States only provided CRF sectoral and summary tables. (In this case, the gap filling methods are used to further disaggregate the emission estimates provided by Member States.)
- To enable the presentation of consistent trends for the EU.

For data gaps in Member States' inventory submissions, the following procedure is applied by the ETC/ACM in accordance with the implementing provisions under Council Decision No 280/2004/EC for missing emission data:

- If a consistent time series of reported estimates for the relevant source category is available from the Member State for previous years that has not been subject to adjustments under Article 5.2 of the Kyoto Protocol, extrapolation of this time series is used to obtain the emission estimate. As far as $CO_2$ emissions from the energy sector are concerned, extrapolation of emissions should be based on the percentage change of Eurostat $CO_2$ emission estimates if appropriate.

- If the estimate for the relevant source category was subject to adjustments under Article 5.2 of the Kyoto Protocol in previous years and the Member State has not submitted a revised estimate, the basic adjustment method used by the expert review team as provided in the 'Technical guidance on methodologies for adjustments under Article 5.2 of the Kyoto Protocol' is used without application of the conservativeness factor.
- If a consistent time series of reported estimates for the relevant source category is not available and if the source category has not been subject to adjustments under Article 5.2 of the Kyoto Protocol, the estimation should be based on the methodological guidance provided in the 'Technical guidance on methodologies for adjustments under Article 5.2 of the Kyoto Protocol' without application of the conservativeness factor.

The Commission prepares the estimates by 31 March of the reporting year, following consultation with the Member State concerned, and communicates the estimates to the other Member States. The Member State concerned shall use the estimates referred to for its national submission to the UNFCCC to ensure consistency between the EU inventory and Member States' inventories.

The methods used for gap filling include interpolation, extrapolation and clustering. These methods are consistent with the adjustment methods described in UNFCCC Adjustment Guidelines (Table 1) and in the IPCC GPG 2000.(18) On the basis of the general approaches mentioned above concrete methodologies were developed for each sector/gas (Table 1.18).

**Table 1.18 Gap filling methodologies**

| |
|---|
| **Estimates at the beginning or at the end of a time series** |
| **Fuel combustion related GHG emissions ($CO_2$, $CH_4$, $N_2O$ of sector 1A):** |
| The percentage change from Eurostat $CO_2$ emission estimates was used for extrapolation, where available |
| If there were no Eurostat $CO_2$ emission estimates available linear trend extrapolation was used. |
| **Other sectors:** |
| Linear trend extrapolation was used, where no striking dips or jumps in the time series were identified. In general the trend extrapolation was made on basis of the time series 2000-2004. |
| Previous year values were used where striking dips or jumps in the time series were identified. |
| **Estimates for years within a time series** |
| Linear interpolation between the years available was used |
| **Estimates if no time series is available (only relevant for fluorinated gases):** |
| **HFCs:** |
| Emissions were estimated for 2F1 'Refrigeration and air conditioning equipment' on basis of average per capita emissions of either a set of similar countries (if available) or on basis of one single country (if a set of similar countries was not available). Population data was used from Eurostat. |
| **PFCs:** |
| It was checked if aluminum production occurs in the relevant countries, which was not the case. For other PFC emissions no estimates were prepared because of lack of data. |
| **SF6:** |
| Emissions were estimated for 2F7 'Electrical equipment' on basis of average emissions per electricity consumption of either a set of similar countries (if available) or on basis of one single country (if a set of similar countries was not available). Data on electricity consumption was used from Eurostat. |

### 1.7.2.1 Gap filling in GHG inventory submissions 2011

As for 2009 GHG inventory estimates are available for all EU Member States no gap filling was needed.

Data basis of the European Union greenhouse gas inventory

The 2011 EU-15 GHG inventory data consist of GHG submissions of the Member States to the European Commission in 2010; no gap filling was needed. Table 1.19 to Table 1.22 show the data basis of the 2011 EU GHG inventory.

18 ETC ACC technical note on gap filling procedures , December 2006

**Table 1.19 Data basis of $CO_2$ emissions excluding LULUCF (Tg)**

| EU Member State | 1990 | 1995 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Austria | 62 | 64 | 66 | 70 | 72 | 78 | 78 | 80 | 77 | 74 | 74 | 68 |
| Belgium | 119 | 124 | 125 | 125 | 124 | 128 | 128 | 125 | 121 | 117 | 119 | 108 |
| Denmark | 53 | 61 | 53 | 55 | 55 | 60 | 54 | 51 | 59 | 54 | 51 | 48 |
| Finland | 57 | 58 | 57 | 62 | 64 | 72 | 68 | 56 | 68 | 66 | 58 | 55 |
| France | 394 | 393 | 409 | 414 | 408 | 413 | 417 | 420 | 406 | 398 | 391 | 373 |
| Germany | 1,042 | 930 | 891 | 907 | 891 | 890 | 881 | 864 | 870 | 847 | 848 | 789 |
| Greece | 83 | 87 | 103 | 106 | 105 | 109 | 110 | 113 | 112 | 114 | 110 | 104 |
| Ireland | 32 | 35 | 45 | 47 | 46 | 45 | 46 | 48 | 47 | 47 | 48 | 42 |
| Italy | 436 | 446 | 464 | 470 | 472 | 488 | 491 | 490 | 485 | 476 | 466 | 417 |
| Luxembourg | 12 | 9 | 9 | 9 | 10 | 11 | 12 | 12 | 12 | 11 | 11 | 11 |
| Netherlands | 159 | 171 | 170 | 176 | 176 | 180 | 181 | 176 | 173 | 172 | 175 | 170 |
| Portugal | 44 | 53 | 64 | 64 | 68 | 63 | 65 | 68 | 63 | 61 | 59 | 56 |
| Spain | 226 | 254 | 305 | 308 | 327 | 331 | 349 | 364 | 355 | 364 | 335 | 297 |
| Sweden | 57 | 59 | 54 | 55 | 56 | 56 | 56 | 53 | 53 | 52 | 50 | 47 |
| United Kingdom | 585 | 548 | 548 | 561 | 544 | 554 | 555 | 552 | 549 | 541 | 529 | 477 |
| **EU-15** | **3,359** | **3,290** | **3,362** | **3,428** | **3,419** | **3,478** | **3,490** | **3,473** | **3,450** | **3,396** | **3,323** | **3,063** |

**Table 1.20 Data basis of $CH_4$ emissions in $CO_2$ equivalents (Tg)**

| EU Member State | 1990 | 1995 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Austria | 8 | 8 | 7 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 |
| Belgium | 10 | 10 | 8 | 8 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 6 |
| Denmark | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 |
| Finland | 6 | 6 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 4 | 4 |
| France | 68 | 71 | 71 | 70 | 70 | 69 | 68 | 67 | 67 | 67 | 68 | 67 |
| Germany | 107 | 92 | 75 | 72 | 68 | 65 | 60 | 57 | 54 | 52 | 51 | 49 |
| Greece | 10 | 10 | 10 | 10 | 10 | 9 | 9 | 9 | 9 | 9 | 9 | 9 |
| Ireland | 14 | 14 | 13 | 13 | 13 | 14 | 13 | 13 | 13 | 12 | 12 | 12 |
| Italy | 44 | 44 | 46 | 45 | 44 | 43 | 41 | 41 | 39 | 39 | 38 | 37 |
| Luxembourg | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Netherlands | 26 | 24 | 20 | 19 | 18 | 18 | 18 | 17 | 17 | 17 | 17 | 17 |
| Portugal | 10 | 11 | 11 | 12 | 13 | 13 | 13 | 13 | 13 | 12 | 13 | 13 |
| Spain | 26 | 29 | 34 | 35 | 35 | 35 | 35 | 36 | 36 | 37 | 36 | 36 |
| Sweden | 7 | 7 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 5 | 5 |
| United Kingdom | 110 | 90 | 67 | 61 | 58 | 52 | 50 | 48 | 47 | 46 | 44 | 43 |
| **EU-15** | **452** | **423** | **379** | **369** | **360** | **348** | **337** | **331** | **325** | **321** | **317** | **311** |

**Table 1.21 Data basis of $N_2O$ emissions in $CO_2$ equivalents (Tg)**

| EU Member State | 1990 | 1995 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Austria | 6 | 7 | 6 | 6 | 6 | 6 | 5 | 5 | 6 | 6 | 6 | 5 |
| Belgium | 11 | 12 | 11 | 11 | 10 | 9 | 10 | 9 | 9 | 8 | 7 | 8 |
| Denmark | 10 | 9 | 8 | 8 | 7 | 7 | 7 | 6 | 6 | 6 | 6 | 6 |
| Finland | 7 | 7 | 7 | 6 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 6 |
| France | 94 | 92 | 79 | 77 | 75 | 73 | 70 | 70 | 67 | 67 | 68 | 64 |
| Germany | 88 | 83 | 65 | 66 | 65 | 64 | 67 | 65 | 64 | 66 | 67 | 67 |
| Greece | 10 | 9 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 7 | 7 |
| Ireland | 9 | 9 | 9 | 9 | 8 | 8 | 8 | 8 | 8 | 7 | 7 | 7 |
| Italy | 37 | 38 | 40 | 40 | 39 | 38 | 39 | 38 | 32 | 32 | 29 | 28 |
| Luxembourg | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| Netherlands | 20 | 20 | 18 | 17 | 16 | 16 | 16 | 16 | 16 | 14 | 10 | 10 |
| Portugal | 6 | 6 | 6 | 6 | 6 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| Spain | 28 | 26 | 32 | 31 | 30 | 31 | 30 | 28 | 29 | 29 | 26 | 26 |
| Sweden | 8 | 8 | 8 | 8 | 8 | 8 | 7 | 7 | 7 | 7 | 7 | 7 |
| United Kingdom | 68 | 56 | 45 | 42 | 41 | 40 | 41 | 39 | 38 | 37 | 36 | 35 |
| **EU-15** | **403** | **382** | **343** | **334** | **326** | **320** | **321** | **312** | **300** | **299** | **291** | **280** |

**Table 1.22 Data basis of actual HFCs, PFCs and $SF_6$ emissions in $CO_2$ equivalents (Gg)**

| Member State | | 1990 | 1995 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Austria | HFC | 26 | 412 | 902 | 925 | 969 | 950 | 955 | 986 | 963 | 1,062 | 1,058 | 1,056 |
| | PFC | 1,079 | 71 | 85 | 96 | 98 | 116 | 137 | 134 | 146 | 190 | 174 | 35 |
| | $SF_6$ | 494 | 1,154 | 596 | 652 | 635 | 567 | 497 | 507 | 465 | 375 | 383 | 349 |
| Belgium | HFC | 443 | 443 | 916 | 1,045 | 1,255 | 1,410 | 1,442 | 1,414 | 1,499 | 1,668 | 1,741 | 1,801 |
| | PFC | 1,753 | 2,335 | 361 | 223 | 82 | 209 | 306 | 153 | 157 | 178 | 198 | 124 |
| | $SF_6$ | 1,662 | 2,205 | 112 | 129 | 112 | 100 | 84 | 86 | 75 | 81 | 89 | 96 |
| Denmark | HFC | IA,NE,NO | 218 | 607 | 650 | 676 | 701 | 755 | 802 | 823 | 850 | 853 | 799 |
| | PFC | IA,NE,NO | 1 | 18 | 22 | 22 | 19 | 16 | 14 | 16 | 15 | 13 | 14 |
| | $SF_6$ | 44 | 107 | 59 | 30 | 25 | 31 | 33 | 22 | 36 | 30 | 32 | 37 |
| Finland | HFC | 0 | 29 | 492 | 646 | 463 | 651 | 694 | 863 | 747 | 903 | 993 | 889 |
| | PFC | 0 | 0 | 22 | 20 | 13 | 15 | 12 | 10 | 15 | 8 | 11 | 9 |
| | $SF_6$ | 94 | 69 | 51 | 55 | 51 | 48 | 34 | 35 | 40 | 36 | 40 | 41 |
| France | HFC | 3,740 | 3,210 | 7,474 | 8,565 | 9,629 | 10,851 | 11,497 | 12,495 | 13,689 | 14,470 | 15,037 | 15,433 |
| | PFC | 4,293 | 2,562 | 2,487 | 2,191 | 3,477 | 3,218 | 2,180 | 1,430 | 1,167 | 920 | 559 | 365 |
| | $SF_6$ | 2,016 | 2,237 | 1,575 | 1,212 | 1,041 | 1,027 | 1,180 | 995 | 865 | 746 | 693 | 574 |
| Germany | HFC | 4,369 | 6,469 | 6,483 | 7,891 | 8,799 | 8,628 | 9,247 | 10,001 | 10,539 | 11,145 | 11,474 | 11,952 |
| | PFC | 2,708 | 1,750 | 781 | 717 | 789 | 851 | 822 | 709 | 571 | 530 | 531 | 432 |
| | $SF_6$ | 4,785 | 7,220 | 4,826 | 4,346 | 3,570 | 3,490 | 3,658 | 3,726 | 3,651 | 3,537 | 3,288 | 3,223 |
| Greece | HFC | 935 | 3,262 | 4,275 | 3,978 | 4,210 | 4,037 | 4,222 | 3,957 | 2,032 | 2,098 | 2,483 | 2,569 |
| | PFC | 263 | 86 | 152 | 93 | 91 | 80 | 73 | 73 | 62 | 60 | 76 | 36 |
| | $SF_6$ | 3 | 4 | 4 | 4 | 4 | 4 | 4 | 6 | 8 | 10 | 8 | 5 |
| Ireland | HFC | 1 | 45 | 231 | 253 | 278 | 351 | 387 | 437 | 509 | 501 | 521 | 501 |
| | PFC | 0 | 75 | 305 | 296 | 212 | 229 | 182 | 168 | 148 | 131 | 106 | 66 |
| | $SF_6$ | 35 | 83 | 56 | 69 | 70 | 118 | 67 | 95 | 67 | 69 | 61 | 65 |
| Italy | HFC | 351 | 671 | 1,986 | 2,550 | 3,191 | 3,902 | 4,635 | 5,401 | 6,106 | 6,855 | 7,513 | 8,173 |
| | PFC | 1,808 | 491 | 345 | 451 | 423 | 497 | 348 | 354 | 284 | 287 | 201 | 218 |
| | $SF_6$ | 333 | 601 | 493 | 795 | 740 | 468 | 502 | 465 | 406 | 428 | 436 | 398 |
| Luxembourg | HFC | 14 | 16 | 29 | 34 | 42 | 47 | 49 | 53 | 57 | 61 | 64 | 66 |
| | PFC | NA,NO | NA,NO | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | $SF_6$ | 1 | 2 | 2 | 3 | 3 | 4 | 5 | 5 | 6 | 6 | 7 | 7 |
| Netherlands | HFC | 4,432 | 6,018 | 3,886 | 1,555 | 1,645 | 1,501 | 1,638 | 1,494 | 1,704 | 1,820 | 1,889 | 2,061 |
| | PFC | 2,264 | 1,938 | 1,582 | 1,489 | 2,187 | 621 | 286 | 266 | 257 | 323 | 251 | 168 |
| | $SF_6$ | 217 | 301 | 315 | 317 | 274 | 231 | 252 | 239 | 198 | 192 | 186 | 175 |
| Portugal | HFC | IA,NE,NO | 55 | 303 | 391 | 498 | 607 | 684 | 780 | 864 | 947 | 1,038 | 1,108 |
| | PFC | IA,NE,NO | NA,NO | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | $SF_6$ | IA,NE,NO | 5 | 6 | 6 | 6 | 7 | 8 | 7 | 8 | 8 | 8 | 8 |
| Spain | HFC | 2,403 | 4,645 | 8,349 | 5,518 | 4,173 | 5,351 | 5,050 | 5,423 | 6,006 | 6,329 | 7,080 | 7,361 |
| | PFC | 883 | 833 | 436 | 269 | 297 | 305 | 313 | 288 | 294 | 298 | 315 | 297 |
| | $SF_6$ | 67 | 108 | 205 | 183 | 207 | 208 | 254 | 272 | 324 | 340 | 354 | 351 |
| Sweden | HFC | 4 | 127 | 564 | 612 | 665 | 711 | 774 | 804 | 835 | 870 | 912 | 932 |
| | PFC | 377 | 343 | 241 | 236 | 261 | 258 | 254 | 257 | 245 | 248 | 225 | 35 |
| | $SF_6$ | 107 | 127 | 94 | 111 | 104 | 69 | 81 | 142 | 111 | 151 | 84 | 82 |
| United Kingdom | HFC | 11,386 | 15,447 | 8,699 | 9,336 | 9,510 | 10,389 | 9,429 | 10,197 | 10,538 | 10,498 | 10,778 | 10,852 |
| | PFC | 1,401 | 462 | 466 | 386 | 321 | 277 | 342 | 261 | 306 | 221 | 208 | 147 |
| | $SF_6$ | 1,030 | 1,239 | 1,798 | 1,425 | 1,509 | 1,324 | 1,127 | 1,108 | 874 | 792 | 711 | 661 |
| **EU-15** | HFC | 40,891 | 35,732 | 46,210 | 45,196 | 43,950 | 46,004 | 50,086 | 51,458 | 55,106 | 56,911 | 60,077 | 63,433 |
| | PFC | 15,003 | 11,572 | 8,679 | 7,281 | 6,490 | 8,274 | 6,694 | 5,271 | 4,117 | 3,668 | 3,409 | 2,869 |
| | $SF_6$ | 14,313 | 14,395 | 10,351 | 10,192 | 9,338 | 8,352 | 7,694 | 7,786 | 7,713 | 7,134 | 6,801 | 6,377 |

### 1.7.3 Geographical coverage of the European Union inventory

Table 1.23 shows the geographical coverage of the EU-15 Member States' national inventories. As the EU-15 inventory is the sum of the Member States' inventories, the EU-15 inventory covers the same geographical area as the inventories of the Member States.

**Table 1.23 Geographical coverage of the EU-15 inventory**

| Member State | Geographical coverage | EU-territory coverage (UNFCCC and Kyoto) | Party coverage (UNFCCC) | Party coverage (Kyoto Protocol) |
|---|---|---|---|---|
| Austria | Austria | x | x | x |
| Belgium | Belgium consisting of Flemish Region, Walloon Region and Brussels Region | x | x | x |
| Denmark | Denmark (excluding Greenland and the Faeroe Islands) | x | | |
| | Denmark, Faroe Islands and Greenland | | x | |
| | Denmark and Greenland | | | x |
| Finland | Finland including Åland Islands | x | x | x |
| France | France mainland and the overseas territories under the EU (Guadeloupe, Martinique, Guyana, Reunion, Saint-Barthélémy and Saint-Martin) | x | | x |
| | France mainland and the overseas territories under the EU (Guadeloupe, Martinique, Guyana, Reunion, Saint-Barthélémy and Saint-Martin) and the overseas territories not covered by the EU (New Caledonia, Wallis and Futuna, Austral and Antarctic territories) | | x | |
| Germany | Germany | x | x | x |
| Greece | Greece | x | x | x |
| Ireland | Ireland | x | x | x |
| Italy | Italy | x | x | x |
| Luxembourg | Luxembourg | x | x | x |
| Netherlands | The reported emissions have to be allocated to the legal territory of The Netherlands. This includes a 12-mile zone from the coastline and also inland water bodies. It excludes Aruba and The Netherlands Antilles, which are self-governing dependencies of the Royal Kingdom of The Netherlands. Emissions from offshore oil and gas production on the Dutch part of the continental shelf are included. | x | x | x |
| Portugal | Mainland Portugal and the two Autonomous regions of Madeira and Azores Islands. Includes also emissions from air traffic and navigation bunkers realized between these areas. | x | x | x |
| Spain | Spanish part of Iberian mainland, Canary Islands, Balearic Islands, Ceuta and Melilla | x | x | x |
| Sweden | Sweden | x | x | x |
| United Kingdom | England, Scotland, Wales and Northern Ireland, and Gibraltar, excluding the UK Crown Dependencies (Jersey, Guernsey and the Isle of Man) and the UK Overseas Territories (except Gibraltar). | x | | |
| | England, Scotland, Wales and Northern Ireland, Gibraltar, the UK Crown Dependencies (Jersey, Guernsey and the Isle of Man) and the UK Overseas Territories that have ratified the UNFCCC and the Kyoto Protocol (Bermuda, Cayman, Falkland Islands, Montserrat and Gibraltar). | | x | x |
| EU-15 | | x | | |

### 1.7.4 Completeness of the European Union submission

#### 1.7.4.1 National inventory report

The EU NIR follows – as far as posible - the annotated outline of the UNFCCC secretariat with the exception of the annexes. The main reason for this is the nature of the EU inventory being the sum of Member States' inventories. Therefore the main purpose of the annexes is to make transparent the EU emission estimates by providing the basic basic Member States tables for every CRF table.

Table 1.24 provides explanations for not including the annexes as required by the UNFCCC reporting guidelines.

**Table 1.24 Explanations for exclusion of annexes as outlied in the UNFCCC reporting guidelines**

| Annex required in the UNFCCC reporting guidelines | Comment |
|---|---|
| Annex 1: Key categories | This annex is included in the EU NIR |
| Annex 2: Detailed discussion of methodology and data for estimating $CO_2$ emissions from fossil fuel combustion | Due to the nature of the EU inventory being the sum of Member States' inventories detailed methodologies for estimating $CO_2$ emissions from fossil fuel combustion are included in Member States' NIRs. However, summary information on methodologies used by Member States is provided in the EU NIR for the EU key sources. |
| Annex 3: Other detailed methodological descriptions for individual source or sink categories (where relevant) | Due to the nature of the EU inventory being the sum of Member States' inventories detailed methodological descriptions for other source or sink categories are included in Member States' NIRs. However, summary information on methodologies used by Member States is provided in the EU NIR for the EU key sources. |
| Annex 4: $CO_2$ reference approach and comparison with sectoral approach, and relevant information on the national energy balance | Information on the reference approach is included in the EU NIR. Due to the nature of the EU inventory being the sum of Member States' inventories there is no national energy balance which could be included in this annex. |
| Annex 5: Assessment of completeness and (potential) sources and sinks of greenhouse gas emissions and removals excluded | Information on completeness as reported by Member States in CRF Table 9 is included in the EU NIR in Table 1.20. In addition, for the EU key sources explanations for the NE are included in the sector chapters of the NIR, where relevant. |
| Annex 6: Additional information to be considered as part of the NIR submission (where relevant) or other useful reference information | The EU considers the Member States CRF and NIR as part fo the EU submission. |
| Annex 7: Tables 6.1 and 6.2 of the IPCC good practice guidance | Due to the nature of the EU inventory EU uncertainties are not estimated on basis of uncertainties of emission factors and activity data (see chapter 1.7). Therefore no Table 6.1 can be provided for the EU. Tier 2 uncertainty analysis has not yet been carried out. |
| Annex 8: Other annexes - (Any other relevant information – optional). | |

*CRF tables in Annex 1.2*

The European Union cannot provide all data in the sectoral background tables. The main reasons for not completing all sectoral background data tables are: (1) limited data availability partly due to confidentiality issues; and (2) the use of different type of activity data by Member States. Latter is due to the fact that the Member States are responsible for calculating emissions. If they use country-specific methods they may also use different types of activity data. At EU-15 level these different types of activity data cannot be simply added up. As at EU-15 level no emissions are calculated directly on the basis of activity data, the documentation of very detailed background data seems to be of lower importance. All the details for the calculation of the emissions are documented in the Member States' CRF tables, as part of their national GHG inventories, which also form part of the EU GHG inventory submission (see Annex 1.12, which is available at the EEA website http://www.eea.eu.int) and in the sector annexes.

Table 1.25 provides an overview of sectoral report and sectoral background tables available in Annex 1.2, an explanation for each table which is not filled in at EU-15 level and activity data provided for the calculation of implied emission factors. Further information is provided in the relevant sector chapters.

**Table 1.25 Inclusion of CRF tables in Annex 1.2**

| Table | Included in Annex 1.2 | Comment |
|---|---|---|
| Energy | | |
| Table 1 | Yes | |
| Table 1.A (a) | Yes | |
| Table 1.A (b) | Yes | |
| Table 1.A (c) | Yes | |
| Table 1.A (d) | Yes | |
| Table 1B1 | Yes | |
| Table 1B2 | Partly | Emissions are included, activity data is not estimated because type of activity data used by the MS varies; overview table for 1B2b included in the NIR |

| Table | Included in Annex 1.2 | Comment |
|---|---|---|
| Table 1.C | Yes | |
| Industrial processes | | |
| Table 2(I) | Yes | |
| Table 2(II) | Yes | |
| Table 2(I). A-G | Partly | Emissions are included, activity data is not estimated because type of activity data used by the MS varies; overview tables for large key sources included in the NIR |
| Table 2(II). C,E | Partly | Emissions are included, activity data is not estimated because type of activity data used by the MS varies; limited data availability; confidentiality issues |
| Table 2(II). F | Yes | For those MS which did not provide Table 2(II).F emissions are allocated to the sub-categories according to the aggregated average allocation of those MS which provided Table 2(II).F. |
| Solvent use | | |
| Table 3 | Yes | |
| Table 3. A-D | No | Type of activity data used by the MS varies |
| Agriculture | | |
| Table 4 | Yes | |
| Table 4. A | Yes | |
| Table 4. B(a) | Yes | |
| Table 4. B(b) | Yes | |
| Table 4. C | Yes | |
| Table 4. D | Yes | |
| Table 4. E | Yes | |
| Table 4. F | Yes | |
| LUCF | | |
| Table 5 | Yes | |
| Table 5. A | Yes | |
| Table 5. B | Yes | |
| Table 5. C | Yes | |
| Table 5. D | Yes | |
| Table 5. E | Yes | |
| Table 5. F | Yes | |
| Table 5 (I) | Yes | |
| Table 5 (II) | Yes | |
| Table 5 (III) | Yes | |
| Table 5 (IV) | Yes | |
| Table 5 (V) | Partly | Emissions are included, activity data is not estimated because type of activity data used by the MS varies |
| Waste | | |
| Table 6 | Yes | |
| Table 6. A, C | Partly | Emissions and some activity data are included |
| Table 6. B | Partly | Emissions are included, activity data is not estimated because of limited data availability |
| Summary Tables | | |
| Summary 1.A | Yes | |
| Summary 1.B | Yes | |
| Summary 2 | Yes | |
| Summary 3 | Yes | |
| Other Tables | | |
| Table 7 | Yes | |
| Table 8(a) | Yes | |
| Table 8(b) | Partly | It is indicated in which MS recalculations were performed. In addition, the explanations for recalculations are provided in the EU NIR for the EU key sources together with the contribution of every MS to the EU recalculations. Summary information is also provided in Chapter 10 (Tables 10.1 and 10.2). |
| Table 9 | Partly | Annex 1.4 provides a list of all NEs and IEs and includes explanations taken from the Member States' CRF Tables 9. This information is equivalent to CRF Table 9 which cannot be filled-in automatically for the EU-15 due to the amount of information from the Member States. In addition, information on completeness is included in the NIR for the EU key sources explanations for the NE and IE are included in the sector chapters of the NIR, where relevant. |

| Table | Included in Annex 1.2 | Comment |
|---|---|---|
| Table 10 | Yes | |

Table 1.26 provides for specific sectoral background tables an overview of activity data used by Member States in order to explain why this activity data cannot be reported at EU-15 level.

**Table 1.26 Activity data reported by Member States in CRF background data tables**

| Table | Source category | | Activity data reported by MS |
|---|---|---|---|
| Table 1B2 | 1. B. 2. a. Oil (3) | I.Exploration | number of wells drilled<br>crude oil<br>number of wells drilled/tested |
| | | ii. Production | Oil throughput<br>PJ of oil produced<br>Crude oil and NGL production<br>Crude oil produced<br>Oil and gas produced |
| | | iii.Transport | oil loaded in tankers<br>PJ Loaded<br>Crude oil imports<br>Transport of crude oil<br>Offshore loading of oil only |
| | | iv.Refining / Storage | Oil refined (SNAP 0401)<br>PJ oil refined<br>crude oil & products<br>kt oil refined<br>Refinery input (crude oil and NGL)<br>Refery input: crude oil, NGL<br>crude oil & products<br>Oil refinery throughput |
| | | v. Distribution of Oil Products | Gasoline Consumption (SNAP 0505)<br>kt oil refined<br>Domestic supply of gasoline<br>Oil products |
| | | vi.Other | Transfer loss gas works gas<br>onshore loading of oil only |
| | 1. B. 2. b. Natural Gas | i.Exploration | natural gas<br>number of wells drilled/tested |
| | | ii. Production (4) / Processing | Gas throughput<br>PJ gas produced<br>natural gas from crude oil extraction<br>Natural gas production<br>Mm3 gas produced |

| Table | Source category | | Activity data reported by MS |
|---|---|---|---|
| | | iii.Transmission | Pipelines length (km)<br>total amount of gas consumed<br>PJ gas consumed<br>Length of transmission pipeline<br>Mm3 gas transported<br>gas transported<br>PJ gas (NCV)<br>Pressure levelling losses |
| | | iv.Distribution | Distribution network length<br>consumption<br>distribution net<br>PJ gas distributed via local networks<br>PJ gas consumed<br>Length of distribution mains<br>Mm3 gas transported |
| | | v. Other Leakage | PJ gas consumed<br>t of natural gas released from pipelines |
| | 1. B. 2. c. Venting(5) | i.Oil | PJ oil produced<br>kt oil refined<br>Crude oil and NGL production |
| | | ii. Gas | PJ gas produced<br>Sour Natural gas production |
| | | iii.Combined | |
| | Flaring | i.Oil | PJ gas consumption<br>kt oil refined<br>Consumed<br>Crude oil and NGL production<br>Mm3 gas consumption<br>oil produced<br>Refinery gas other liquid fuels |
| | | ii. Gas | PJ gas consumption<br>natural gas<br>Natural gas production<br>quantity of gas flared |
| | | iii.Combined | |
| Table 2(I) | 2.A Mineral products | 1. Cement production | Clinker production<br>AD confidential |
| | | 2. Lime production | Lime produced<br>Lime and dolomite production<br>Production of lime and bricks<br>Limestone consumed |
| | | 3. Limestone and | Limestone and dolomite used |

| Table | Source category | | Activity data reported by MS |
|---|---|---|---|
| | | dolomite use | Limestone consumption<br>Clay, shale and limestone use<br>Carbonates input to brick, tiles, ceramic production |
| | | 4. Soda ash production | Soda ash production |
| | | 4. Soda ash use | Soda ash use<br>Use of soda |
| | | 5. Asphalt roofing | Roofing material production<br>Bitumen consumption |
| | | 6. Road paving with asphalt | Asphalt production<br>Bitumen consumption<br>Asphalt used in paving<br>Asphalt liquefied |
| | 2B Chemical industry | 1. Ammonia production | Ammonia production<br>Natural gas consumption |
| | | 2. Nitric acid production | Nitric acid production<br>Nitric acid production: Medium pressure plants |
| Table 2(II) C | 2C Metal production | 1. Iron and steel production | |
| | | Steel | Steel production<br>Crude steel production<br>Production of secondary steel |
| | | Pig iron | Iron production<br>Production of primary iron<br>Pig iron production |
| | | Sinter | Sinter production<br>Sinter consumption |
| | | Coke | Coke production<br>Coke consumption<br>Coke consumed in blast furnace |
| | | 2. Ferroalloys production | Ferroalloys production<br>Laterite consumption<br>Use of coal and coke electrodes |
| | | 3. Aluminium production | Aluminium production<br>Primary aluminium production |
| | C.PFCs and $SF_6$ from MetalProduction | PFCs from aluminium production | Aluminium production<br>Primary aluminium production |
| | | $SF_6$ used in Aluminium and Magnesium Foundries | |
| | | Aluminium foundries | Cast aluminium<br>Consumption of aluminium foundries<br>$SF_6$ consumption |
| | | Magnesium foundries | Cast magnesium |

| Table | Source category | | Activity data reported by MS |
|---|---|---|---|
| | | | Consumption Mg-Production<br>$SF_6$ consumption |
| Table 4D | 1. Direct soil emissions | 3. N-fixing crops | Nitrogen fixed by N-fixing crops<br>Dry pulses and soybeans produced<br>Area of cultivated soils |
| | | 4. Crop residues | Nitrogen in crop residues returned to soils<br>Dry production of other crops |
| Table 5(V) | A. Forest land | | Area burned (ha)<br>Biomass burned (kg dm) |
| | B. Cropland | | Area burned (ha)<br>Biomass burned (kg dm) |
| | C. Grassland | | Area burned (ha)<br>Biomass burned (kg dm) |
| | E. Settlements | | Area burned (ha)<br>Biomass burned (kg dm) |

# 2 EU-15 GREENHOUSE GAS EMISSION TRENDS

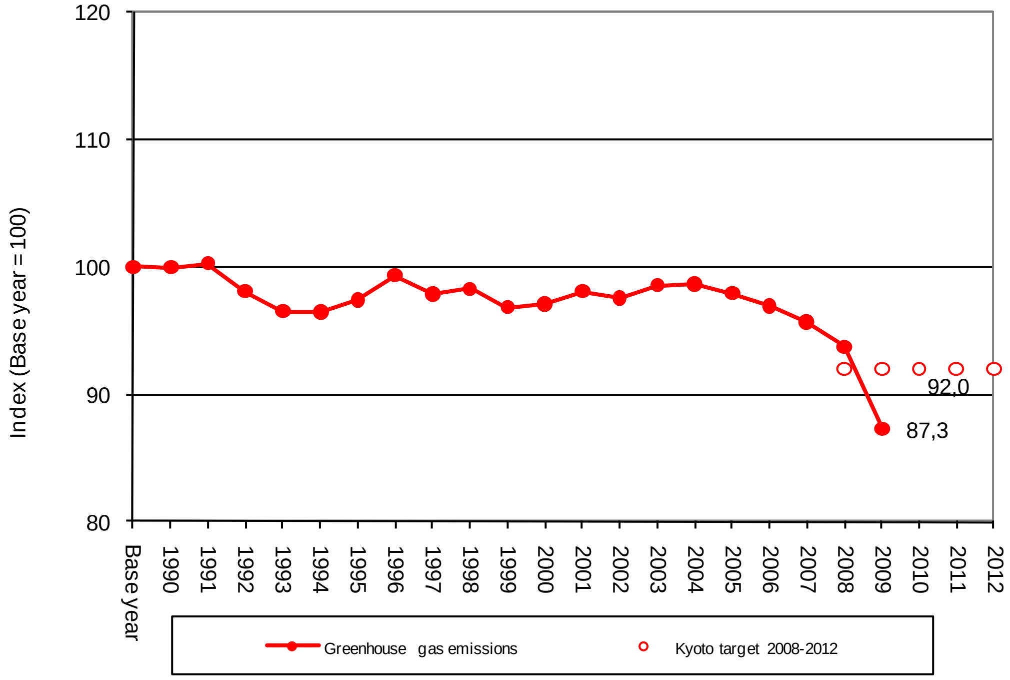
This chapter presents the main GHG emission trends in the EU-15. Firstly, aggregated results are described as regards total GHG emissions and progress towards fulfilling the EU Kyoto target (for EU-15 only). Then, emission trends are briefly analysed mainly at gas level and a short overview of Member States' contributions to EU GHG trends is given. Finally, the trends of indirect GHGs and $SO_2$ emissions are presented.

## 2.1 Aggregated greenhouse gas emissions

In 2009 total GHG emissions in the EU-15, without LULUCF, were 12.7 % (541 million tonnes $CO_2$ equivalents) below 1990. Emissions decreased by 6.9 % (274 million tonnes $CO_2$ equivalents) between 2008 and 2009.

Under the Kyoto Protocol, the EU agreed to reduce its GHG emissions by 8 % by 2008–12 compared to the'base year'[19]. This can be achieved by a combination of existing and planned domestic policies and measures, the use of carbon sinks and the use of Kyoto mechanisms. 2009 was the first year emissions (i.e. domestic) fell below the EU-15 Kyoto target (Figure ES.2).

**Figure 2.1** **EU-15 GHG emissions 1990–2008 compared with target for 2008–12 (excl. LULUCF)**




***Notes:*** *GHG emission data for the EU-15 as a whole refer to domestic emissions (i.e. within its territory) and do not include emissions and removals from LULUCF; nor do they include emissions from international aviation and international maritime transport. $CO_2$ emissions from biomass with energy recovery are reported as a Memorandum item according to UNFCCC Guidelines and not included in national totals. In addition, no adjustments for temperature variations or electricity trade are considered. The global warming potentials are those from the 1996 revised IPCC Guidelines for National Greenhouse Gas Inventories.*

[19] Following the UNFCCC reviews of Member States' 'initial reports' during 2007 and 2008 and pursuant to Article 3, Paragraphs 7 and 8 of the Kyoto Protocol, the base-year emissions for the EU-15 have been fixed to 4 265.5 Mt $CO_2$ equivalent.

### 2.1.1 Main trends by source category, 1990-2009

Table 2.1 shows the source categories contributing the most to changes in greenhouse gas emissions between 1990 and 2009.

**Table 2.1 EU-15: Overview of Top decreasing/increasing source categories 1990-2009 (+/- 20 Million tonnes $CO_2$ equivalents)**

| Source category | EU-15<br>Million tonnes ($CO_2$ eq.) |
|---|---|
| Road transport (CO2 from 1A3b) | 115.0 |
| Consumption of Halocarbons (HFC from 2F) | 63.0 |
| Nitric acid production (N2O from 2B2) | -24.4 |
| Production of Halocarbons (HFC from 2E) | -25.6 |
| Agricultural Soils ($N_2O$ from 4D) | -42.0 |
| Fugitive Emissions ($CH_4$ from 1B) | -46.8 |
| Adipic acid production ($N_2O$ from 2B3) | -48.1 |
| Manufacture of Solid fuels (CO2 from 1A1c) | -55.6 |
| Households and services ($CO_2$ from 1A4) | -59.6 |
| Public Electricity and Heat Production (CO2 from 1A1a) | -61.6 |
| Iron and steel production ($CO_2$ from 1A2a+2C1) | -69.3 |
| Solid Waste Disposal ($CH_4$ from 6A) | -69.4 |
| Manufacturing industries (excl. iron and steel) (Energy-related $CO_2$ from 1A2 excl. 1A2a) | -131.8 |
| **Total** | **-541.2** |

***Notes:*** *As the table only presents sectors whose emissions increased or decreased by 20 million tonnes $CO_2$-equivalents, the sum for each country grouping EU-15/EU-27 does not match the total change listed at the bottom of the table.*

### 2.1.2 *Main trends by source category, 2008-2009*

Table 2.2 shows the source categories contributing the most to changes in greenhouse gas emissions between 2008 and 2009.

**Table 2.2** **EU-15: Overview of Top decreasing/increasing source categories 2008-2009 (+/- 3 Million tonnes $CO_2$ equivalents)**

| Source category | EU-15 ($CO_2$ eq.) |
|---|---|
| Nitric acid production (N2O from 2B2) | -3.4 |
| Agricultural Soils ($N_2O$ from 4D) | -6.7 |
| Refineries (CO2 from 1A1b) | -8.0 |
| Manufacture of Solid Fuels ($CO_2$ from 1A1c) | -10.1 |
| Cement production ($CO_2$ from 2A1) | -13.9 |
| Road transport ($CO_2$ from 1A3b) | -20.5 |
| Households and Services ($CO_2$ from 1A4) | -21.2 |
| Iron and Steel production ($CO_2$ from 1A2a+2C1) | -41.6 |
| Manufacturing industries (excl. iron and steel) (Energy-related $CO_2$ from 1A2 excl. 1A2a) | -54.1 |
| Public Electricity and Heat Production ($CO_2$ from 1A1a) | -77.1 |
| **Total** | **-274.3** |

***Notes:*** *As the table only presents sectors whose emissions have increased or decreased by at least 3 million tonnes of $CO_2$- equivalents, the sum for each country grouping does not match the total change listed at the bottom of the table*

#### Main reasons for changes in EU-15 emissions, 2008–2009

The strength of the 2009 recession affected all economic sectors in the EU. Consumption of fossil fuels (coal, oil and natural gas) fell compared to the previous year, mainly for coal. The decreased demand for energy linked to the economic recession was accompanied by cheaper natural gas and increased renewable energy use, which together contributed to lower emissions. Despite the relatively colder winter of 2009 emissions fell in the residential sector. In relative terms, the largest emission reductions occurred in industrial processes reflecting lower activity levels in the cement, chemical and iron and steel industries. The 2009 verified emissions from the sectors covered by the EU Emission Trading Scheme (EU-ETS) decreased by 11.6 % compared to 2008. The recession in 2009 accelerated, temporarily, the downward trend in total greenhouse gas emissions.

The 274.3 million tonnes ($CO_2$ equivalents) decrease in GHG emissions between 2008-2009 was mainly due to:

- A steep decrease of $CO_2$ emission (-77.1 million tonnes or -8 %) from public electricity and heat production occurred between 2008 and 2009. The United Kingdom (-22.1 million tonnes $CO_2$), Germany (-19.8 million tonnes $CO_2$), Italy (-16.5 million tonnes $CO_2$) and Spain (-15.7 million tonnes $CO_2$) contributed most to this decrease. Seven countries, however, report increases (Belgium, Denmark, Finland, Luxembourg, the Netherlands, Portugal, Sweden). In Spain and Germany and the United Kingdom the main reason was the strong decline in coal use for power generation.
- Strong emission reduction (-54.1 million tonnes or -12.5 %) in the category manufacturing industries excluding iron and steel industry (mainly caused by Germany, Italy, United Kingdom and Spain) as a result of the 2009 economic recession and contraction of industrial output.
- A strong decrease in emissions (-41.6 million tonnes or -30.2 %) in the iron and steel production due to a significant decline in crude steel production in all major steel producing countries (EU-15 -29.8 % according to the World Steel Association).

- Emissions also fell in households and services (-21.2 million tonnes or -4 %) - despite the colder winter - and in road transport (-20.5 million tonnes or -2.7 %).

Substantial increases in GHG emissions between 2008-2009 took place in the following source categories:

- $N_2O$ emissions from adipic acid production increasesd (+2.2 million tonnes or +25 %)
- Increases in HFC emissions from the consumption of halocarbons (+2.2 million tonnes or +4 %) stem from Refrigeration and Air Conditioning. France, Italy and Spain report the highest increases.

### *2.1.3 Overview of GHG emissions in EU Member States*

**Table 2.3 Greenhouse gas emissions in $CO_2$ equivalents (excl. LULUCF) and Kyoto Protocol targets for 2008–12**

| MEMBER STATE | 1990 (million tonnes) | Kyoto Protocol base year [(a)] (million tonnes) | 2009 (million tonnes) | 2008–2009 (million tonnes) | Change 2008–2009 (%) | Change 1990-2009 (%) | Change base year–2009 (%) | Targets 2008–12 under Kyoto Protocol and "EU burden sharing" (%) |
|---|---|---|---|---|---|---|---|---|
| Austria | 78.2 | 79.0 | 80.1 | -6.9 | -7.9% | 2.4% | 1.3% | -13.0% |
| Belgium | 143.3 | 145.7 | 124.4 | -10.7 | -7.9% | -13.2% | -14.6% | -7.5% |
| Denmark | 68.0 | 69.3 | 61.0 | -2.7 | -4.2% | -10.3% | -12.0% | -21.0% |
| Finland | 70.4 | 71.0 | 66.3 | -4.1 | -5.8% | -5.7% | -6.6% | 0.0% |
| France | 562.9 | 563.9 | 517.2 | -21.9 | -4.1% | -8.1% | -8.3% | 0.0% |
| Germany | 1247.9 | 1232.4 | 919.7 | -61.4 | -6.3% | -26.3% | -25.4% | -21.0% |
| Greece | 104.4 | 107.0 | 122.5 | -6.0 | -4.7% | 17.4% | 14.5% | 25.0% |
| Ireland | 54.8 | 55.6 | 62.4 | -5.4 | -8.0% | 13.8% | 12.2% | 13.0% |
| Italy | 519.2 | 516.9 | 491.1 | -50.6 | -9.3% | -5.4% | -5.0% | -6.5% |
| Luxembourg | 12.8 | 13.2 | 11.7 | -0.58 | -4.7% | -8.9% | -11.3% | -28.0% |
| Netherlands | 211.9 | 213.0 | 198.9 | -5.7 | -2.8% | -6.1% | -6.6% | -6.0% |
| Portugal | 59.4 | 60.1 | 74.6 | -3.4 | -4.3% | 25.5% | 24.0% | 27.0% |
| Spain | 283.2 | 289.8 | 367.5 | -37.2 | -9.2% | 29.8% | 26.8% | 15.0% |
| Sweden | 72.5 | 72.2 | 60.0 | -3.6 | -5.6% | -17.2% | -16.9% | 4.0% |
| United Kingdom | 776.1 | 776.3 | 566.2 | -54.0 | -8.7% | -27.0% | -27.1% | -12.5% |
| **EU-15** | **4264.9** | **4265.5** | **3723.7** | **-274.3** | **-6.9%** | **-12.7%** | **-12.7%** | **-8.0%** |

*([a])The base year under the Kyoto Protocol for each Member State and EU-15 is further outlined in Table 1.4 and 1.5.*

## 2.2 Emission trends by gas

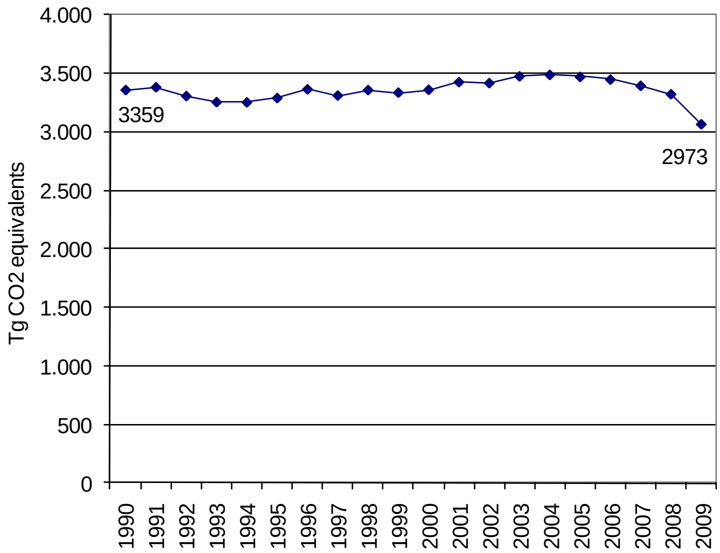



Table 2.4, Figure 2.2 and

Figure 2.3 give an overview of the main trends in EU-15 GHG emissions and removals for 1990–2009. In the EU-15 the most important GHG is $CO_2$, accounting for 82.3 % of total EU-15 emissions in 2009. In 2009, EU-15 $CO_2$ emissions without LULUCF were 3 063 Tg, which was 8.8 % below 1990 levels. Compared to 2008, $CO_2$ emissions decreased by 7.8 %.

**Table 2.4 Overview of EU-15 GHG emissions and removals from 1990 to 2009 in $CO_2$ equivalents (Tg)**

| GREENHOUSE GAS EMISSIONS | 1990 | 1995 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Net $CO_2$ emissions/removals | 3,125 | 3,026 | | 3,126 | 3,157 | 3,227 | 3,230 | 3,212 | 3,164 | 3,138 | 3,040 | 2,765 |
| $CO_2$ emissions (without LULUCF) | 3,359 | 3,290 | 3,362 | 3,428 | 3,419 | 3,478 | 3,490 | 3,473 | 3,450 | 3,396 | 3,323 | 3,063 |
| $CH_4$ | 452 | 423 | 379 | 369 | 360 | 348 | 337 | 331 | 325 | 321 | 317 | 311 |
| $N_2O$ | 403 | 382 | 343 | 334 | 326 | 320 | 321 | 312 | 300 | 299 | 291 | 280 |
| HFCs | 28 | 41 | 45 | 44 | 46 | 50 | 51 | 55 | 57 | 60 | 63 | 66 |
| PFCs | 17 | 11 | 7 | 6 | 8 | 7 | 5 | 4 | 4 | 3 | 3 | 2 |
| $SF_6$ | 11 | 15 | 10 | 9 | 8 | 8 | 8 | 8 | 7 | 7 | 6 | 6 |
| **Total (with net $CO_2$ emissions/removals)** | **4,036** | **3,898** | **3,864** | **3,889** | **3,905** | **3,960** | **3,954** | **3,922** | **3,857** | **3,828** | **3,720** | **3,430** |
| **Total (without CO2 from LULUCF)** | **4,270** | **4,162** | **4,146** | **4,191** | **4,167** | **4,211** | **4,214** | **4,183** | **4,143** | **4,085** | **4,003** | **3,729** |
| **Total (without LULUCF)** | **4,265** | **4,155** | **4,140** | **4,185** | **4,162** | **4,205** | **4,208** | **4,178** | **4,137** | **4,080** | **3,998** | **3,724** |

**Figure 2.2** $CO_2$ emissions without LULUCF 1990 to 2009 in $CO_2$ equivalents (Tg)

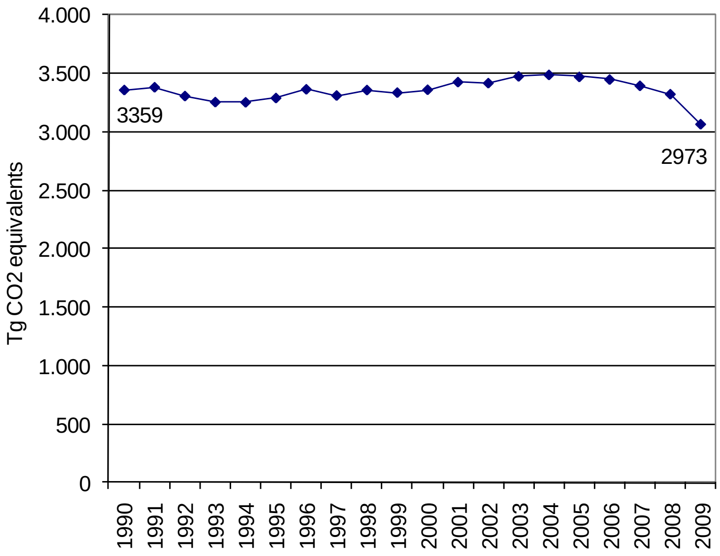
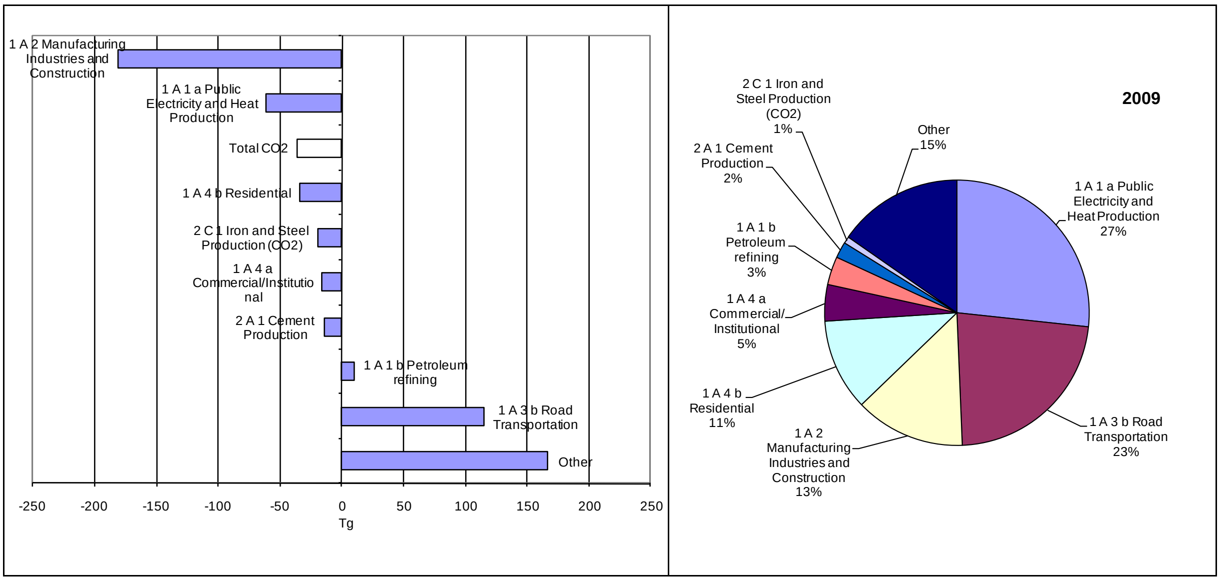



**Figure 2.3** Absolute change of $CO_2$ emissions by large key source categories 1990 to 2009 in $CO_2$ equivalents (Tg) for EU-15 and share of largest key source categories in 2009 for EU-15




$CH_4$ emissions account for 8.4 % of total EU-15 GHG emissions in 2009 and decreased by 31 % since 1990 to 311 Tg $CO_2$ equivalents in 2009 (Figure 2.4). The two largest key sources account for 57 % of $CH_4$ emissions in 2009. Figure 2.5 shows that the main reasons for declining $CH_4$ emissions were reductions in managed waste disposal on land and coal mining.

**Figure 2.4** **$CH_4$ emissions 1990 to 2009 in $CO_2$ equivalents (Tg)**

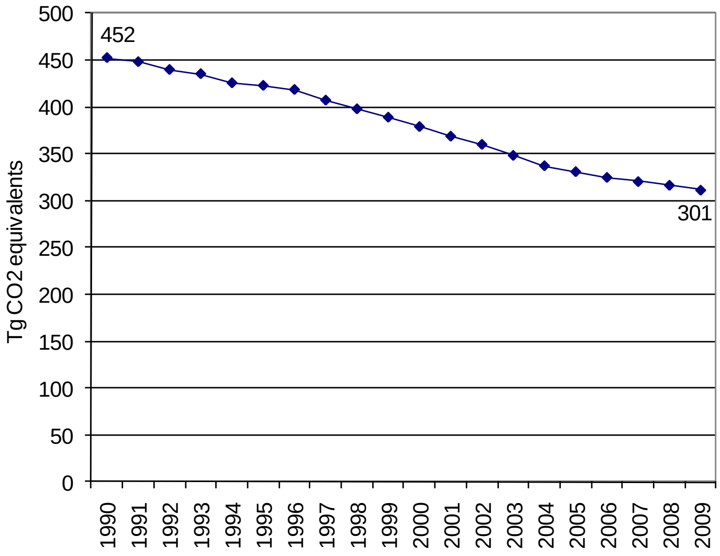
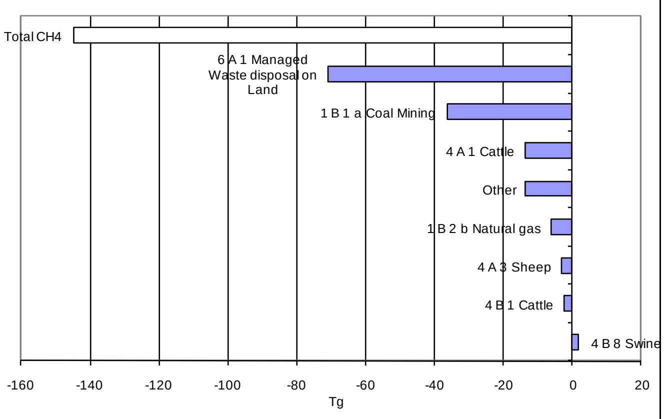
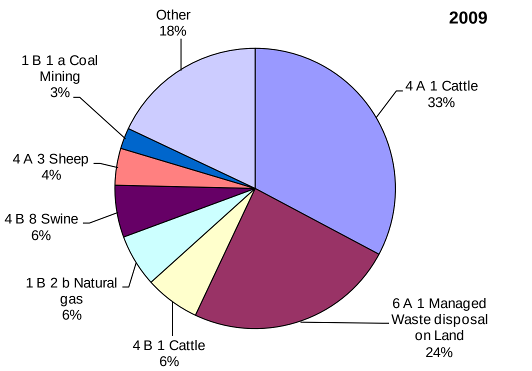



**Figure 2.5** **Absolute change of $CH_4$ emissions by large key source categories 1990 to 2009 in $CO_2$ equivalents (Tg) for EU-15 and share of largest source categories in 2009 for EU-15**




$N_2O$ emissions are responsible for 7.5 % of total EU-15 GHG emissions and decreased by 30.4 % to 280 Tg $CO_2$ equivalents in 2009 (Figure 2.6). The two largest key sources account for about 55 % of $N_2O$ emissions in 2009. Figure 2.7 shows that the main reason for large $N_2O$ emission cuts were reduction measures in the adipic acid production.

**Figure 2.6** **$N_2O$ emissions 1990 to 2009 in $CO_2$ equivalents (Tg)**

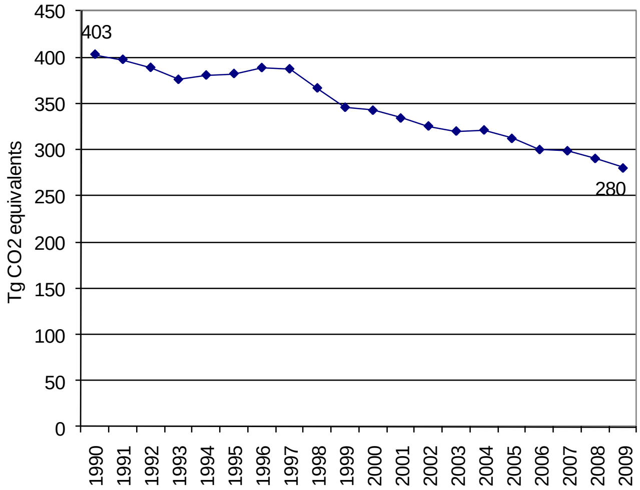
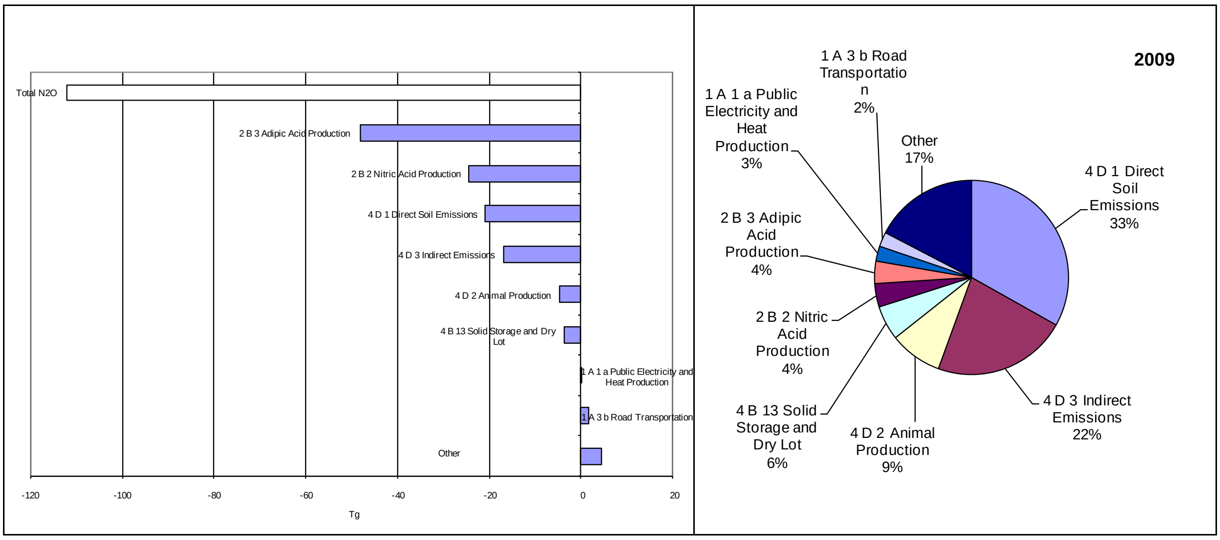



**Figure 2.7** **Absolute change of $N_2O$ emissions by large key source categories 1990 to 2009 in $CO_2$ equivalents (Tg) for EU-15 and share of largest source categories in 2009 for EU-15**




Fluorinated gas emissions account for 2 % of total EU-15 GHG emissions. In 2009, emissions were 74 Tg $CO_2$ equivalents, which was 32 % above 1990 levels (Figure 2.8). The two largest key sources account for 95 % of fluorinated gas emissions in 2009. Figure 2.9 shows that HFCs from consumption of halocarbons showed large increases between 1990 and 2009. The main reason for this is the phase-out of ozone-depleting substances such as chlorofluorocarbons under the Montreal Protocol and the replacement of these substances with HFCs (mainly in refrigeration, air conditioning, foam production and as aerosol propellants). On the other hand, HFC emissions from production of halocarbons decreased substantially. The decrease started in 1998 and was strongest in 1999 and 2000.

**Figure 2.8 Fluorinated gas emissions 1990 to 2009 in $CO_2$ equivalents (Tg)**

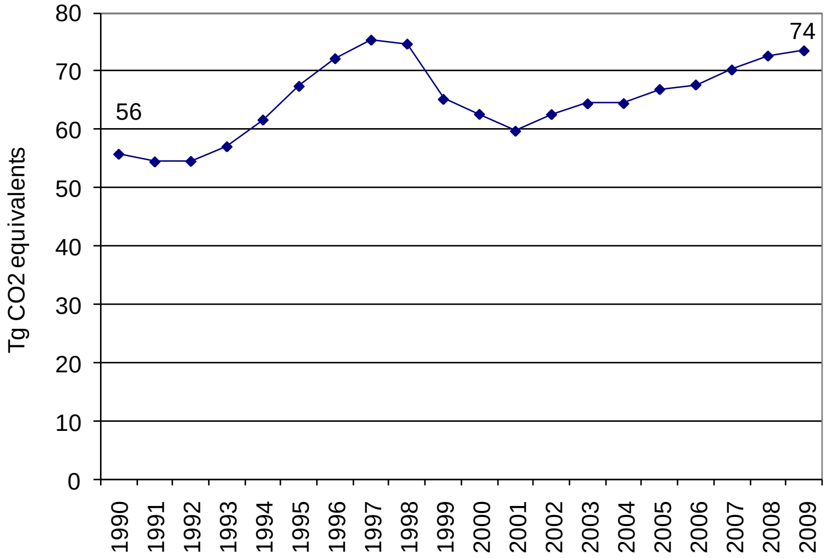
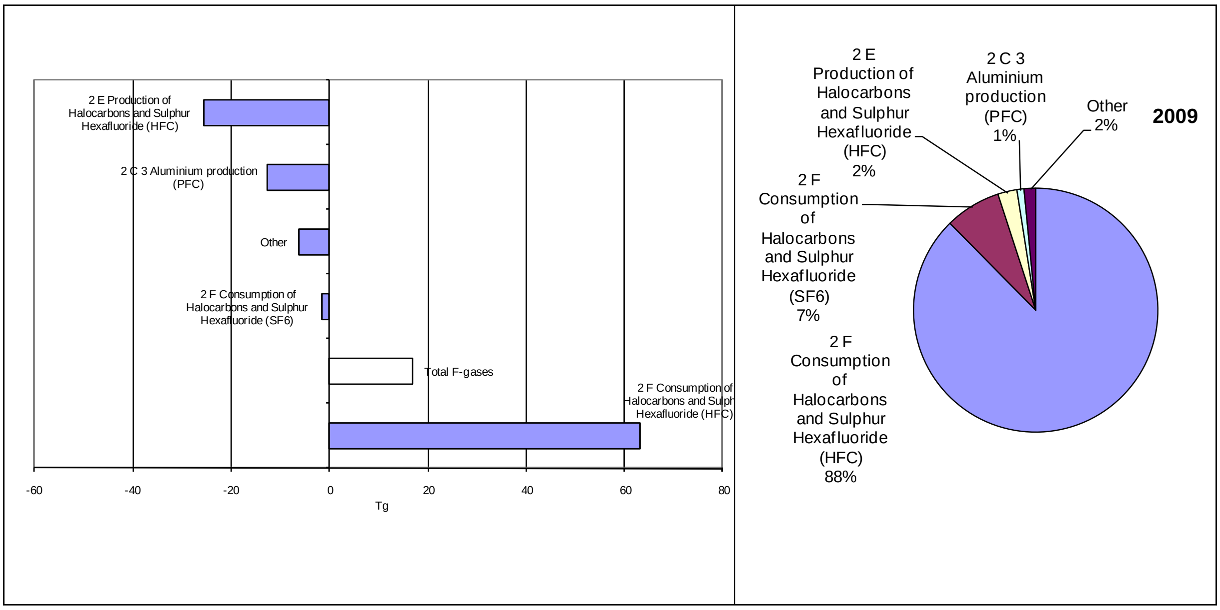



**Figure 2.9 Absolute change of fluorinated gas emissions by large key source categories 1990 to 2009in $CO_2$ equivalents (Tg) for EU-15 and share of largest source categories in 2009 for EU-15**



## 2.3 Emission trends by source

Table 2.5 gives an overview of EU-15 GHG emissions in the main source categories for 1990–2009. More detailed trend descriptions are included in Chapters 3 to 9.

**Table 2.5 Overview of EU-15 GHG emissions in the main source and sink categories 1990 to 2009 in $CO_2$ equivalents (Tg)**

| GHG SOURCE AND SINK | 1990 | 1995 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Energy | 3,274 | 3,200 | 3,252 | 3,323 | 3,313 | 3,361 | 3,363 | 3,342 | 3,317 | 3,258 | 3,196 | 2,973 |
| 2. Industrial Processes | 353 | 351 | 309 | 298 | 295 | 303 | 311 | 309 | 302 | 306 | 290 | 250 |
| 3. Solvent and Other Product Use | 14 | 12 | 12 | 12 | 11 | 11 | 10 | 10.515 | 11 | 10 | 10 | 9 |
| 4. Agriculture | 441 | 419 | 419 | 410 | 404 | 399 | 398 | 393 | 387 | 388 | 387 | 379 |
| 5. Land-Use, Land-Use Change and Forestry | -229 | -257 | -276 | -296 | -257 | -245 | -255 | -255 | -280 | -252 | -278 | -293 |
| 6. Waste | 184 | 173 | 148 | 142 | 138 | 132 | 126 | 123 | 121 | 117 | 115 | 112 |
| 7. Other | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Total (with net $CO_2$ emissions/removals)** | **4,036** | **3,898** | **3,864** | **3,889** | **3,905** | **3,960** | **3,954** | **3,922** | **3,857** | **3,828** | **3,720** | **3,430** |
| **Total (without LULUCF)** | **4,265** | **4,155** | **4,140** | **4,185** | **4,162** | **4,205** | **4,208** | **4,178** | **4,137** | **4,080** | **3,998** | **3,724** |

## 2.4 Emission trends by Member State

Table 2.6 gives an overview of EU-15 Member States' contributions to the EU GHG emissions for 1990–2009. Member States show large variations in GHG emission trends.

**Table 2.6 Overview of Member States' contributions to EU-15 GHG emissions excluding LULUCF from 1990 to 2009 in $CO_2$ equivalents (Tg)**

| Member State | 1990 | 1995 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Austria | 78 | 80 | 80 | 84 | 86 | 92 | 91 | 93 | 90 | 87 | 87 | 80 |
| Belgium | 143 | 150 | 145 | 145 | 144 | 146 | 147 | 143 | 138 | 133 | 135 | 124 |
| Denmark | 68 | 76 | 68 | 70 | 69 | 74 | 68 | 64 | 72 | 67 | 64 | 61 |
| Finland | 70 | 71 | 69 | 74 | 77 | 84 | 80 | 68 | 80 | 78 | 70 | 66 |
| France | 563 | 560 | 567 | 569 | 564 | 566 | 566 | 569 | 553 | 545 | 539 | 517 |
| Germany | 1,248 | 1,120 | 1,042 | 1,057 | 1,037 | 1,031 | 1,021 | 1,000 | 1,002 | 980 | 981 | 920 |
| Greece | 104 | 109 | 126 | 127 | 127 | 131 | 131 | 134 | 131 | 133 | 129 | 123 |
| Ireland | 55 | 58 | 68 | 70 | 68 | 68 | 68 | 69 | 69 | 68 | 68 | 62 |
| Italy | 519 | 530 | 552 | 557 | 559 | 573 | 577 | 575 | 564 | 555 | 542 | 491 |
| Luxembourg | 13 | 10 | 10 | 10 | 11 | 11 | 13 | 13 | 13 | 12 | 12 | 12 |
| Netherlands | 212 | 223 | 213 | 215 | 214 | 215 | 217 | 211 | 207 | 205 | 205 | 199 |
| Portugal | 59 | 69 | 81 | 82 | 87 | 82 | 84 | 86 | 81 | 79 | 78 | 75 |
| Spain | 283 | 315 | 380 | 380 | 397 | 404 | 420 | 434 | 426 | 437 | 405 | 368 |
| Sweden | 72 | 74 | 69 | 70 | 70 | 71 | 70 | 68 | 67 | 66 | 64 | 60 |
| United Kingdom | 776 | 710 | 670 | 674 | 653 | 658 | 656 | 651 | 645 | 634 | 620 | 566 |
| **EU-15** | **4,265** | **4,155** | **4,140** | **4,185** | **4,162** | **4,205** | **4,208** | **4,178** | **4,137** | **4,080** | **3,998** | **3,724** |

The overall EU GHG emission trend is dominated by the two largest emitters Germany and the United Kingdom, accounting for 40 % of total EU-15 GHG emissions in 2009. These two Member States have achieved total GHG emission reductions of 538 million tonnes $CO_2$-equivalents compared to 1990[20].

The main reasons for the favourable trend in Germany were increasing efficiency in power and heating plants and the economic restructuring of the five new Länder after German reunification. The reduction of GHG emissions in the United Kingdom was primarily the result of liberalising energy markets and the subsequent fuel switches from oil and coal to gas in electricity production and $N_2O$ emission reduction measures in the production of adipic acid.

(*20*) The EU-15 as a whole needs emission reductions of total GHG of 8 %, i.e. 341 million tonnes on the basis of the 2008 inventory in order to meet the Kyoto target. This can be achieved by a combination of existing and planned domestic policies and measures, the use of carbon sinks and the use of Kyoto mechanisms.

France and Italy were the third and fourth largest emitters with a share of 14 % and 13 %, respectively. Italy's GHG emissions were 5.4 % below 1990 levels in 2009. Italian GHG emissions increased since 1990 primarily from road transport, electricity and heat production and petrol refining, however, decreased significantly since 2008 (-9.3 %). France's emissions were 8.1 % below 1990 levels in 2009. In France, large reductions were achieved in $N_2O$ emissions from the adipic acid production, but $CO_2$ emissions from road transport and HFC emissions from consumption of halocarbons increased considerably between 1990 and 2009.

Spain is the fifth largest emitter in the EU-15, accounting for 10 % of total EU-15 GHG emissions. Spain increased emissions by 30 % between 1990 and 2009. This was largely due to emission increases from road transport, electricity and heat production, and manufacturing industries.

## 2.5 Emission trends for indirect greenhouse gases and sulphur dioxide

Emissions of CO, NOx, NMVOC and SO2 have to be reported to the UNFCCC Secretariat because they influence climate change indirectly: CO, NOx and NMVOC are precursor substances for ozone which itself is a greenhouse gas. Sulphur emissions produce microscopic particles (aerosols) that can reflect sunlight back out into space and also affect cloud formation. Table 2.7 shows the total indirect GHG and SO2 emissions in the EU-15 between 1990 and 2009. All emissions were reduced significantly from 1990 levels: the largest reduction was achieved in $SO_2$ (–84 %), followed by CO (–65 %), NMVOC (–54 %) and $NO_x$ (–45 %).

**Table 2.7 Overview of EU-15 indirect GHG and SO2 emissions for 1990–2009 (Gg)**

| GREENHOUSE GAS EMISSIONS | 1990 | 1995 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | (Gg) | | | | | | | | | | | |
| NOx | 13,555 | 11,963 | 10,517 | 10,312 | 10,060 | 9,902 | 9,749 | 9,502 | 9,207 | 8,900 | 8,201 | 7,503 |
| CO | 52,547 | 41,837 | 31,817 | 30,166 | 28,174 | 27,046 | 25,954 | 24,002 | 22,782 | 21,642 | 20,685 | 18,310 |
| NMVOC | 15,928 | 13,012 | 10,634 | 10,131 | 9,608 | 9,604 | 8,966 | 8,730 | 8,629 | 8,070 | 7,697 | 7,265 |
| SO2 | 16,485 | 9,981 | 6,153 | 5,887 | 5,638 | 5,161 | 4,932 | 4,560 | 4,348 | 4,162 | 3,100 | 2,608 |

Table 2.8 shows the $NO_x$ emissions of the EU-15 Member States between 1990–2009. The largest emitters, the UK, Spain, Germany, France and Italy, made up 76 % of total EU-15 $NO_x$ emissions in 2009. Most EU-15 Member States reduced their emissions, only Greece had emission increases between 1990 and 2009.

**Table 2.8 Overview of Member States' contributions to EU-15 NOx emissions for 1990–2009 (Gg)**

| Member State | 1990 | 1995 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Austria | 194 | 181 | 206 | 215 | 222 | 232 | 230 | 235 | 222 | 216 | 203 | 186 |
| Belgium | 396 | 386 | 329 | 311 | 295 | 293 | 296 | 285 | 263 | 257 | 235 | 207 |
| Denmark | 278 | 267 | 200 | 200 | 197 | 206 | 189 | 181 | 183 | 169 | 150 | 131 |
| Finland | 295 | 245 | 211 | 212 | 209 | 218 | 204 | 176 | 193 | 184 | 168 | 154 |
| France | 1,892 | 1,774 | 1,646 | 1,617 | 1,593 | 1,557 | 1,525 | 1,501 | 1,428 | 1,368 | 1,274 | 1,190 |
| Germany | 2,942 | 2,209 | 1,911 | 1,830 | 1,737 | 1,676 | 1,643 | 1,581 | 1,584 | 1,521 | 1,465 | 1,367 |
| Greece | 331 | 333 | 364 | 386 | 387 | 396 | 402 | 419 | 415 | 419 | 395 | 376 |
| Ireland | 123 | 124 | 135 | 137 | 127 | 123 | 123 | 124 | 119 | 117 | 109 | 87 |
| Italy | 2,021 | 1,899 | 1,438 | 1,411 | 1,356 | 1,337 | 1,300 | 1,221 | 1,169 | 1,140 | 1,067 | 987 |
| Luxembourg | 0.2 | 0.5 | 1 | 1 | 1 | 1 | 0.4 | 0.4 | IE,NA,NE,NO | IE,NA,NE,NO | IE,NA,NE,NO | IE,NA,NE,NO |
| Netherlands | 551 | 460 | 387 | 378 | 367 | 358 | 345 | 332 | 317 | 296 | 286 | 265 |
| Portugal | 259 | 291 | 315 | 315 | 325 | 306 | 308 | 313 | 287 | 274 | 261 | 254 |
| Spain | 1,289 | 1,350 | 1,378 | 1,349 | 1,388 | 1,377 | 1,419 | 1,410 | 1,366 | 1,367 | 1,183 | 1,066 |
| Sweden | 303 | 267 | 212 | 202 | 196 | 191 | 182 | 175 | 170 | 164 | 155 | 150 |
| United Kingdom | 2,681 | 2,177 | 1,785 | 1,749 | 1,661 | 1,631 | 1,583 | 1,549 | 1,491 | 1,409 | 1,248 | 1,082 |
| **EU-15** | **13,555** | **11,963** | **10,517** | **10,312** | **10,060** | **9,902** | **9,749** | **9,502** | **9,207** | **8,900** | **8,201** | **7,503** |

Table 2.9 shows the CO emissions of the EU-15 Member States between 1990–2009. The largest emitters, France, Germany, Italy and the United Kingdom that made up 68 % of the total CO emissions in 2008, reduced their emissions from 1990 levels substantially. But also all other EU-15 Member States reduced emissions.

**Table 2.9 Overview of Member States' contributions to EU-15 CO emissions for 1990–2009 (Gg)**

| Member State | 1990 | 1995 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Austria | 1,433 | 1,269 | 953 | 915 | 880 | 874 | 835 | 819 | 771 | 719 | 680 | 647 |
| Belgium | 1,327 | 1,054 | 998 | 1,008 | 980 | 948 | 895 | 787 | 759 | 596 | 591 | 364 |
| Denmark | 716 | 624 | 459 | 454 | 433 | 439 | 427 | 437 | 430 | 441 | 420 | 392 |
| Finland | 709 | 634 | 587 | 586 | 578 | 567 | 550 | 521 | 508 | 497 | 463 | 455 |
| France | 11,513 | 9,841 | 7,165 | 6,713 | 6,552 | 6,242 | 6,327 | 5,823 | 5,259 | 4,996 | 4,851 | 4,338 |
| Germany | 12,266 | 6,563 | 4,896 | 4,640 | 4,346 | 4,165 | 3,934 | 3,718 | 3,651 | 3,555 | 3,490 | 3,089 |
| Greece | 1,251 | 1,069 | 1,054 | 1,020 | 975 | 933 | 923 | 723 | 741 | 748 | 630 | 599 |
| Ireland | 416 | 314 | 252 | 241 | 222 | 211 | 201 | 190 | 181 | 170 | 161 | 155 |
| Italy | 7,191 | 7,107 | 4,890 | 4,583 | 4,184 | 3,978 | 3,773 | 3,377 | 3,163 | 3,083 | 2,881 | 2,637 |
| Luxembourg | 17 | 10 | 7 | 7 | 7 | 7 | 4 | 4 | IE,NA,NE,NO | IE,NA,NE,NO | IE,NA,NE,NO | IE,NA,NE,NO |
| Netherlands | 1,142 | 903 | 749 | 771 | 676 | 679 | 689 | 661 | 654 | 636 | 641 | 593 |
| Portugal | 883 | 830 | 706 | 631 | 621 | 697 | 582 | 672 | 544 | 516 | 516 | 493 |
| Spain | 3,756 | 3,245 | 2,752 | 2,639 | 2,423 | 2,499 | 2,342 | 2,207 | 2,298 | 2,086 | 1,950 | 1,742 |
| Sweden | 939 | 868 | 666 | 627 | 611 | 614 | 584 | 582 | 550 | 544 | 533 | 536 |
| United Kingdom | 8,988 | 7,508 | 5,683 | 5,328 | 4,686 | 4,193 | 3,888 | 3,481 | 3,275 | 3,055 | 2,877 | 2,270 |
| **EU-15** | **52,547** | **41,837** | **31,817** | **30,166** | **28,174** | **27,046** | **25,954** | **24,002** | **22,782** | **21,642** | **20,685** | **18,310** |

Table 2.10 shows the NMVOC emissions of the EU-15 Member States between 1990–2009. The largest emitters France, Germany and Italy that made up 60 % of the total NMVOC emissions in 2009, reduced their emissions from 1990 levels, together with all other EU-15 Member States.

**Table 2.10 Overview ofMember States' contributions to EU-15 NMVOC emissions for 1990–2009 (Gg)**

| Member State | 1990 | 1995 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Austria | 276 | 226 | 178 | 177 | 176 | 173 | 154 | 164 | 173 | 159 | 150 | 123 |
| Belgium | 365 | 321 | 252 | 232 | 218 | 213 | 195 | 202 | 201 | 173 | 165 | 156 |
| Denmark | 189 | 168 | 139 | 132 | 128 | 123 | 120 | 117 | 112 | 107 | 103 | 95 |
| Finland | 229 | 192 | 165 | 164 | 158 | 154 | 150 | 139 | 137 | 133 | 116 | 110 |
| France | 3,831 | 3,476 | 2,997 | 2,877 | 2,714 | 3,012 | 2,600 | 2,607 | 2,623 | 2,243 | 2,155 | 2,072 |
| Germany | 3,750 | 2,156 | 1,663 | 1,569 | 1,500 | 1,431 | 1,436 | 1,413 | 1,402 | 1,347 | 1,297 | 1,284 |
| Greece | 279 | 269 | 274 | 271 | 268 | 256 | 256 | 222 | 232 | 221 | 228 | 212 |
| Ireland | 83 | 76 | 69 | 67 | 62 | 59 | 56 | 55 | 54 | 52 | 51 | 48 |
| Italy | 2,030 | 2,096 | 1,625 | 1,539 | 1,466 | 1,402 | 1,351 | 1,274 | 1,245 | 1,230 | 1,163 | 1,109 |
| Luxembourg | 6 | 6 | 5 | 5 | 5 | 5 | 6 | 6 | 5 | 5 | 5 | 5 |
| Netherlands | 460 | 326 | 231 | 207 | 195 | 182 | 170 | 174 | 165 | 162 | 162 | 152 |
| Portugal | 332 | 294 | 267 | 255 | 252 | 247 | 236 | 236 | 226 | 221 | 216 | 201 |
| Spain | 1,043 | 976 | 1,009 | 988 | 908 | 914 | 897 | 858 | 843 | 833 | 780 | 696 |
| Sweden | 353 | 247 | 200 | 188 | 186 | 188 | 186 | 184 | 182 | 183 | 181 | 180 |
| United Kingdom | 2,702 | 2,182 | 1,561 | 1,460 | 1,371 | 1,246 | 1,153 | 1,078 | 1,032 | 1,002 | 927 | 824 |
| **EU-15** | **15,928** | **13,012** | **10,634** | **10,131** | **9,608** | **9,604** | **8,966** | **8,730** | **8,629** | **8,070** | **7,697** | **7,265** |

Table 2.11 shows the $SO_2$ emissions of the EU-15 Member Statesbetween 1990–2009. The largest emitters, the United Kingdom, Spain and Germany, that made up 50 % of the total $SO_2$ emissions in 2009, reduced their emissions from 1990 levels, together with all other EU-15 Member States.

**Table 2.11 Overview of Member States' contributions to EU-15 SO2 emissions for 1990–2009 (Gg)**

| Member State | 1990 | 1995 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Austria | 74 | 47 | 32 | 33 | 31 | 32 | 27 | 27 | 28 | 25 | 22 | 21 |
| Belgium | 360 | 260 | 171 | 166 | 156 | 154 | 157 | 144 | 134 | 124 | 96 | 75 |
| Denmark | 179 | 139 | 29 | 28 | 26 | 33 | 26 | 23 | 26 | 24 | 19 | 15 |
| Finland | 249 | 105 | 80 | 90 | 88 | 101 | 83 | 68 | 84 | 82 | 69 | 59 |
| France | 1,352 | 1,006 | 661 | 595 | 548 | 530 | 517 | 489 | 451 | 443 | 382 | 322 |
| Germany | 5,312 | 1,725 | 656 | 650 | 601 | 586 | 571 | 539 | 543 | 517 | 507 | 448 |
| Greece | 477 | 541 | 497 | 505 | 516 | 555 | 549 | 528 | 534 | 539 | 446 | 427 |
| Ireland | 182 | 161 | 140 | 134 | 101 | 79 | 72 | 71 | 60 | 55 | 45 | 32 |
| Italy | 1,795 | 1,320 | 750 | 698 | 617 | 519 | 482 | 403 | 381 | 338 | 282 | 231 |
| Luxembourg | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | IE,NA,NE,NO | IE,NA,NE,NO | IE,NA,NE,NO | IE,NA,NE,NO |
| Netherlands | 187 | 128 | 71 | 73 | 65 | 62 | 65 | 63 | 63 | 59 | 50 | 37 |
| Portugal | 323 | 331 | 307 | 288 | 286 | 193 | 195 | 197 | 173 | 166 | 119 | 81 |
| Spain | 2,177 | 1,792 | 1,463 | 1,439 | 1,542 | 1,278 | 1,321 | 1,275 | 1,171 | 1,171 | 534 | 431 |
| Sweden | 105 | 69 | 42 | 41 | 40 | 41 | 37 | 36 | 36 | 33 | 30 | 30 |
| United Kingdom | 3,711 | 2,357 | 1,253 | 1,146 | 1,018 | 997 | 830 | 697 | 662 | 586 | 498 | 397 |
| **EU-15** | **16,485** | **9,981** | **6,153** | **5,887** | **5,638** | **5,161** | **4,932** | **4,560** | **4,348** | **4,162** | **3,100** | **2,608** |

# 3 ENERGY (CRF SECTOR 1)

This chapter starts with an overview on emission trends in CRF Sector 1 Energy. For each EU-15 key category overview tables are presented including the Member States' contributions to the key category in terms of level and trend, information on methodologies and emission factors. The chapter includes also sections on uncertainty estimates, sector-specific QA/QC, recalculations, the reference approach, and international bunkers.

## 3.1 Overview of sector (EU-15)

CRF Sector 1 Energy contributes 80 % to total GHG emissions and is the largest emitting sector in the EU-15. Total GHG emissions from this sector decreased by 9.2 % from  3274 Tg in 1990 to 2973 Tg in 2009 (Figure 3.1). In 2009, emissions decreased by 7 % compared to 2008, as a consequence of the economic recession.

The most important energy-related gas is $CO_2$ that makes up 78 % of the total EU-15 GHG emissions. $CH_4$ and $N_2O$ are each responsible for 1 % of the total GHG emissions. The key sources in this sector are as follows.

- 1 A 1 a Public Electricity and Heat Production: Gaseous Fuels ($CO_2$)
- 1 A 1 a Public Electricity and Heat Production: Liquid Fuels ($CO_2$)
- 1 A 1 a Public Electricity and Heat Production: Other Fuels ($CO_2$)
- 1 A 1 a Public Electricity and Heat Production: Solid Fuels ($CO_2$)
- 1 A 1 b Petroleum refining: Gaseous Fuels ($CO_2$)
- 1 A 1 b Petroleum refining: Liquid Fuels ($CO_2$)
- 1 A 1 b Petroleum refining: Solid Fuels ($CO_2$)
- 1 A 1 c Manufacture of Solid fuels and Other Energy Industries: Gaseous Fuels ($CO_2$)
- 1 A 1 c Manufacture of Solid fuels and Other Energy Industries: Solid Fuels ($CO_2$)
- 1 A 2 a Iron and Steel: Gaseous Fuels ($CO_2$)
- 1 A 2 a Iron and Steel: Liquid Fuels ($CO_2$)
- 1 A 2 a Iron and Steel: Solid Fuels ($CO_2$)
- 1 A 2 b Non-Ferous Metals: Solid Fuels ($CO_2$)
- 1 A 2 c Chemicals: Gaseous Fuels ($CO_2$)
- 1 A 2 c Chemicals: Liquid Fuels ($CO_2$)
- 1 A 2 c Chemicals: Other Fuels ($CO_2$)
- 1 A 2 c Chemicals: Solid Fuels ($CO_2$)
- 1 A 2 d Pulp, Paper and Print: Gaseous Fuels ($CO_2$)
- 1 A 2 d Pulp, Paper and Print: Liquid Fuels ($CO_2$)
- 1 A 2 e Food Processing, Beverages and Tobacco: Gaseous Fuels ($CO_2$)
- 1 A 2 e Food Processing, Beverages and Tobacco: Liquid Fuels ($CO_2$)
- 1 A 2 e Food Processing, Beverages and Tobacco: Solid Fuels ($CO_2$)
- 1 A 2 f Other: Gaseous Fuels ($CO_2$)
- 1 A 2 f Other: Liquid Fuels ($CO_2$)
- 1 A 2 f Other: Other Fuels ($CO_2$)
- 1 A 2 f Other: Solid Fuels ($CO_2$)
- 1 A 3 a Civil Aviation: Jet Kerosene ($CO_2$)
- 1 A 3 b Road Transportation: Diesel oil ($CO_2$)
- 1 A 3 b Road Transportation: Diesel oil ($N_2O$)
- 1 A 3 b Road Transportation: Gasoline ($CH_4$)
- 1 A 3 b Road Transportation: Gasoline ($CO_2$)
- 1 A 3 b Road Transportation: LPG ($CO_2$)
- 1 A 3 c Railways: Liquid Fuels ($CO_2$)
- 1 A 3 d Navigation: Gas/Diesel Oil ($CO_2$)
- 1 A 3 d Navigation: Residual Oil ($CO_2$)

- 1 A 4 a Commercial/Institutional: Gaseous Fuels ($CO_2$)
- 1 A 4 a Commercial/Institutional: Liquid Fuels ($CO_2$)
- 1 A 4 a Commercial/Institutional: Solid Fuels ($CO_2$)
- 1 A 4 b Residential: Gaseous Fuels ($CO_2$)
- 1 A 4 b Residential: Liquid Fuels ($CO_2$)
- 1 A 4 b Residential: Solid Fuels ($CO_2$)
- 1 A 4 c Agriculture/Forestry/Fisheries: Gaseous Fuels ($CO_2$)
- 1 A 4 c Agriculture/Forestry/Fisheries: Liquid Fuels ($CO_2$)
- 1 A 4 c Agriculture/Forestry/Fisheries: Solid Fuels ($CO_2$)
- 1 A 5 a Stationary: Solid Fuels ($CO_2$)
- 1 A 5 b Mobile: Liquid Fuels ($CO_2$)
- 1 B 1 a Coal Mining: ($CH_4$)
- 1 B 2 a Oil: ($CO_2$)
- 1 B 2 b Natural gas: ($CH_4$)

**Figure 3.1** **CRF Sector 1 Energy: EU-15 GHG emissions in $CO_2$ equivalents (Tg) for 1990–2009**

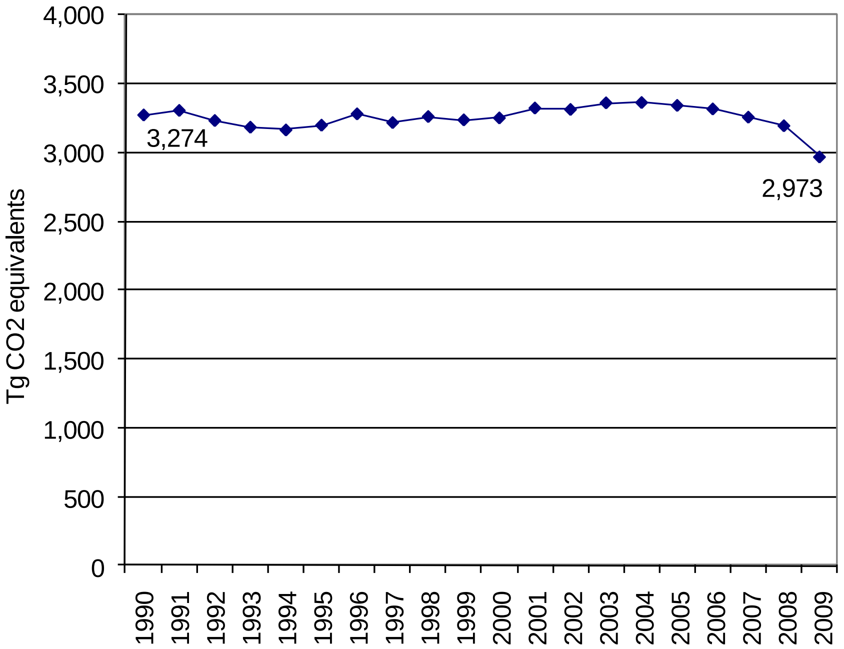
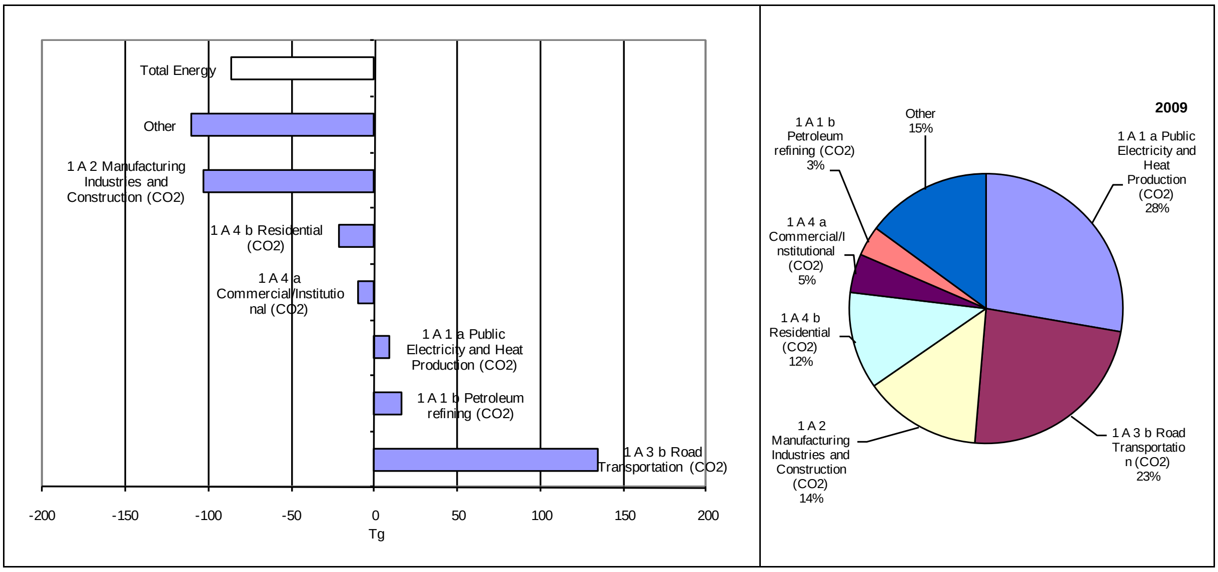



Figure 3.2 shows that $CO_2$ emissions from road transport had the highest increase in absolute terms of all energy-related emissions, while $CO_2$ emissions from 1A2 Manufacturing Industries decreased substantially between 1990 and 2009. The increases in road transport occurred in almost all Member States, whereas the emission reductions from manufacturing industries mainly occurred in Germany after the reunification. The decline of coal-mining ($CH_4$) and decreasing $CO_2$ emissions from 1A1c Manufacture of Solid Fuels and Other Energy Industries are the main reasons for the large absolute emission reductions from Other in Figure 3.2. Figure 3.2 shows that the six largest key sources account for 80 % of emissions in Sector 1.

**Figure 3.2** CRF Sector 1 Energy: Absolute change of GHG emissions in $CO_2$ equivalents (Tg) by large key source categories for 1990–2009 and share of largest key source categories in 2009




## 3.2 Source categories (EU-15)

### *3.2.1 Energy industries (CRF Source Category 1A1)*

Energy industries (CRF 1A1) comprises emissions from fuels combusted by the fuel extraction or energy-producing industries. For the EU-15, this source category includes three key sources: $CO_2$ from 'Public electricity and heat production' (CRF 1A1a), $CO_2$ from 'Petroleum-refining' (CRF 1A1b), and $CO_2$ from 'Manufacture of solid fuels and other energy industries' (CRF 1A1c).

Figure 3.3 shows the trends in emissions in energy industries for the EU-15 between 1990 and 2009, which was mainly dominated by $CO_2$ emissions from public electricity and heat production. $CO_2$ from 1A1a currently represents about 83 % of greenhouse gas emissions in 1A1 (i.e. including methane and nitrous oxide).

Total greenhouse gas emissions from 1A1 decreased by 9 %, between 1990 and 2009. This was mainly due to a decrease of $CO_2$ emission from Public Electricity and Heat Production (-62 TG $CO_2$and the manufacturing of solid fuels 8- 56 Tg $CO_2$). $CO_2$ emissions from petroleum refining increased by 10 Tg in the period 1990-2009.

**Figure 3.3 1A1 Energy Industries: Total GHG, $CO_2$ and $N_2O$ emission trends and Activity Data**

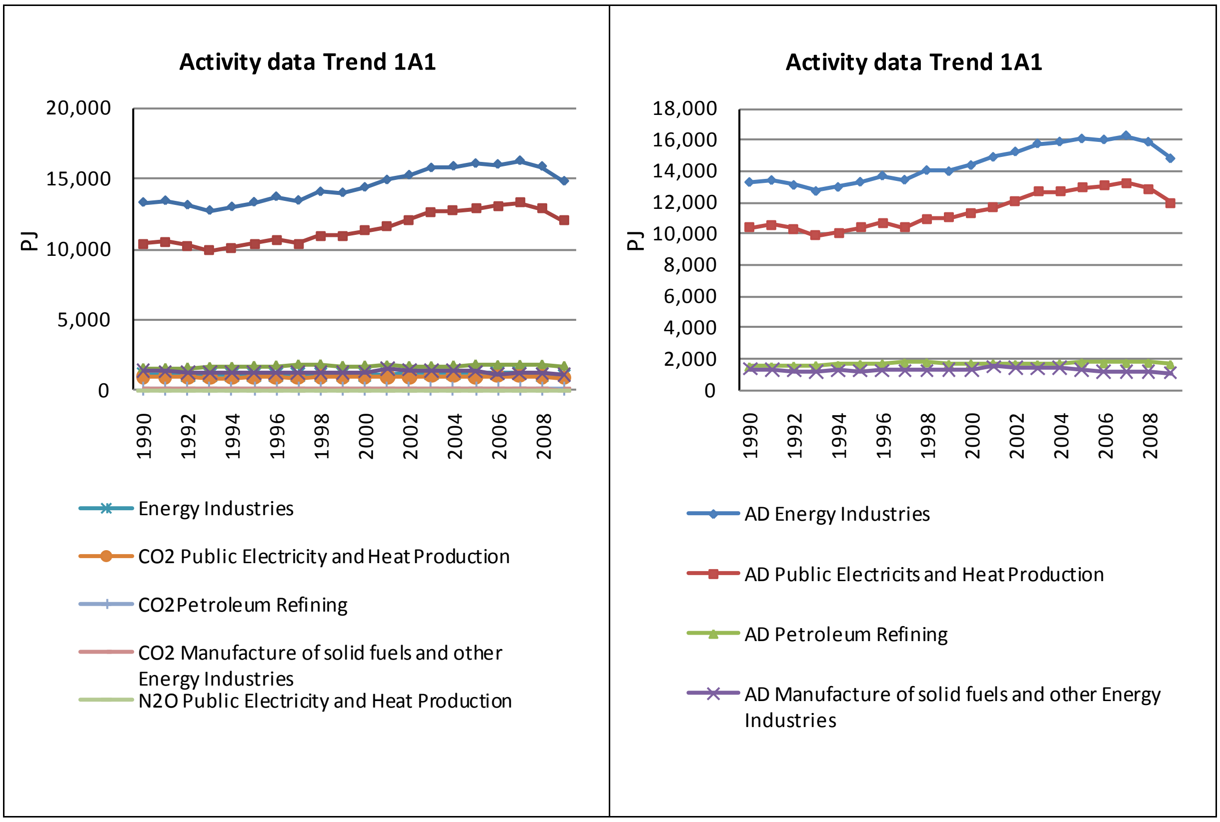



Table 3.1 summarises the information by Member State. Between 1990 and 2009, greenhouse gas emissions from energy industries increased in eight Member States and fell in seven. The highest absolute increase was accounted for by Spain, the Netherlands and Greece. Germany and the UK. account for the largest part of reductions (-139 Tg)The change in the EU-15 was a net decrease of 106.2 Tg. The table also shows the shares of $CO_2$ and $N_2O$ separately.

**Table 3.1 1A1 Energy industries: Member States' contributions to $CO_2$ and $N_2O$ emissions**

| Member State | GHG emissions in 1990 (Gg $CO_2$ equivalents) | GHG emissions in 2009 (Gg $CO_2$ equivalents) | $CO_2$ emissions in 1990 (Gg) | CO2 emissions in 2009 (Gg) | $N_2O$ emissions in 1990 (Gg $CO_2$ equivalents) | N2O emissions in 2009 (Gg $CO_2$ equivalents) |
|---|---|---|---|---|---|---|
| Austria | 13,842 | 12,753 | 13,792 | 12,649 | 46 | 97 |
| Belgium | 30,046 | 26,553 | 29,826 | 26,359 | 203 | 174 |
| Denmark | 26,048 | 23,997 | 25,952 | 23,698 | 85 | 113 |
| Finland | 19,187 | 25,428 | 19,057 | 25,120 | 122 | 288 |
| France | 65,682 | 60,557 | 65,005 | 59,838 | 601 | 676 |
| Germany | 428,118 | 343,706 | 423,418 | 338,535 | 4,416 | 3,582 |
| Greece | 43,159 | 54,818 | 42,993 | 54,620 | 154 | 181 |
| Ireland | 11,239 | 13,072 | 11,159 | 12,926 | 74 | 139 |
| Italy | 137,214 | 132,989 | 136,503 | 132,368 | 516 | 512 |
| Luxembourg | 36 | 1,159 | 33 | 1,155 | 2 | 3 |
| Netherlands | 52,699 | 64,602 | 52,501 | 64,234 | 139 | 257 |
| Portugal | 16,013 | 19,650 | 15,948 | 19,505 | 61 | 137 |
| Spain | 77,702 | 89,868 | 77,354 | 89,066 | 283 | 654 |
| Sweden | 9,919 | 10,438 | 9,569 | 9,897 | 328 | 452 |
| United Kingdom | 236,415 | 181,547 | 234,194 | 179,979 | 2,019 | 1,319 |
| **EU-15** | **1,167,319** | **1,061,136** | **1,157,305** | **1,049,950** | **9,049** | **8,583** |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

Figure 3.4 shows the relative contributions of greenhouse gas emissions from energy industries in each Member State, ranging from relatively low shares in Luxembourg and France to relatively high in Finland, Germany, Denmark, and Greece. Figure 3.5 shows the absolute contributions to EU-15 greenhouse gas emissions from energy industries, which are clearly dominated by Germany and the UK. These two countries represent about half of the EU's greenhouse gas emissions from energy industries.

**Figure 3.4 Share of greenhouse gas emissions from energy industries in total greenhouse gas emissions by Member State in 2008**

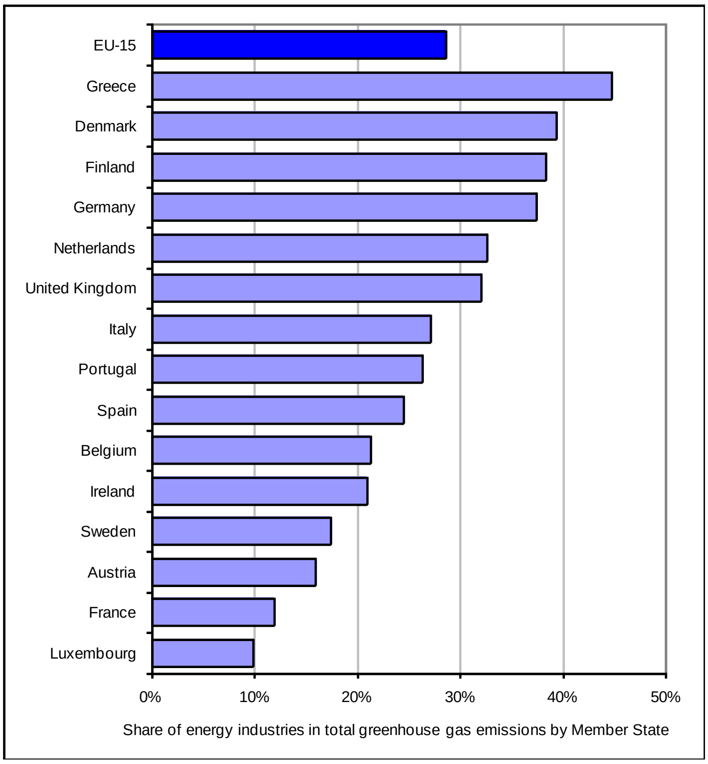
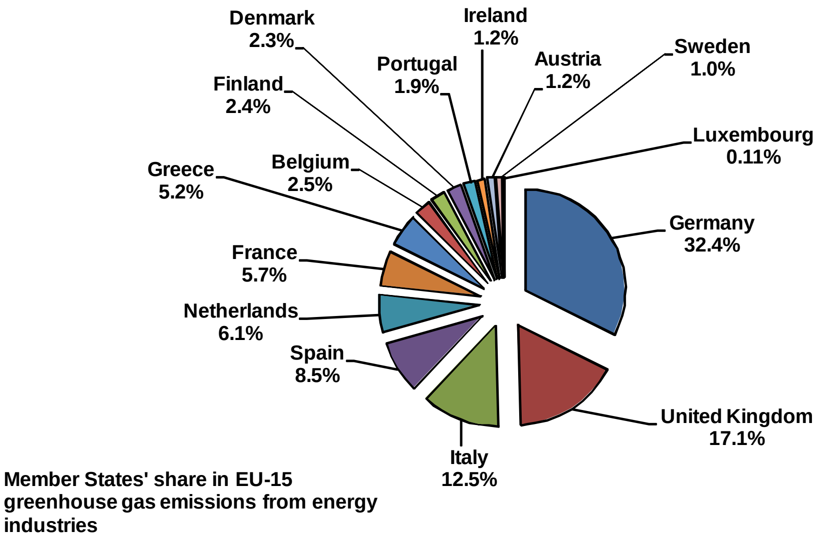



**Figure 3.5 Member States' share of greenhouse gas emissions from energy industries in EU-15**



Public heat and electricity production is the largest source category in the EU-15, as well as the main source of emissions from energy industries. Differences in the intensity of greenhouse gas emissions of heat and electricity production between the Member States are to a large extent explained by the mix of fuels. The relatively low share of greenhouse gas emissions from energy industries in France can be partly explained by the use of nuclear energy for power generation. Luxembourg is a net importer of electricity from neighbouring countries. Some countries rely more on coal than on gas. At the EU-15 level, about 45 % of the fuel used in energy industries comes from solid fuels. Its contribution has been steadily declining in favour of relatively cleaner natural gas, whose share stood at about 38 % in 2009.

Table 3.2 provides information on the Member States' contribution to EU-15 recalculations in $CO_2$ from 1A1 Energy Industries for 1990 and 2008 as well as the main explanations for the largest recalculations in absolute terms.

**Table 3.2 1A1 Energy Industries: Contribution of MS to EU-15 recalculations in $CO_2$ for 1990 and 2008 (difference between latest submission and previous submission in Gg of $CO_2$ equivalents and percent)**

| | 1990 | | 2008 | | Main explanations |
|---|---|---|---|---|---|
| | Gg $CO_2$ equiv. | Percent | Gg $CO_2$ equiv. | Percent | |
| Austria | 0 | 0.0 | 226 | 1.7 | Revision of energy balance |
| Belgium | -121 | -0.4 | 695 | 2.8 | New methodology applied for the calculation of emissions of CO2 in cokesmanufacturing industry in the Flemish region. In the 2011 submission emissions are calculated based on the fuel consumption instead of on the C-balance in the 2010 submission. |
| Denmark | -263 | -1.0 | 152 | 0.6 | The emission factor time-series for coal and residual oil have been improved based on EU ETS data. In addition emission factors for LPG, kerosene, refinery gas and natural gas applied in off-shore gas turbines have also been updated. Discussed in detail in NIR chapter 3.2.5. |
| Finland | 0 | 0.0 | -30 | -0.1 | Plant specific emission factor corrected. |
| France | -461 | -0.7 | 105 | 0.2 | - 1A1b: MAJ du périmètre en retranchant les consommations d'un vapocraqueur sur toute la série.<br>- 1A1c: Suite à la revue CCNUCC, les émissions sont sont basées sur les consommations et non plus sur les niveaux de production. |
| Germany | 8,564 | 2.1 | 10,296 | 2.9 | - Reallocation of CO2 emissions from blast furnace gas combustion in cokeries from source catagory 2C1 to source catagory 1A1<br>- new available data from national statistics |
| Greece | 0 | 0.0 | 102 | 0.2 | |
| Ireland | 0 | 0.0 | 0 | 0.0 | |
| Italy | 0 | 0.0 | -1,867 | -1.2 | steam coal and natural gas emission factor update |
| Luxembourg | -1,266 | -97.4 | -140 | -12.2 | - An electicity producing plant (autoproducer) of the iron and steel industry allocated to 1A1a was reallocated to 1A2a, as recommended in ARR 2009 59. This plant used liquid, solid and gaseous fuels and operated from 1990-1997. From 1990-1995, there were no other plants producing electricity and using liquid fuels.<br>- Activity data was revised due to new energy statistics from National Statistics (STATEC), and due to the application of national densities and NCVs, which are now streamlined with STATEC. |
| Netherlands | 0 | 0.0 | -44 | -0.1 | improved final AD |
| Portugal | 4 | 0.0 | 580 | 3.0 | - New fuel consumption data was made available from Autonomous Region.<br>- Further analysis into EU-ETS showed need for activity data corrections.<br>- Fuel consumption double counting was identified in sectors with emissions estimated with energy balance data. |
| Spain | 0 | 0.0 | 257 | 0.2 | - Pre-operational (testing phase) fuel consumption in a power plant, that was not included in the previous inventory edition, has been added, as well as the corresponding emissions estimates.<br>- The information regarding the fuel consumption of low-power electricity generation plants operating under the ordinary regime has been revised in accordance with the data appearing in Annex V of the Statistics on Electrical Power (prepared by the Ministry of Industry, Tourism and Trade, MITYC), which were not available at the time of the previous edition of the inventory |
| Sweden | 0 | 0.0 | 0 | 0.0 | |
| UK | -1,881 | -0.8 | -429 | -0.2 | - Emission factor revised for colliery methane (based on time series average for natural gas) and for OPG (based on EU ETS data and used across the time series).<br>- Power stations database reviewed to improve transparency and traceability of data. Updates made to oil use in coal fired and oil fired power stations. |
| **EU-15** | **4,574** | **0.4** | **9,904** | **0.9** | |

Table 3.3 provides information on the Member States' contribution to EU-15 recalculations in $N_2O$ from 1A1 Energy Industries for 1990 and 2008 and main explanations for the largest recalculations in absolute terms.

**Table 3.3 1A1 Energy industries: Contribution of MS to EU-15 recalculations in $N_2O$ for 1990 and 2008 (difference between latest submission and previous submission in Gg of $CO_2$ equivalents and percent)**

| | 1990 | | 2008 | | Main explanations |
|---|---|---|---|---|---|
| | Gg CO2 equiv. | Percent | Gg CO2 equiv. | Percent | |
| Austria | 0 | 0.0 | 2 | 1.6 | Revision of energy balance |
| Belgium | -31 | -13.2 | 3 | 2.0 | - New methodology applied for the calculation of emissions of CO2 in cokesmanufacturing industry in the Flemish region. In the 2011 submission emissions are calculated based on the fuel consumption instead of on the C-balance in the 2010 submission.<br>- The emissions of CO2 of a new installation was added in 2007 and 2008 during the 2011 submission in the Flemish region (Essent) in the sector 1A1a |
| Denmark | -34 | -28.3 | -21 | -15.5 | Emission factors that are not nationally referenced have been updated and now all refer to IPCC Guidelines (1996) |
| Finland | 0 | 0.0 | -2 | -0.5 | New emission factor (plants from ETS data). |
| France | 7 | 1.2 | -136 | -16.5 | La révision du facteur d'émission de N2O des centrales électriques à lit fluidisé circulant entraine une<br>baisse des émissions sur l'ensemble de la période. |
| Germany | 0 | 0.0 | 35 | 0.9 | new available data from national statistics |
| Greece | 0 | 0.0 | 0 | 0.0 | |
| Ireland | 0 | 0.0 | 0 | 0.0 | |
| Italy | 0 | 0.0 | 0 | 0.0 | |
| Luxembourg | 0 | - | 0 | - | |
| Netherlands | -1 | -0.7 | 0 | 0.0 | improved final AD |
| Portugal | 0 | 0.0 | 3 | 2.4 | Improvement in the fuel consumption data collection for Azores and Madeira island power plants. Double counting rectification in the auto-producers resulting from improved streamline with DGEG's energy balance. Inclusion of a biomass power plant not previously considered in the inventory. Update AD for the incineration of MSW (Municipal Solid Waste) with energy recovery. |
| Spain | 0 | 0.0 | 3 | 0.4 | - Pre-operational (testing phase) fuel consumption in a power plant, that was not included in the previous inventory edition, has been added, as well as the corresponding emissions estimates.<br>- The information regarding the fuel consumption of low-power electricity generation plants operating under the ordinary regime has been revised in accordance with the data appearing in Annex V of the Statistics on Electrical Power (prepared by the Ministry of Industry, Tourism and Trade, MITYC), which were not available at the time of the previous edition of the inventory |
| Sweden | 0 | 0.0 | 0 | 0.0 | |
| UK | -7 | -0.3 | -6 | -0.4 | Emission factors for oils revised due to revisions to the GCV. National statistics revisions for coal in power stations and natural gas in power stations refineries and gas production. EU ETS data used for sour gas and LPG/OPG at gas separation plant. Revised estimates for oils in power stations. |
| **EU-15** | **-65** | **-0.7** | **-120** | **-1.3** | |

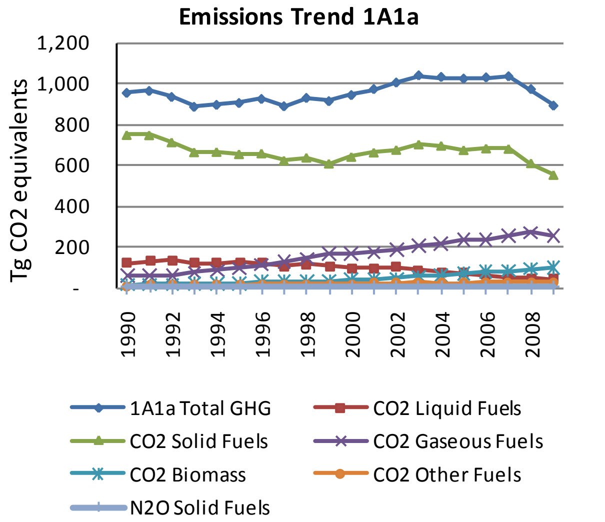
### 3.2.1.1 Public Electricity and Heat Production (1A1a) (EU-15)

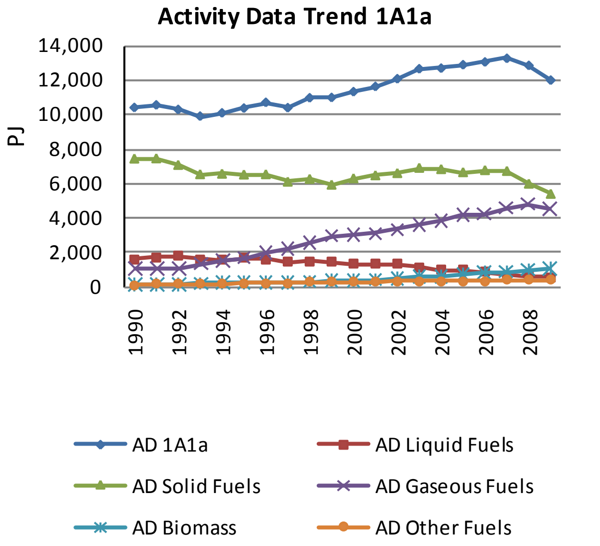
According to the IPCC, emissions from public electricity and heat production (CRF 1A1a) should include emissions from main activity producers of electricity generation, combined heat and power generation, and heat plants. Main activity producers (i.e. public utilities) are defined as those undertakings whose primary activity is to supply the public. They may be in public or private ownership. Emissions from own on-site use of fuel should be included. Emissions from autoproducers (undertakings which generate electricity/heat wholly or partly for their own use, as an activity that supports their primary activity) should be assigned to the sector where they were generated and not under 1A1a. Autoproducers may be in public or private ownership.

$CO_2$ emissions from electricity and heat production is the largest key source in the EU-15 accounting for 23.9% of total greenhouse gas emissions in 2009 and for 84 % of greenhouse gas emissions of the Energy Industries Sector. Between 1990 and 2009, $CO_2$ emissions from electricity and heat production decreased by 6 % in the EU-15.

Figure 3.6 (left) shows the trends in emissions originating from the production of public heat and electricity by fuel in the EU-15 between 1990 and 2009. Figure 3.6 (right) shows the activity data behind the emissions[21].

**Figure 3.6 1A1a-Public Electricity and Heat Production: Total, $CO_2$ and $N_2O$ emission and activity trends**



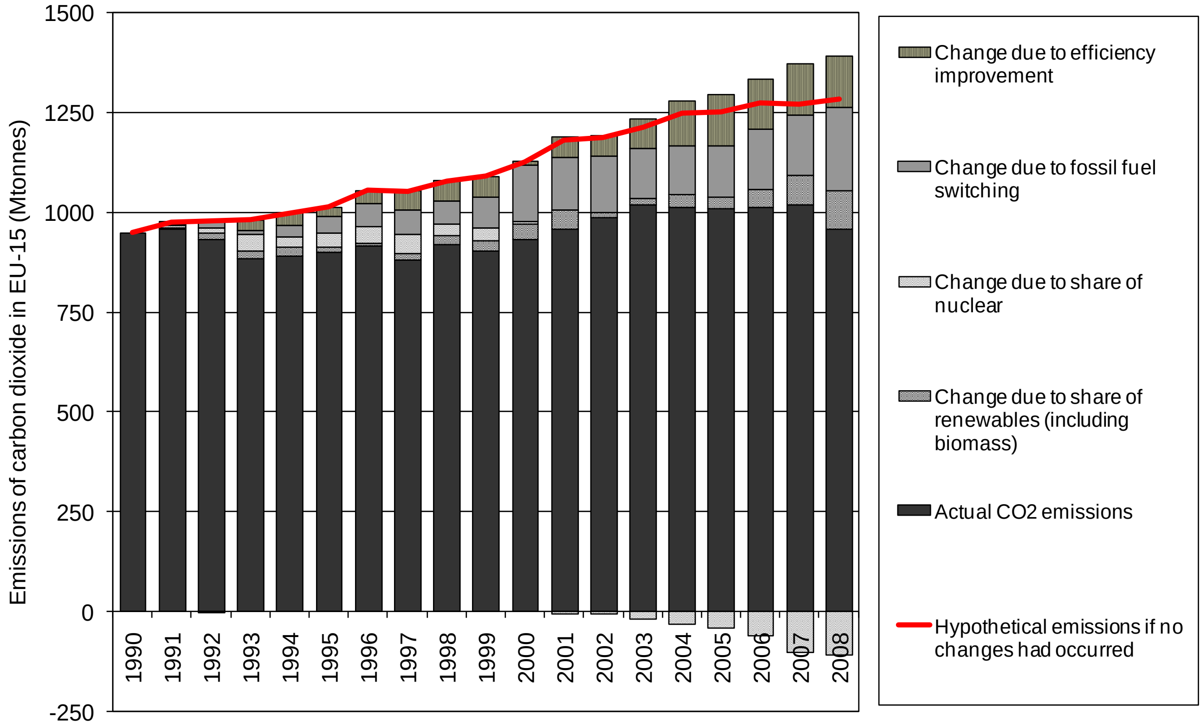




Fuel used for public electricity and heat production increased by 15 % in the EU-15 between 1990 and 2009. Solid fuels still represent almost half of the fuel used in public conventional thermal power plants, although its share in the fuel mix has been declining (-26%). Gas has increased very rapidly, by a factor of 3 between 1990 and 2009, and its share stands at 38% of all the fuel used for the production of heat and electricity in the EU-15. Liquid fuels still account for some 5 % but its use has declined gradually during the past 19 years. The use of biomass has increased even more rapidly than the use of gas, but its share in the fuel mix is relatively small, at around 9 %.

$CO_2$ emissions from public electricity and heat production did not increase in line with fuel consumption. There are several reasons for this. Figure 3.7 below shows the estimated impact of different factors on the reduction of $CO_2$ emissions from public heat and electricity generation in the EU-15 between 1990–2009. The main explanatory factors at the EU-15 level during the past 19 years have been improvements in energy efficiency and (fossil) fuel switching from coal to gas.

[21] $CO_2$ emissions from the combustion of biomass fuels are reported as a memo item and are therefore not included in the emissions from public electricity and heat production. The biomass used as a fuel is however included in the national energy consumption (i.e. activity data). The fact that $CO_2$ emissions from biomass are treated differently from other fuel emissions does not imply emissions from the production of heat and electricity are due to fossil fuel combustion only. Biomass $CO_2$ emissions are just reported elsewhere. Non-$CO_2$ emissions from the combustion of biomass ($CH_4$ and $N_2O$) are reported under the energy sector.

**Figure 3.7 Estimated impact of different factors on the reduction in emissions of $CO_2$ from public electricity and heat production in the EU-15 between 1990 and 2008.**




***Note:*** *The chart show the estimated contributions of the various factors that have affected emissions from public electricity and heat production (including public thermal power stations, nuclear power stations, hydro power plants and wind plants). The top line represents the hypothetical development of emissions that would have occurred due to increasing public heat and electricity production between 1990 and 2008, if the structure of electricity and heat production had remained unchanged since 1990, i.e. if the shares of input fuels used to produce electricity and heat had remained constant, and if the efficiency of electricity and heat production also stayed the same. However, there were a number of changes that tended to reduce emissions. The contribution of each of these changes to reducing emissions are shown by each of the bars. The cumulative effect of all these changes was that emissions from electricity and heat production actually followed the trend shown by the black bars. This is a frequently used approach for portraying the primary driving forces of emissions. It is based on the IPAT and Kaya identities. The explanatory factors should not be seen as fundamental factors in themselves nor should they be seen as independent from each other. The underpinning energy data is based on Eurostat's energy balances.*

Based on the chart above, $CO_2$ emissions from public heat and electricity production increased by 1 % during 1990-2008, but emissions would have risen by over 35 %, had the shares of input fuels used to produce electricity and heat and the efficiency remained constant, an increase which would be in line with the additional amount of electricity and heat produced (34 %). The relationship between the increase in electricity generation and the actual reduction in emissions during 1990-2008 can be explained by the following factors:

- An improvement in the thermal efficiency of electricity and heat production. During 1990-2008, there was a 10 % reduction in the fossil-fuel input per unit of electricity produced from fossil fuels.

- Changes in the fossil fuel mix used to produce electricity, i.e. fuel switching from coal and lignite to natural gas. There was a 18 % reduction in the $CO_2$ emissions per unit of fossil-fuel input during 1990-2008.

- The lower combined share of nuclear and renewable energy for electricity and heat production in 2008 compared to 1990[22]. During 1990-2008, the share of electricity from fossil fuels in total electricity production increased by 1 %.

These three factors interact with each other in a multiplicative way: Actual $CO_2$ emissions change = 1.35 (increase in electricity production) X 0.90 (efficiency improvement) X 0.82 (fossil fuel switching) X 1.01 (lower nuclear-renewable share)= 1.06. The combined effect was an increase of about 1 % in $CO_2$ emissions in 2005 compared to the 1990 level.

Returning to the 2011 inventory, Table 3.4 summarises emissions arising from the production of public heat and electricity by Member State. $CO_2$ emissions increased in eight Member States and fell in seven. Of the eight countries where emissions were higher in 2009 than in 1990, roughly a quarter of the increase was each accounted for by the Netherlands, Spain and Greece. Of the seven countries, where emissions fell, 81.3% of the total reduction were accounted for by UK (49.6%) and Germany (31.7%). The change in the EU-15 between 1990 and 2009 was a net decrease of about 62 Tg.

**Table 3.4 1A1a Public Electricity and Heat Production: Member States' contributions to $CO_2$ emissions**

| Member State | $CO_2$ emissions in Gg | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | |
|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) |
| Austria | 10,888 | 10,315 | 9,326 | 1.1% | -989 | -10% | -1,562 | -14% |
| Belgium | 23,504 | 20,430 | 21,390 | 2.4% | 960 | 5% | -2,114 | -9% |
| Denmark | 24,518 | 21,165 | 21,224 | 2.4% | 59 | 0% | -3,294 | -13% |
| Finland | 16,450 | 20,828 | 22,100 | 2.5% | 1,272 | 6% | 5,650 | 34% |
| France | 47,234 | 44,898 | 43,528 | 4.9% | -1,371 | -3% | -3,706 | -8% |
| Germany | 339,018 | 324,997 | 305,235 | 34.4% | -19,762 | -6% | -33,783 | -10% |
| Greece | 40,582 | 53,273 | 50,554 | 5.7% | -2,719 | -5% | 9,972 | 25% |
| Ireland | 10,876 | 14,005 | 12,466 | 1.4% | -1,539 | -11% | 1,590 | 15% |
| Italy | 107,136 | 114,385 | 97,886 | 11.0% | -16,499 | -14% | -9,249 | -9% |
| Luxembourg | 33 | 1,007 | 1,155 | 0.1% | 148 | 15% | 1,121 | 3369% |
| Netherlands | 39,932 | 52,372 | 52,556 | 5.9% | 185 | 0% | 12,624 | 32% |
| Portugal | 13,964 | 16,785 | 17,266 | 1.9% | 481 | 3% | 3,302 | 24% |
| Spain | 64,331 | 90,774 | 75,061 | 8.5% | -15,713 | -17% | 10,730 | 17% |
| Sweden | 7,493 | 6,996 | 7,551 | 0.9% | 554 | 8% | 58 | 1% |
| United Kingdom | 203,016 | 172,211 | 150,071 | 16.9% | -22,140 | -13% | -52,945 | -26% |
| **EU-15** | **948,976** | **964,442** | **887,369** | **100.0%** | **-77,072** | **-8%** | **-61,607** | **-6%** |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

*Note that German $CO_2$ emissions from SO2 scrubbing are included in this source category. Other Member States include these emissions in 1B1 or 2A3.*

Figure 3.8 shows the relative contributions of greenhouse gas emissions from public electricity and heat production in each Member State, ranging from relatively low shares in France and Luxembourg to relatively high in Finland, Denmark, Germany, and Greece. Figure 3.9 shows the absolute contributions to EU-15 $CO_2$ emissions from this source category, dominated by Germany and the UK. These two countries represent about half of the EU's greenhouse gas emissions from public electricity and heat production.

[22] The specific nuclear effect can be separated from the renewable effect in an additive way. These two factors will then be additive to each other and the combined renewable and nuclear effect will remain multiplicative to the already-mentioned fuel-switching and efficiency factors.

**Figure 3.8 Share of $CO_2$ emissions from public electricity and heat production in total greenhouse gas emissions by Member State in 2008**

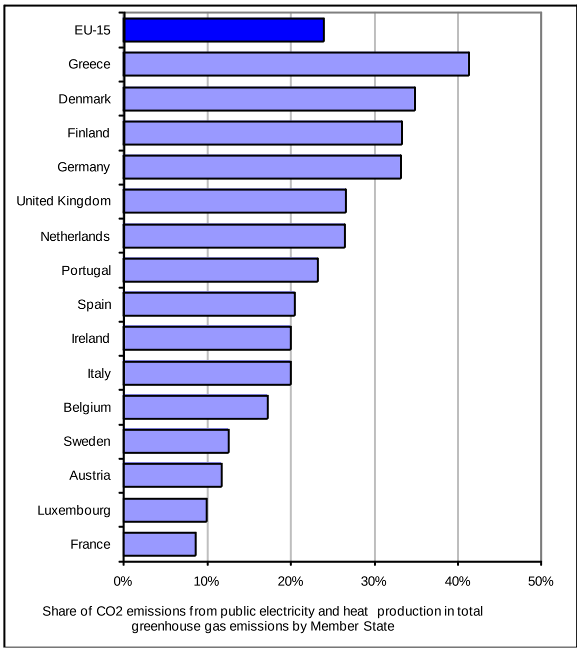
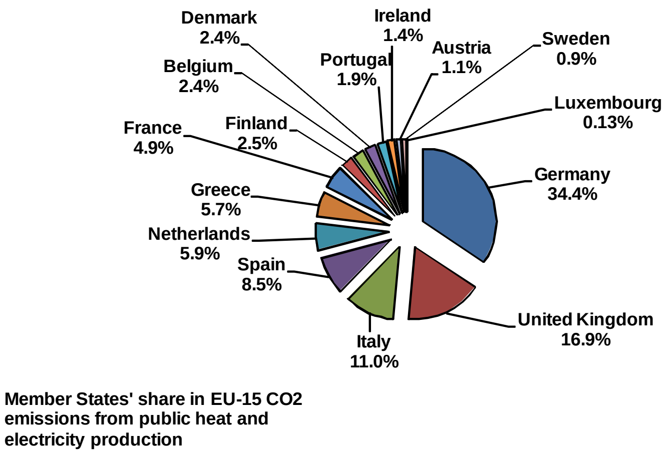



**Figure 3.9 Member States' share of $CO_2$ emissions from public heat and electricity production in EU-15**




Finally, $N_2O$ emissions currently represent 0.8 % of greenhouse gas emissions from public electricity and heat production. Between 1990 and 2009, any changes in emissions offset by each other (Table 3.5). Emissions from this source category only declined in the United Kingdom, Germany and Italy. The biggest increases occurred in Spain and Finland.

**Table 3.5 1A1a Public Electricity and Heat Production: Member States' contributions to $N_2O$ emissions**

| Member State | $N_2O$ emissions in Gg | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | |
|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) |
| Austria | 41 | 95 | 91 | 1.2% | -4 | -4% | 50 | 121% |
| Belgium | 71 | 89 | 82 | 1.1% | -7 | -8% | 11 | 16% |
| Denmark | 78 | 92 | 93 | 1.3% | 2 | 2% | 15 | 19% |
| Finland | 104 | 277 | 263 | 3.6% | -15 | -5% | 158 | 152% |
| France | 460 | 556 | 548 | 7.5% | -8 | -1% | 88 | 19% |
| Germany | 3,610 | 3,579 | 3,371 | 46.3% | -208 | -6% | -239 | -7% |
| Greece | 147 | 175 | 171 | 2.4% | -4 | -2% | 24 | 16% |
| Ireland | 74 | 137 | 138 | 1.9% | 1 | 1% | 64 | 87% |
| Italy | 326 | 325 | 299 | 4.1% | -26 | -8% | -27 | -8% |
| Luxembourg | 2 | 3 | 3 | 0.0% | 0 | 0% | 1 | 73% |
| Netherlands | 131 | 228 | 241 | 3.3% | 13 | 6% | 111 | 85% |
| Portugal | 52 | 119 | 125 | 1.7% | 6 | 5% | 74 | 143% |
| Spain | 197 | 621 | 545 | 7.5% | -76 | -12% | 347 | 176% |
| Sweden | 304 | 390 | 425 | 5.8% | 35 | 9% | 121 | 40% |
| United Kingdom | 1,662 | 1,027 | 880 | 12.1% | -147 | -14% | -782 | -47% |
| **EU-15** | **7,259** | **7,712** | **7,275** | **100.0%** | **-437** | **-6%** | **16** | **0%** |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

## 1A1a Electricity And Heat Production - Liquid Fuels ($CO_2$)

$CO_2$ emissions arising from the combustion of liquid fuels for public electricity and heat generation account for about 5 % of all greenhouse gas emissions from 1A1a. Within the EU-15, emissions fell by about 65 % between 1990 and 2009 (Table 3.6).

**Table 3.6 1A1a Public Electricity and Heat Production, liquid fuels: Member States' contributions to $CO_2$ emissions and information on method applied and emission factor**

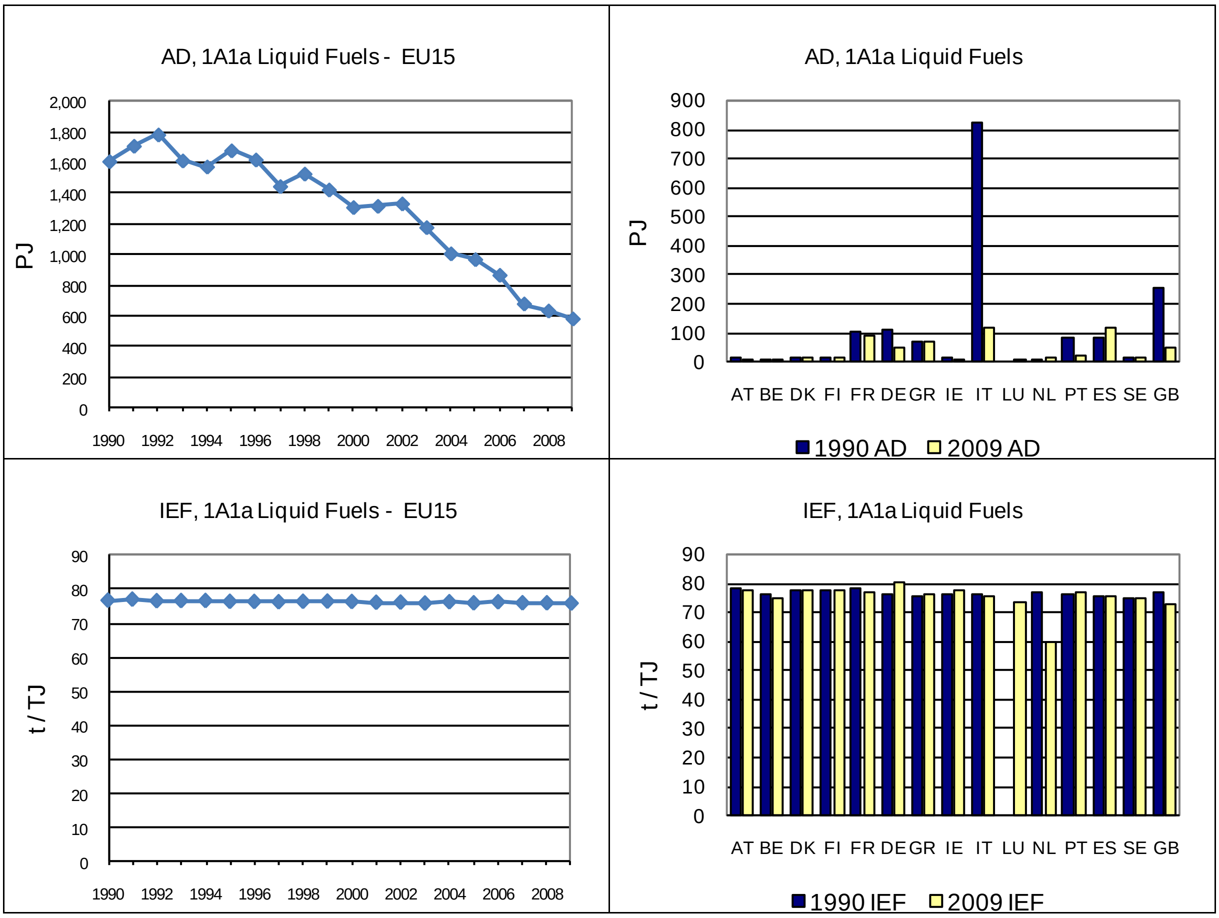
| Member State | $CO_2$ emissions in Gg | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| Austria | 1228.70 | 696.08 | 702.58 | 2% | 6.50 | 1% | -526.11 | -43% | T2 | CS,PS |
| Belgium | 659.33 | 217.91 | 126.85 | 0% | -91.06 | -42% | -532.48 | -81% | CS,T3,T1 | CS,D |
| Denmark | 950.72 | 832.26 | 995.54 | 2% | 163.28 | 20% | 44.83 | 5% | CR | CS,PS,C,D |
| Finland | 1243.64 | 876.98 | 1045.68 | 2% | 168.71 | 19% | -197.96 | -16% | T3 | CS,D,PS |
| France | 7893.61 | 6633.63 | 6896.08 | 16% | 262.45 | 4% | -997.52 | -13% | CR | CS |
| Germany | 8506.92 | 2965.95 | 3667.82 | 8% | 701.86 | 24% | -4839.11 | -57% | CS | CS |
| Greece | 5374.95 | 6947.37 | 5329.16 | 12% | -1618.21 | -23% | -45.79 | -1% | T2 | PS |
| Ireland | 1086.52 | 1143.44 | 680.41 | 2% | -463.03 | -40% | -406.11 | -37% | T3 | PS |
| Italy | 63047.35 | 10874.09 | 8777.65 | 20% | -2096.44 | -19% | -54269.70 | -86% | T3 | CS |
| Luxembourg | NO | 2.34 | 3.17 | 0% | 0.83 | 36% | 3.17 | - | T2 | CS |
| Netherlands | 206.85 | 837.40 | 684.05 | 2% | -153.35 | -18% | 477.19 | 231% | T2 | CS |
| Portugal | 6304.31 | 1839.87 | 1430.41 | 3% | -409.46 | -22% | -4873.91 | -77% | T2 | D,CR,PS |
| Spain | 6006.63 | 9331.00 | 8813.50 | 20% | -517.51 | -6% | 2806.86 | 47% | T2 | PS,C |
| Sweden | 1276.02 | 627.27 | 970.50 | 2% | 343.23 | 55% | -305.52 | -24% | T2 | CS |
| United Kingdom | 19715.78 | 3871.07 | 3554.38 | 8% | -316.69 | -8% | -16161.40 | -82% | T2 | CS |
| **EU-15** | **123501.34** | **47696.66** | **43677.78** | **100%** | **-4018.88** | **-8%** | **-79823.55** | **-65%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

Figure 3.10 shows the activity data and implied emission factors for $CO_2$ emissions from liquid fuels used in public electricity and heat production. The charts clearly show the importance of liquid fuels has been declining gradually since 1992. The implied emission factor has remained stable at the EU-15 level (76 t/TJ in 2008). The largest emitters in 2009 were Italy, Spain and France together responsible for 56 % of the EU-15 emissions, although emissions have fallen markedly in Italy compared to 1990.

In 2009 Germany had the highest IEF of all EU-15 countries (80 t/TJ). This can be explained by the increase in the use of petroleum coke to generate electricity. The high IEF of 80 arises from the category ‘other mineral oil products’, a mixture of diverse mineral products, and it is based on expert judgement. In the Netherlands, the IEF declined from 71 t/TJ in 1994 to about 60 t/TJ in 1995. This is explained by the sharp increase in the use of residual chemical gas. In the Netherlands in this sector, among others, residual gases from the chemical industry are combusted. The implied emission factor is low because these residual gases contain hydrogen gas.

**Figure 3.10 1A1a-Public Electricity and Heat Production, liquid fuels: Activity Data and Implied Emission Factors for $CO_2$**



## 1A1a Electricity and Heat Production - Solid Fuels ($CO_2$, $N_2O$)

$CO_2$ emissions from the combustion of solid fuels represented about two thirds of all greenhouse gas emissions from public electricity and heat production. Within the EU-15, emissions fell by 26 % between 1990 and 2009 (Table 3.7).

**Table 3.7 1A1a Public Electricity and Heat Production, solid fuels: Member States' contributions to $CO_2$ emissions and information on method applied and emission factor**

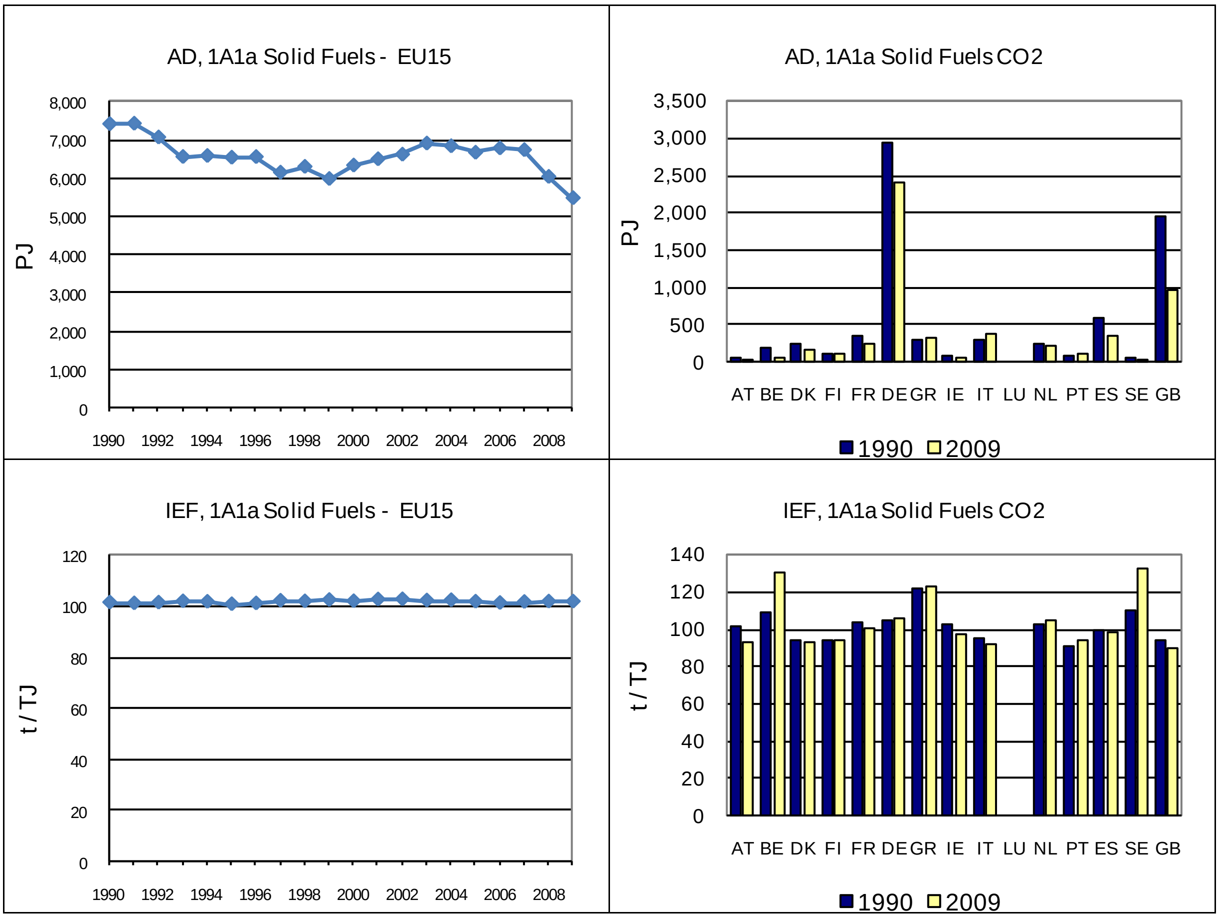
| Member State | $CO_2$ emissions in Gg | | | Share in EU15 emissions | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| Austria | 6,247 | 4,440 | 3,018 | 3.5% | -1,422 | -32% | -3,229 | -52% | T2 | CS,PS |
| Belgium | 19,345 | 8,097 | 7,433 | 1.3% | -664 | -8% | -11,912 | -62% | CS,T3 | CS,D |
| Denmark | 22,225 | 15,246 | 15,336 | 2.8% | 90 | 1% | -6,889 | -31% | CR | CS,PS,D |
| Finland | 9,281 | 8,427 | 10,535 | 1.9% | 2,107 | 25% | 1,254 | 14% | T3 | CS,D,PS |
| France | 36,565 | 27,155 | 24,803 | 4.5% | -2,352 | -9% | -11,762 | -32% | CR | CS |
| Germany | 307,928 | 273,299 | 253,797 | 45.6% | -19,502 | -7% | -54,131 | -18% | CS | CS |
| Greece | 35,207 | 40,601 | 41,185 | 7.4% | 583 | 1% | 5,977 | 17% | T2 | CS |
| Ireland | 7,909 | 6,631 | 5,766 | 1.0% | -865 | -13% | -2,144 | -27% | T3 | PS |
| Italy | 28,148 | 39,569 | 35,438 | 6.4% | -4,131 | -10% | 7,291 | 26% | T3 | CS |
| Luxembourg | NO | NO | NO | - | - | - | - | - | NA | NA |
| Netherlands | 25,776 | 25,365 | 23,621 | 4.2% | -1,745 | -7% | -2,155 | -8% | T2 | CS |
| Portugal | 7,659 | 9,387 | 10,582 | 1.9% | 1,195 | 13% | 2,922 | 38% | T2 | D,CR,PS |
| Spain | 57,778 | 46,674 | 34,910 | 6.3% | -11,764 | -25% | -22,867 | -40% | T2 | PS |
| Sweden | 5,178 | 4,468 | 3,952 | 0.7% | -516 | -12% | -1,226 | -24% | T2 | CS |
| United Kingdom | 183,150 | 104,126 | 85,644 | 15.4% | -18,481 | -18% | -97,506 | -53% | T2 | CS |
| **EU-15** | **752,396** | **613,487** | **556,020** | **100.0%** | **-57,468** | **-9%** | **-196,377** | **-26%** | | |

*Note that German $CO_2$ emissions from SO2 scrubbing are included in this source category. Other Member States include these emissions in 1B1 or 2A3.*
*Abbreviations explained in the Chapter 'Units and abbreviations'.*

Figure 3.11 shows the relevant activity data and implied emission factors for solid fuels. The amount of solid fuels used decreased gradually until 1999 and has slight increased thereafter. In the last two years,  the upwards trend in solid fuel use in public electricity and heat production has reversed. Between 1990 and 2009 activity data decreased by 26%. mainly due to decreases in UK, Germany and Spain. The EU-15 implied emission factor has remained fairly stable (102 t/TJ in 2009). The largest emitters in 2009 were Germany and the UK, jointly responsible for 61 % of EU-15 emissions. In both countries, however, emissions have fallen compared to 1990, particularly in the UK where a large shift to gas use in electricity production occurred.

Solid fuels used in public heat and electricity production in Luxembourg are insignificant after 1997. Before then, the emission factor was the highest of EU-15 countries because of the use of blast furnace technology. In Belgium and Sweden, the emission factors increased sharply since the late 1990s due to the use of blast furnace gas.

**Figure 3.11** **1A1a- Public Electricity and Heat Production, solid fuels: Activity Data and Implied Emission Factors for $CO_2$**




The related $N_2O$ emissions from the use of solid fuels are responsible for almost 1 % of all greenhouse gas emissions in the heat and power sector. For the EU-15, emissions in 2009 fell by 25 %, although this is the net effect of averaging Member States' trends (Table 3.8).

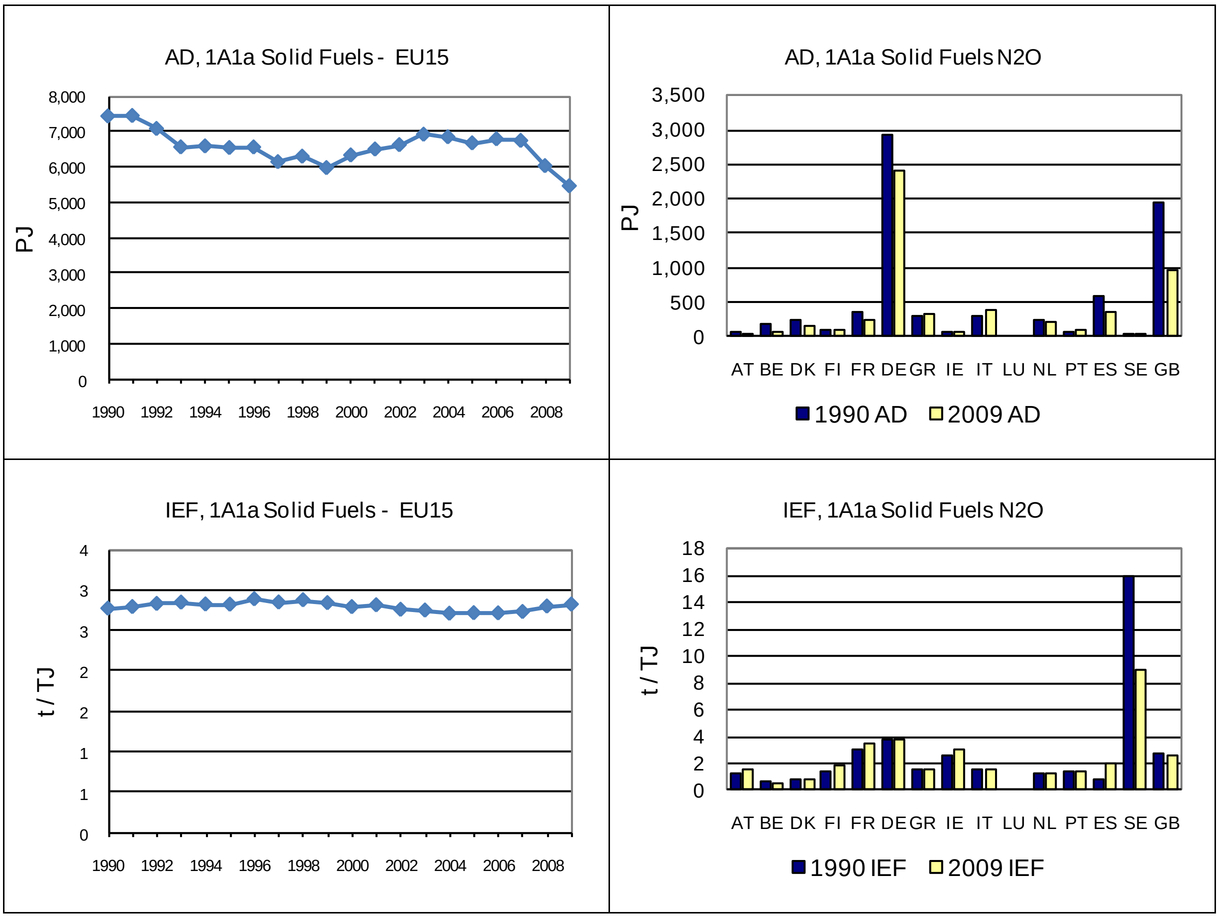
**Table 3.8** **1A1a Electricity and heat production, solid fuels: Member States' contributions to $N_2O$ emissions and information on method applied and emission factor**

| Member State | $N_2O$ emissions in Gg | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| Austria | 23 | 24 | 16 | 0.3% | -7 | -31% | -7 | -29% | T2 | CS |
| Belgium | 33 | 9 | 8 | 0.2% | -1 | -13% | -25 | -76% | 0.0 | 0.0 |
| Denmark | 60 | 40 | 41 | 0.9% | 0 | 1% | -19 | -32% | CR | CR,CS |
| Finland | 43 | 62 | 63 | 1.3% | 1 | 1% | 20 | 47% | T3 | CS |
| France | 329 | 286 | 266 | 5.6% | -20 | -7% | -63 | -19% | CR | CS |
| Germany | 3,431 | 3,034 | 2,814 | 58.9% | -220 | -7% | -618 | -18% | T2 | CS |
| Greece | 134 | 155 | 156 | 3.3% | 1 | 1% | 22 | 16% | T2 | D |
| Ireland | 62 | 58 | 57 | 1.2% | -1 | -1% | -5 | -8% | T1,T2 | D |
| Italy | 138 | 200 | 179 | 3.7% | -21 | -11% | 41 | 30% | T3 | CR,D |
| Luxembourg | NO | NO | NO | - | - | - | - | - | NA | NA |
| Netherlands | 101 | 89 | 91 | 1.9% | 2 | 2% | -10 | -10% | T1 | D |
| Portugal | 36 | 42 | 48 | 1.0% | 6 | 13% | 12 | 33% | T2 | CR,D |
| Spain | 146 | 246 | 213 | 4.5% | -33 | -13% | 68 | 46% | T2 | D,CR,OTH |
| Sweden | 232 | 81 | 83 | 1.7% | 2 | 2% | -149 | -64% | T2 | CS |
| United Kingdom | 1,607 | 900 | 745 | 15.6% | -155 | -17% | -862 | -54% | T2 | CS |
| **EU-15** | **6,374** | **5,226** | **4,778** | **100.0%** | **-448** | **-9%** | **-1,596** | **-25%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

Figure 3.12 shows the related activity data and implied emission factors for $N_2O$. The EU-15 implied emission factor has somewhat remained stable compared to 1990, and stood at 2.7 kg/TJ in 2009. The largest emitter in 2009 was Germany, accounting for 59% of EU-15 emissions. In 2009, IEF was highest in Sweden (9 kg/TJ) after a gradual but strong decline in the IEF between 1990-2006. This was due to the increased use of blast furnace gas and a lower use of coal. Since the IEF for coal is ten times higher than the IEF for blast furnace gas, the IEF for solid fuels declined overall during the period. This comparatively high implied emission factor is regularly reviewed and found to be correct for Swedish conditions.

**Figure 3.12 1A1a Public Electricity and Heat Production, solid fuels: Activity Data and Implied Emission Factors for $N_2O$**




## 1A1a Electricity and Heat Production - Gaseous Fuels ($CO_2$)

$CO_2$ emissions from the combustion of gaseous fuels accounted for 29 % of all greenhouse gas emissions from public electricity and heat generation in 2009. Emissions increased by a factor of three in the EU-15 between 1990 and 2009 (Table 3.9). In all EU-15 Member States the consumption of gas was higher in 2009 than in 1990.

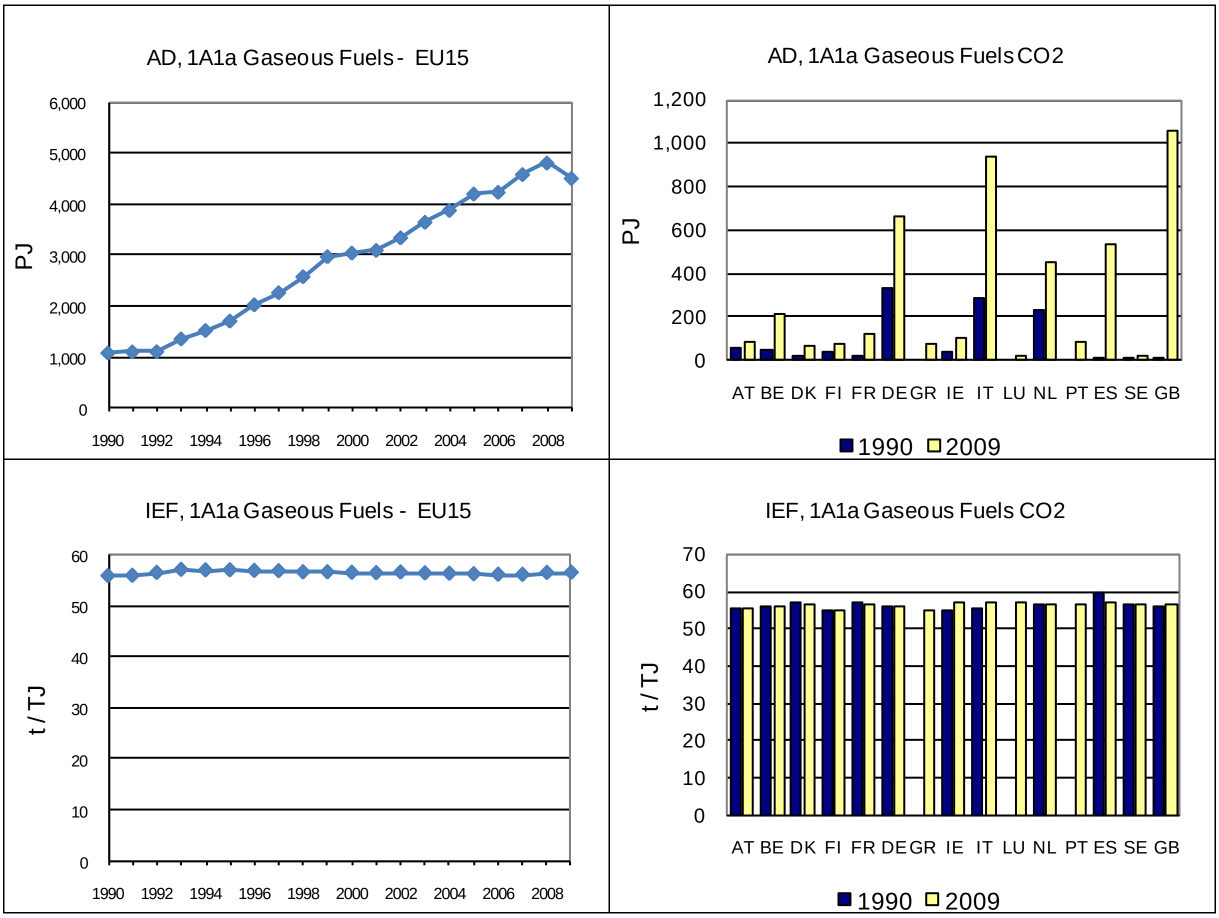
**Table 3.9 1A1a Electricity and heat production, gaseous fuels: Member States' contributions to $CO_2$ emissions and information on method applied and emission factor**

| Member State | $CO_2$ emissions in Gg | | | Share in EU15 emissions | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| Austria | 3,294 | 4,501 | 4,843 | 1.9% | 342 | 8% | 1,549 | 47% | T2 | CS |
| Belgium | 2,751 | 10,191 | 11,978 | 4.7% | 1,788 | 18% | 9,228 | 335% | CS,T3,T1 | CS,D |
| Denmark | 997 | 3,823 | 3,695 | 1.4% | -127 | -3% | 2,698 | 270% | CR | CS |
| Finland | 1,976 | 4,559 | 4,190 | 1.6% | -369 | -8% | 2,214 | 112% | T3 | CS |
| France | 984 | 5,970 | 6,905 | 2.7% | 935 | 16% | 5,921 | 602% | CR | CS |
| Germany | 18,462 | 39,862 | 37,349 | 14.6% | -2,513 | -6% | 18,887 | 102% | CS | CS |
| Greece | NO | 5,725 | 4,040 | 1.6% | -1,684 | -29% | 4040 | - | T2 | CS,PS |
| Ireland | 1,881 | 6,231 | 6,020 | 2.4% | -210 | -3% | 4,140 | 220% | T3 | PS |
| Italy | 15,787 | 63,631 | 53,364 | 20.9% | -10,267 | -16% | 37,576 | 238% | T3 | CS |
| Luxembourg | NO | 932 | 1,081 | 0.4% | 149 | 16% | 1,081 | - | T2 | CS |
| Netherlands | 13,348 | 23,927 | 25,720 | 10.1% | 1,793 | 7% | 12,372 | 93% | T2 | CS |
| Portugal | NO | 5,209 | 4,890 | 1.9% | -319 | -6% | 4,890 | - | T2 | D,CR,PS |
| Spain | 437 | 33,857 | 30,399 | 11.9% | -3,459 | -10% | 29,961 | 6855% | T2 | PS,CS |
| Sweden | 486 | 598 | 1,232 | 0.5% | 634 | 106% | 746 | 154% | T2 | CS |
| United Kingdom | 16 | 63,224 | 59,669 | 23.4% | -3,555 | -6% | 59,653 | 374158% | T2 | CS |
| **EU-15** | **60,419** | **272,238** | **255,377** | **100.0%** | **-16,861** | **-6%** | **194,958** | **323%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

Figure 3.12 shows the activity data and implied $CO_2$emission factors from gaseous fuels. Gas use in the power generating sector increased strongly after 1992. The EU-15 implied emission factor has remained fairly stable (57 t/TJ in 2009). The increase in the EU-15 factor observed in the early 1990s can be explained by the higher UK's gas share in the EU-15 and by a significant increase in the UK's implied emission factor. The latter is the result of the commissioning of the Peterhead power station in Scotland, which uses sour gas, a fuel with a much higher factor than natural gas. The largest emitters in 2009 were the UK and Italy, jointly responsible for almost half the EU-15 emissions.

**Figure 3.13 1A1a-Public Electricity and Heat Production, gaseous fuels: Activity Data and Implied Emission Factors for $CO_2$**




### 1A1a Electricity and Heat Production - Other Fuels ($CO_2$)

In 2009, the share of $CO_2$ emissions from other fuels stood at about 4 % of total greenhouse gas emissions from public electricity and heat generation. Emissions almost tripled at the EU-15 level and increased in all countries where ‘other fuels’ are used in heat and power generation. Other fuels cover the fossil part of municipal solid waste incineration where there is energy recovery, including plastics (Table 3.10).

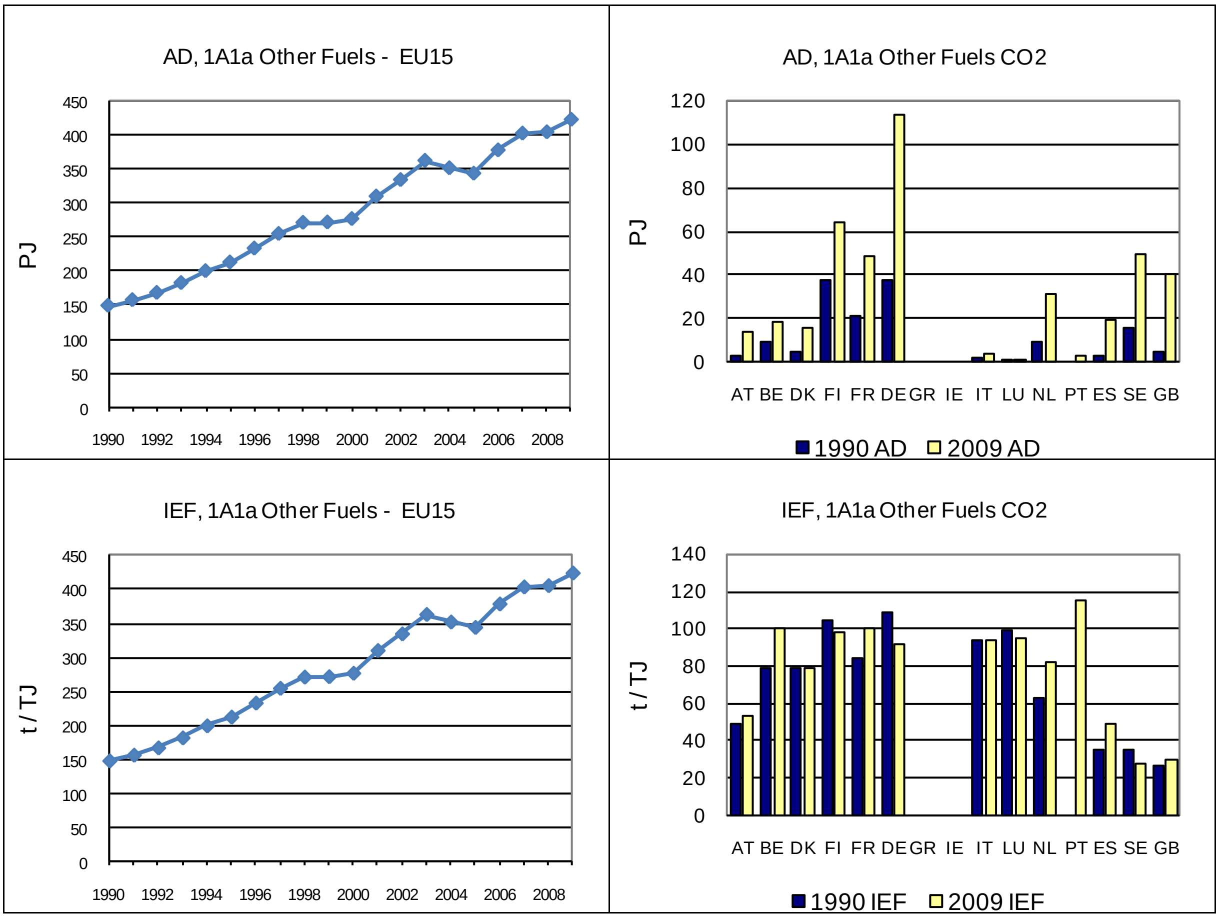
**Table 3.10 1A1a Public Electricity and Heat Production, other fuels: Member States' contributions to $CO_2$ emissions and information on method applied and emission factor**

| Member State | $CO_2$ emissions in Gg | | | Share in EU15 emissions | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| Austria | 118 | 677 | 762 | 2.4% | 85 | 12% | 644 | 546% | T2 | CS(MSW) D(Ind. Waste) |
| Belgium | 749 | 1,924 | 1,852 | 5.7% | -72 | -4% | 1,103 | 147% | CS,T3,T1 | CS,D |
| Denmark | 345 | 1,264 | 1,197 | 3.7% | -67 | -5% | 852 | 247% | CR | CS |
| Finland | 3,950 | 6,964 | 6,330 | 19.6% | -635 | -9% | 2,380 | 60% | T3 | CS |
| France | 1,792 | 5,140 | 4,924 | 15.2% | -216 | -4% | 3,132 | 175% | CR | CS |
| Germany | 4,121 | 8,871 | 10,421 | 32.3% | 1,550 | 17% | 6,300 | 153% | CS | CS |
| Greece | NO | NO | NO | - | - | - | - | - | NO | NO |
| Ireland | NO | NO | NO | - | - | - | - | - | NO | NO |
| Italy | 153 | 311 | 307 | 0.9% | -4 | -1% | 153 | 100% | T3 | CS |
| Luxembourg | 33 | 72 | 70 | 0.2% | -2 | -3% | 37 | 111% | T2 | D |
| Netherlands | 601 | 2,242 | 2,531 | 7.8% | 289 | 13% | 1,929 | 321% | T2 | CS |
| Portugal | NO | 349 | 363 | 1.1% | 14 | 4% | 363 | - | T2 | D,CR,PS |
| Spain | 110 | 912 | 939 | 2.9% | 27 | 3% | 829 | 753% | T2 | PS,CS,C |
| Sweden | 553 | 1,303 | 1,396 | 4.3% | 93 | 7% | 844 | 153% | T2 | CS |
| United Kingdom | 134 | 990 | 1,204 | 3.7% | 213 | 22% | 1,069 | 796% | OTH,T1 | CS |
| **EU-15** | **12,660** | **31,020** | **32,295** | **100.0%** | **1,276** | **4%** | **19,636** | **155%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

Figure 3.14 shows the activity data and implied emission factors. The EU-15 implied emission factor has fallen gradually since 1990, standing at 76 t/TJ in 2009. The largest emitters in 2009 were Germany, Finland and France, which together accounted for about two thirds of EU-15 emissions.

**Figure 3.14** **1A1a Public Electricity and Heat Production, other fuels: Activity Data and Implied Emission Factors for $CO_2$**




In Germany, the IEF declined continuously between 1990 and 2009 (from 109 to 91). This is because the combustion of industrial waste has been greatly reduced in the early 1990s whereas the combustion of residential waste for electricity and heat has increased in the complete reporting period; furthermore, the calorific value of the applied waste has increased due to a better national waste separation management.

Figure 3.14 also shows that the share of Finnish activity in the EU-15 is disproportionally high. This is due to the reporting of 'peat' under 'other fuels' instead of under 'solid fuels' as recommended by the revised 1996 IPCC Guidelines. This apparent mis-allocation is clearly explained and argued[23] and is consistent with national energy statistics as well as with the IPCC 2006 Guidelines. In the Netherlands, the IEF increases considerably after 2003 to reach 80 t/TJ in 2009. This was mainly due to the increase in the share of plastics (with a high carbon fraction) in combustible.

#### 3.2.1.2 Petroleum Refining (1A1b) (EU-15)

According to the IPCC, petroleum refining (CRF 1A1b) should include all combustion activities supporting the refining of petroleum products including on-site combustion for the generation of electricity and heat for own use. It does not include evaporative emissions occurring at the refinery. These emissions should be reported separately under 1B2a.

$CO_2$ emissions from petroleum refining is the ninth largest key source in the EU-15 accounting for 3.0 % of total greenhouse gas emissions in 2009. Between 1990 and 2009, EU-15 $CO_2$ emissions increased by 9 % (Table 3.11). Emissions in 2009 were above 1990 levels in all Member States, with the exception of the UK and the Netherlands.

**Table 3.11 1A1b Petroleum Refining: Member States' contributions to $CO_2$ emissions**

| Member State | $CO_2$ emissions in Gg | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | |
|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) |
| Austria | 2,394 | 2,806 | 2,809 | 2.5% | 3 | 0% | 415 | 17% |
| Belgium | 4,299 | 4,630 | 4,758 | 4.1% | 128 | 3% | 459 | 11% |
| Denmark | 906 | 926 | 933 | 0.8% | 7 | 1% | 26 | 3% |
| Finland | 2,260 | 2,765 | 2,833 | 2.5% | 68 | 2% | 572 | 25% |
| France | 12,943 | 13,706 | 12,982 | 11.3% | -724 | -5% | 39 | 0% |
| Germany | 20,006 | 21,572 | 20,270 | 17.7% | -1,302 | -6% | 264 | 1% |
| Greece | 2,308 | 4,257 | 3,979 | 3.5% | -277 | -7% | 1,671 | 72% |
| Ireland | 182 | 367 | 315 | 0.3% | -52 | -14% | 133 | 73% |
| Italy | 16,337 | 27,456 | 25,251 | 22.0% | -2,205 | -8% | 8,915 | 55% |
| Luxembourg | NO | NO | NO | 0.0% | - | - | - | - |
| Netherlands | 11,041 | 10,935 | 9,741 | 8.5% | -1,194 | -11% | -1,300 | -12% |
| Portugal | 1,910 | 2,865 | 2,239 | 2.0% | -626 | -22% | 330 | 17% |
| Spain | 10,906 | 12,429 | 11,637 | 10.1% | -792 | -6% | 731 | 7% |
| Sweden | 1,778 | 2,193 | 2,092 | 1.8% | -100 | -5% | 314 | 18% |
| United Kingdom | 17,525 | 15,789 | 14,813 | 12.9% | -976 | -6% | -2,712 | -15% |
| **EU-15** | **104,795** | **122,695** | **114,652** | **100.0%** | **-8,043** | **-7%** | **9,857** | **9%** |

Figure 3.15 shows the trends in emissions originating from the refining of petroleum by fuel in the EU-15 between 1990 and 2009 and the activity data behind the emissions.

Fuel used for petroleum refining increased by about 9 % in the EU-15 between 1990 and 2009. Liquid fuels represent 90 % of all fuel used in the refining of petroleum. Gaseous fuels almost fully account for the remaining part and their use has more than doubled since 1990. There remains a small amount of solid fuels used in petroleum refining, mainly in France and Germany.

[23] There are several reasons for reporting peat separately from solid fuels in Finland. Solid fuels include hard coal, coke and other fuels derived from coal (BFG, coke oven gas). The origin of these fuels is totally from imported sources, whereas peat is totally a domestic energy source. This categorization follows the practice used in national energy statistics as well as in the IPCC 2006 Guidelines. Moreover, the $CO_2$ IEF of peat is higher than the IEF of hard coal. Combining both fuels would cause significant variation in the IEF of solid fuels. Finally, other properties of peat and hard coal are very different, and would justify the reporting under two different fuel categories. See also the 2008 Finnish NIR to the UNFCCC.

**Figure 3.15** **1A1b Petroleum Refining: Total and $CO_2$ emission trends**

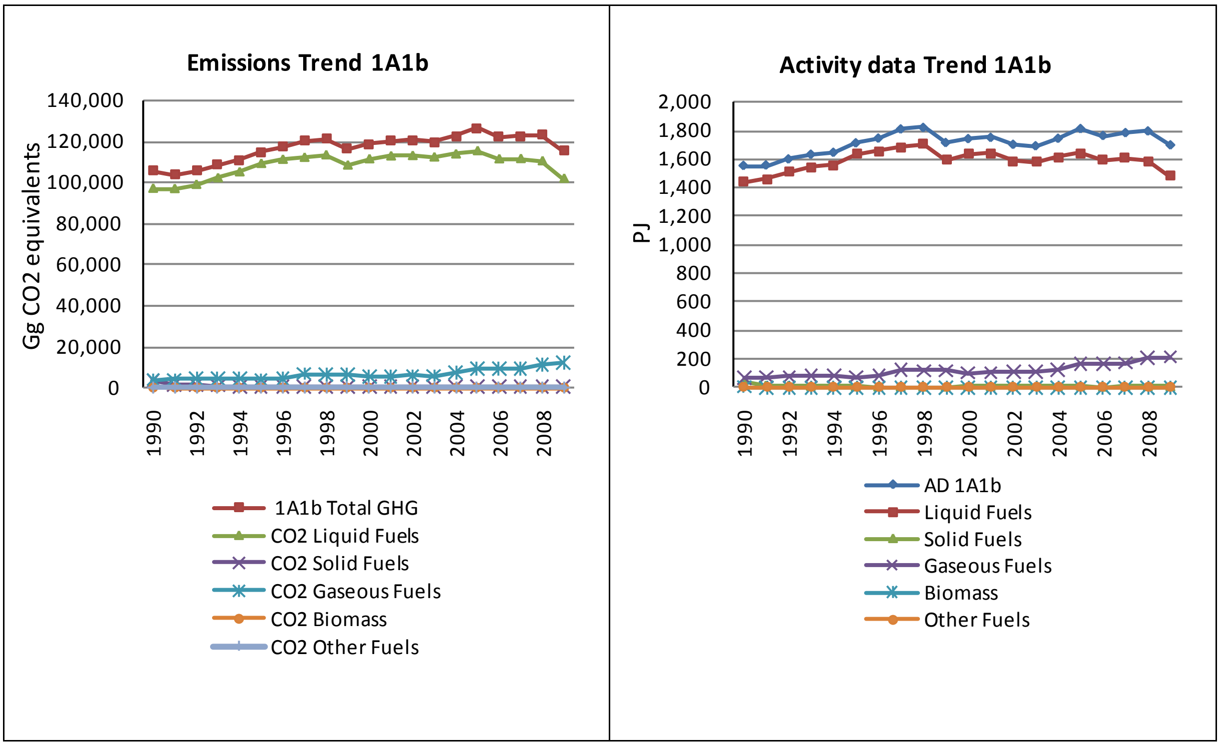



Figure 3.16 shows the relative importance of $CO_2$ emissions from petroleum refining in total greenhouse gas emissions by Member State, ranging from the relatively low share in Ireland to relatively high share in the Netherlands and Italy. Figure 3.17 shows the absolute contributions to EU-15 $CO_2$ emissions from petroleum refining. Italy was the largest EU-15 emitter in 2009, accounting for more than 20 % of all EU-15 emissions.

**Figure 3.16** **Share of $CO_2$ emissions from petroleum refining in total greenhouse gas emissions by Member State in 2009**

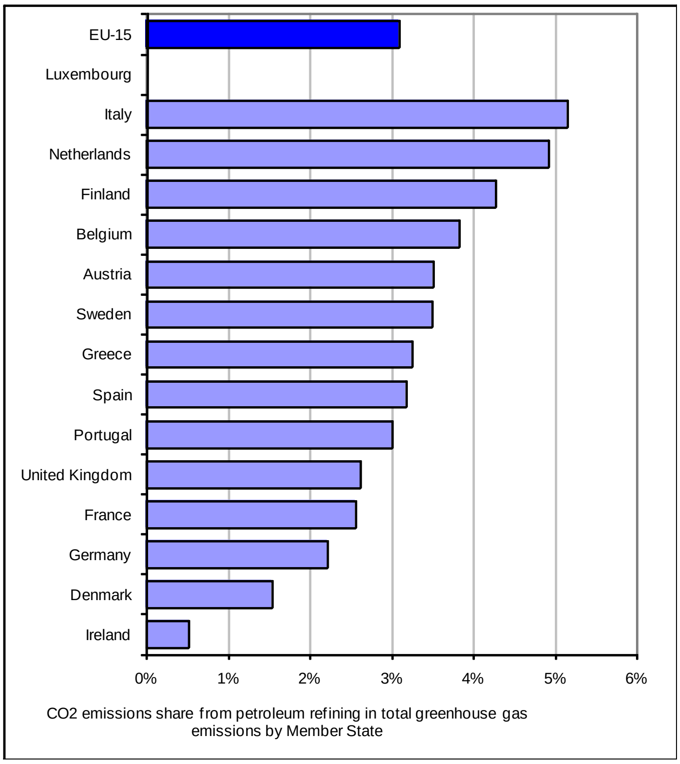
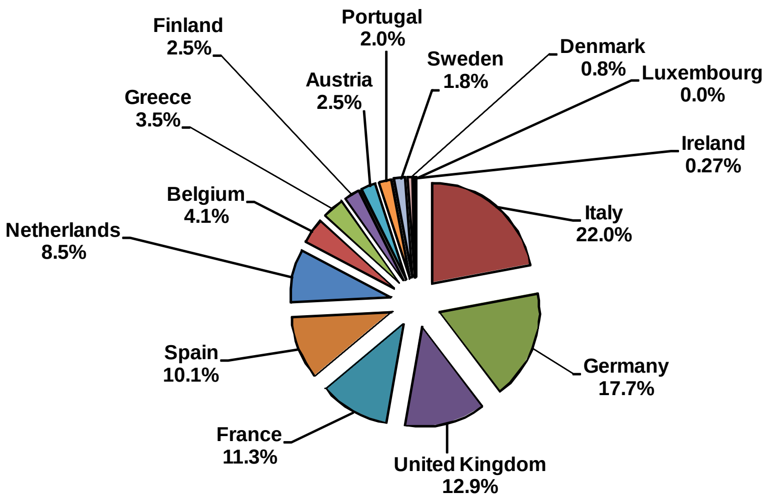



**Figure 3.17** **Member States' share of $CO_2$ emissions from petroleum refining in EU-15**




**Member States' share in EU-15 CO2 emissions from petroleum refining**

### 1A1b Petroleum Refining - Liquid Fuels ($CO_2$)

$CO_2$ emissions from the combustion of liquid fuels used for petroleum refining accounted for 90 % of all greenhouse gas emissions from petroleum refining in 2009. Emissions increased by 5 % between 1990 and 2009 (Table 3.12). Almost half of the gross increase in EU-15 emissions between 1990 and 2008 was due to Italy alone.

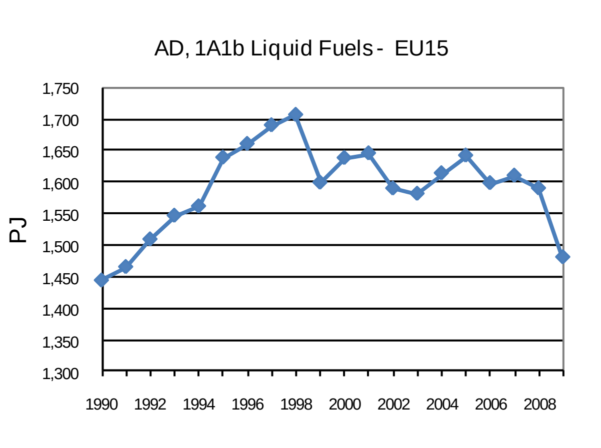
**Table 3.12 1A1b Petroleum Refining, liquid fuels: Member States' contributions to $CO_2$ emissions and information on method applied and emission factor**

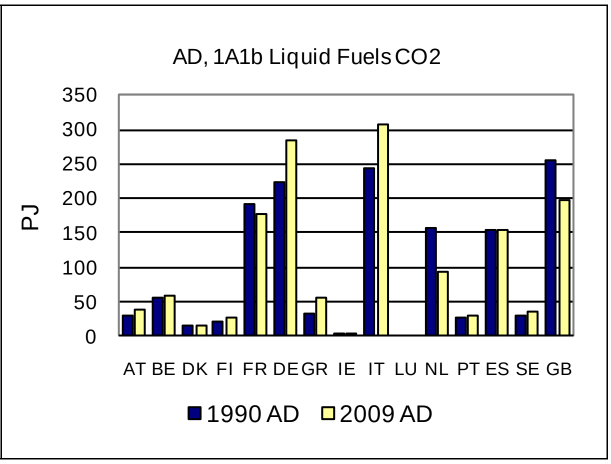
| Member State | $CO_2$ emissions in Gg | | | Share in EU15 emissions | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| Austria | 1,958 | 2,403 | 2,645 | 2.6% | 242 | 10% | 687 | 35% | T2 | PS |
| Belgium | 4,285 | 4,198 | 3,858 | 3.8% | -340 | -8% | -427 | -10% | CS,T3 | PS |
| Denmark | 906 | 926 | 933 | 0.9% | 7 | 1% | 26 | 3% | CR | CS,PS,C,D |
| Finland | 1,603 | 1,630 | 1,843 | 1.8% | 213 | 13% | 239 | 15% | T3 | CS,PS |
| France | 12,436 | 11,935 | 11,332 | 11.1% | -603 | -5% | -1,104 | -9% | CR | CS |
| Germany | 15,315 | 20,425 | 19,232 | 18.8% | -1,193 | -6% | 3,917 | 26% | CS | CS |
| Greece | 2,308 | 4,047 | 3,714 | 3.6% | -333 | -8% | 1,405 | 61% | T2 | PS |
| Ireland | 182 | 367 | 315 | 0.3% | -52 | -14% | 133 | 73% | T3 | PS |
| Italy | 16,178 | 26,148 | 23,406 | 22.9% | -2,742 | -10% | 7,229 | 45% | T3 | CS |
| Luxembourg | NO | NO | NO | - | - | - | - | - | NA | NA |
| Netherlands | 9,999 | 8,212 | 7,150 | 7.0% | -1,062 | -13% | -2,849 | -28% | T2 | CS |
| Portugal | 1,910 | 2,743 | 1,944 | 1.9% | -799 | -29% | 34 | 2% | T2 | D,CR,PS |
| Spain | 10,861 | 10,749 | 9,801 | 9.6% | -948 | -9% | -1,060 | -10% | T2 | PS,C |
| Sweden | 1,778 | 2,151 | 2,061 | 2.0% | -90 | -4% | 284 | 16% | T2 | CS |
| United Kingdom | 17,476 | 14,724 | 13,830 | 13.6% | -894 | -6% | -3,646 | -21% | T2 | CS |
| **EU-15** | **97,195** | **110,657** | **102,064** | **100.0%** | **-8,593** | **-8%** | **4,870** | **5%** | | |

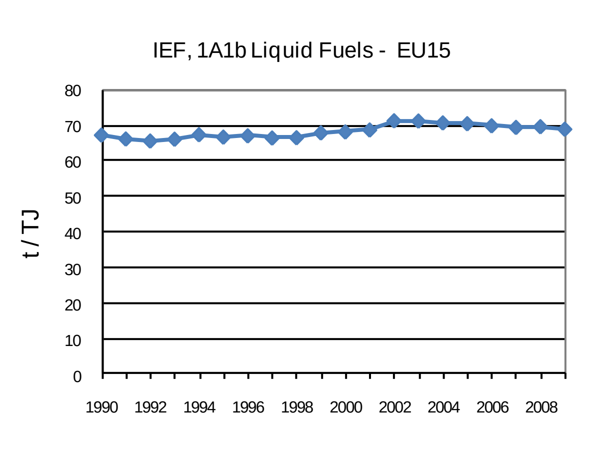
*Abbreviations explained in the Chapter 'Units and abbreviations'.*

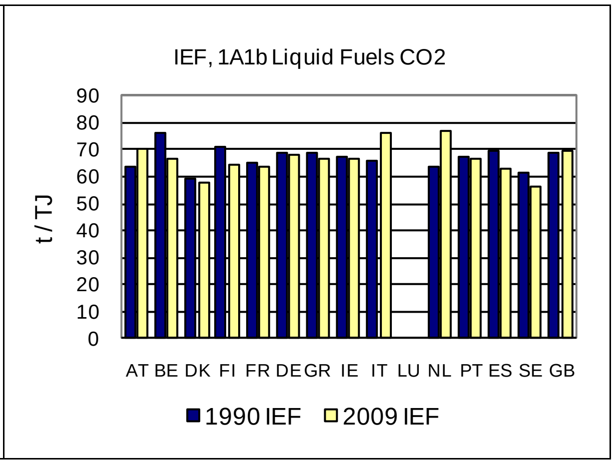
Figure 3.18 shows the activity data and implied emission factors for $CO_2$ emissions from liquid fuels. The use of liquid fuels increased rapidly from 1990 to 1998 and had a decreasing tendency thereafter. The EU-15 implied emission factor has varied between 66 t/TJ and 72 t/TJ. The increase in the EU-15 factor can be partly explained by the growing Italian share in EU-15 activity and emissions and by the increase in Italy's implied emission factor during the period. The largest emitters in 2009 were Italy and Germany, which together contributed 40 % of EU-15 emissions.

**Figure 3.18 1A1b Petroleum Refining, liquid fuels: Activity Data and Implied Emission Factors for $CO_2$**






### 1A1b Petroleum Refining - Solid Fuels ($CO_2$)

$CO_2$ emissions from the combustion of solid fuels in petroleum refining represented less than 1 % of all greenhouse gas emissions from 1A1b in 2009. There are only two countries reporting emissions in the EU-15 in 1990 and/or 2009. EU-emissions fell by 87 % on average between 1990 and 2009 (Table 3.13).

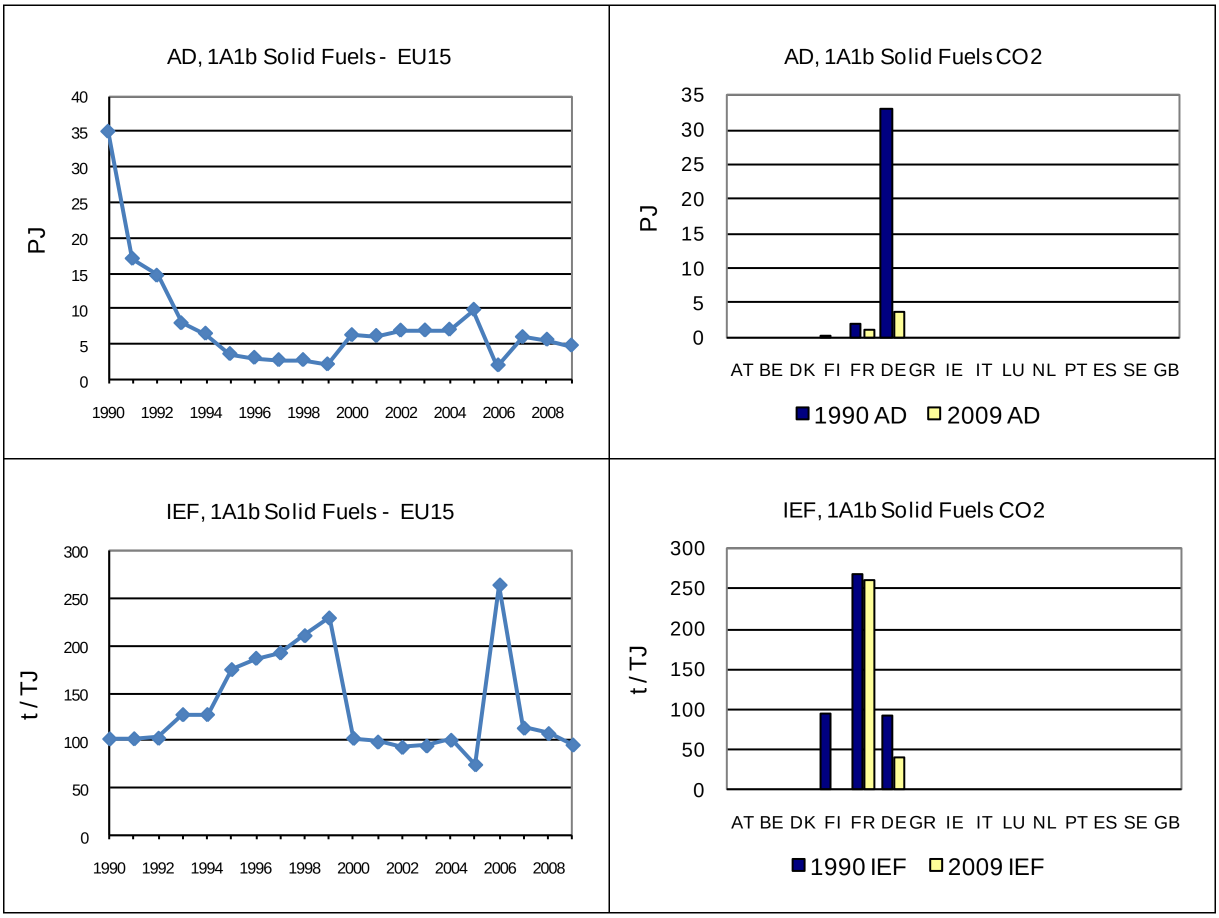
**Table 3.13 1A1b Petroleum Refining, solid fuels: Member States' contributions to $CO_2$ emissions and information on method applied and emission factor**

| Member State | $CO_2$ emissions in Gg | | | Share in EU15 emissions | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| Austria | NO | NO | NO | - | - | - | - | - | NO | NO |
| Belgium | NO | NO | NO | - | - | - | - | - | CS,T3 | PS |
| Denmark | NO | NO | NO | - | - | - | - | - | NA | NA |
| Finland | 12 | NO | NO | - | - | - | -12 | -100% | NA | NA |
| France | 492 | 445 | 313 | 68.8% | -132 | -30% | -179 | -36% | CR | CS |
| Germany | 3,076 | 155 | 142 | 31.2% | -13 | -9% | -2,934 | -95% | CS | CS |
| Greece | NO | NO | NO | - | - | - | - | - | NO | NO |
| Ireland | NO | NO | NO | - | - | - | - | - | NO | NO |
| Italy | NO | NO | NO | - | - | - | - | - | NA | NA |
| Luxembourg | NO | NO | NO | - | - | - | - | - | NA | NA |
| Netherlands | NO | NO | NO | - | - | - | - | - | NA | NA |
| Portugal | NO | NO | NO | - | - | - | - | - | T2 | D,CR,PS |
| Spain | NA | NA | NA | - | - | - | - | - | NO | NO |
| Sweden | NO | NO | NO | - | - | - | - | - | NA | NA |
| United Kingdom | NO | NO | NO | - | - | - | - | - | NA | NA |
| **EU-15** | **3,581** | **601** | **455** | **100.0%** | **-146** | **-24%** | **-3,125** | **-87%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

Figure 3.19 shows the relevant activity data and implied emission factors. The use of solid fuels in petroleum refining has declined markedly since 1990. The EU-15 implied emission factor showed strong fluctuations, and stood at 96 t/TJ in 2009. The variation in the EU-15 factor can be partly explained by the declining use of solid fuels in petroleum refining in Germany between 1990 and 1999. This explains the bigger contribution of the much higher implied emission factor of France. The relatively higher emission factor in France is due to the use of blast furnace gas in the Dunkerque refinery. In Germany, there was a decline in the IEF in the early 1990s compared to a rather stable IEF since the mid-1990s. The reason is that the use of - mainly - lignite has constantly been reduced in favour of cokery gas. The increased EU-15 solid fuel combustion in 2000-2005 and 2007-2008 is due to an increase in fuel combustion in Germany in these years. The higher weight of the German IEF also explains the lower IEF at EU-15 level during these years.

**Figure 3.19 1A1b-Petroleum Refining, solid fuels: Activity Data and Implied Emission Factors for $CO_2$**




## 1A1b Petroleum Refining - Gaseous Fuels ($CO_2$)

In 2009, $CO_2$ emissions from the combustion of gaseous fuels used for petroleum refining accounted for about 10 % of total greenhouse gas emissions from 1A1b. Emissions in the EU-15 increased by a factor of two between 1990 and 2009 (Table 3.14). Only Germany and Austria reduced their emissions.

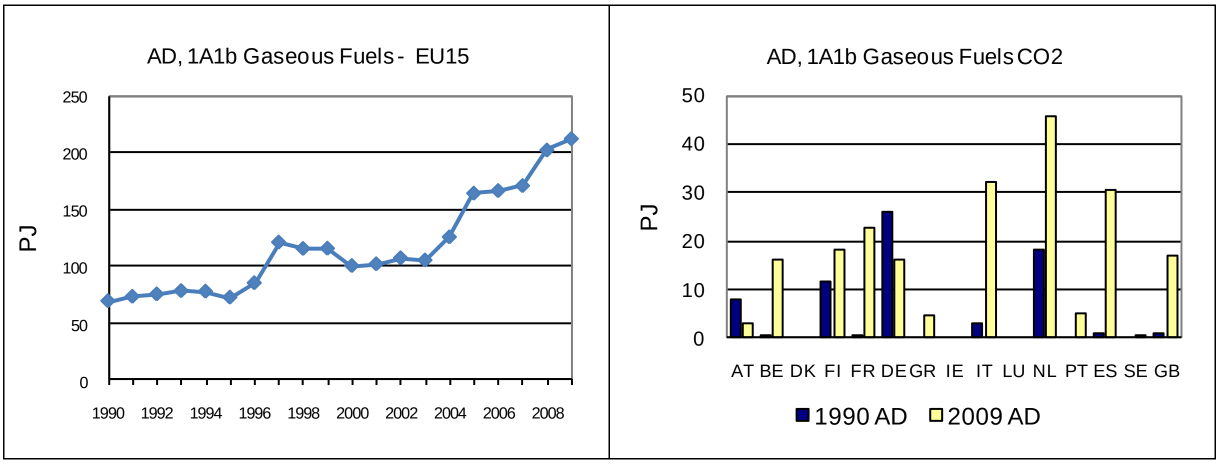
**Table 3.14** **1A1b Petroleum Refining, gaseous fuels: Member States' contributions to $CO_2$ emissions and information on method applied and emission factor**

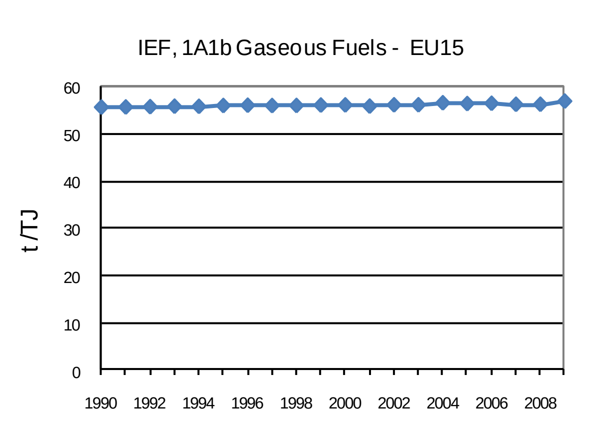
| Member State | $CO_2$ emissions in Gg | | | Share in EU15 emissions | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| Austria | 437 | 403 | 164 | 1.4% | -239 | -59% | -272 | -62% | T2 | CS,PS |
| Belgium | 14 | 432 | 900 | 7.4% | 467 | 108% | 886 | 6411% | CS,T3 | PS |
| Denmark | NO | NO | NO | - | - | - | - | - | NA | NA |
| Finland | 644 | 1,135 | 990 | 8.2% | -145 | -13% | 345 | 54% | T3 | CS |
| France | 14 | 1,283 | 1,301 | 10.8% | 18 | 1% | 1,287 | 9071% | CR | CS |
| Germany | 1,441 | 992 | 896 | 7.4% | -96 | -10% | -545 | -38% | CS | CS |
| Greece | NO | 210 | 266 | 2.2% | 56 | 27% | 266 | - | T2 | PS |
| Ireland | NO | NO | NO | - | - | - | - | - | NO | NO |
| Italy | 159 | 1,308 | 1,845 | 15.3% | 537 | 41% | 1,686 | 1058% | T3 | CS |
| Luxembourg | NO | NO | NO | - | - | - | - | - | NA | NA |
| Netherlands | 1,042 | 2,723 | 2,591 | 21.4% | -132 | -5% | 1,549 | 149% | T2 | CS |
| Portugal | NO | 122 | 296 | 2.4% | 173 | - | 296 | - | T2 | D,CR,PS |
| Spain | 45 | 1,679 | 1,836 | 15.2% | 156 | 9% | 1,790 | 3971% | T2 | PS,CS |
| Sweden | NO | 42 | 31 | 0.3% | -11 | -26% | 31 | - | T2 | CS |
| United Kingdom | 49 | 1,065 | 983 | 8.1% | -83 | -8% | 933 | 1888% | T2 | CS |
| **EU-15** | **3,846** | **11,395** | **12,098** | **100.0%** | **703** | **6%** | **8,252** | **215%** | | |

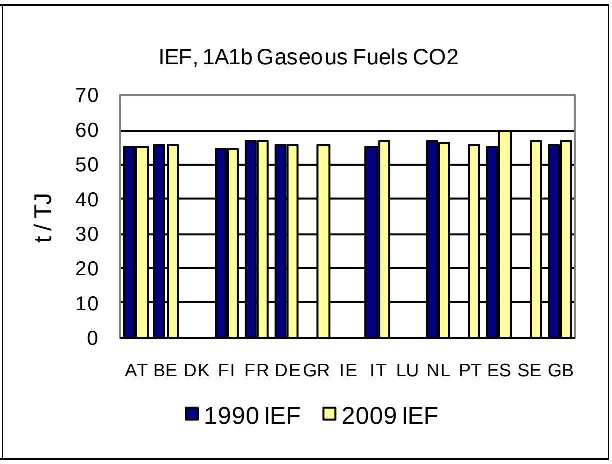
*Abbreviations explained in the Chapter 'Units and abbreviations'*

Figure 3.20 shows the activity data and implied emission factors for $CO_2$ emissions from gaseous fuels. The use of gaseous fuels increased by a factor of two between 1990 and 2009. The EU-15 implied emission factor has remained broadly stable, standing at 57 t/TJ in 2009. The largest emitter in 2009 was the Netherlands with 21 % of all EU-15 emissions, followed by Italy and Spain.

**Figure 3.20** **1A1b Petroleum Refining, gaseous fuels: Activity Data and Implied Emission Factors for $CO_2$**






### 3.2.1.3 Manufacture of Solid Fuels and Other Energy Industries (1A1c) (EU-15)

According to the IPCC, the manufacture of solid fuels and other energy industries includes combustion emissions from fuel use during the manufacture of secondary and tertiary products from solid fuels including production of charcoal. It comprises combustion emissions from the production of coke, brown coal briquettes and patent fuel. It can also cover the emissions from own-energy use in coal mining and gas extraction. Emissions from own on-site fuel use should be included.

$CO_2$ emissions from the manufacture of solid fuels accounted for 2.78 % of total greenhouse gas emissions in 2009. Between 1990 and 2009, $CO_2$ emissions fell by 54 % in the EU-15 (Table 3.15). Emissions from solid fuels fell gradually during the 1990s, but remained stable since 2000.

**Table 3.15 1A1c Manufacture of Solid Fuels and Other Energy Industries: Member States' contributions to $CO_2$ emissions**

| Member State | $CO_2$ emissions in Gg | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | |
|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) |
| Austria | 510 | 528 | 513 | 1.1% | -14 | -3% | 3 | 1% |
| Belgium | 2,023 | 282 | 211 | 0.4% | -71 | -25% | -1,812 | -90% |
| Denmark | 527 | 1,614 | 1,542 | 3.2% | -72 | -4% | 1,014 | 192% |
| Finland | 347 | 334 | 188 | 0.4% | -147 | -44% | -160 | -46% |
| France | 4,828 | 3,630 | 3,329 | 6.9% | -301 | -8% | -1,499 | -31% |
| Germany | 64,394 | 15,573 | 13,030 | 27.2% | -2,543 | -16% | -51,364 | -80% |
| Greece | 102 | 89 | 86 | 0.2% | -3 | -3% | -16 | -16% |
| Ireland | 100 | 124 | 145 | 0.3% | 21 | 17% | 45 | 45% |
| Italy | 13,030 | 15,437 | 9,230 | 19.3% | -6,207 | -40% | -3,800 | -29% |
| Luxembourg | NO | NO | NO | - | - | - | - | - |
| Netherlands | 1,528 | 1,897 | 1,937 | 4.0% | 39 | 2% | 409 | 27% |
| Portugal | 75 | NO | NO | 0.0% | - | - | -75 | -100% |
| Spain | 2,117 | 1,958 | 2,368 | 4.9% | 410 | 21% | 251 | 12% |
| Sweden | 299 | 315 | 254 | 0.5% | -61 | -19% | -45 | -15% |
| United Kingdom | 13,653 | 16,271 | 15,095 | 31.5% | -1,176 | -7% | 1,442 | 11% |
| **EU-15** | **103,534** | **58,053** | **47,928** | **100.0%** | **-10,125** | **-17%** | **-55,605** | **-54%** |

Figure 3.21 shows the trends in emissions from this source category by fuel in the EU-15 between 1990 and 2009. About 90 % of greenhouse gas emissions from the manufacture of solid fuels can be accounted for by $CO_2$ emissions from solid (40 %) and gaseous (33 %) fuels. The figure also shows the activity data behind the emissions.

Fuel used for manufacturing solid fuels fell by 19 % in the EU-15 between 1990 and 2009. In 2009, solid fuels represented 19 % of all fuel use, whereas gaseous fuels took a share of 78%.

**Figure 3.21** **1A1c-Manufacture of Solid Fuels and Other Energy Industries: Total and $CO_2$ emission and activity trends**

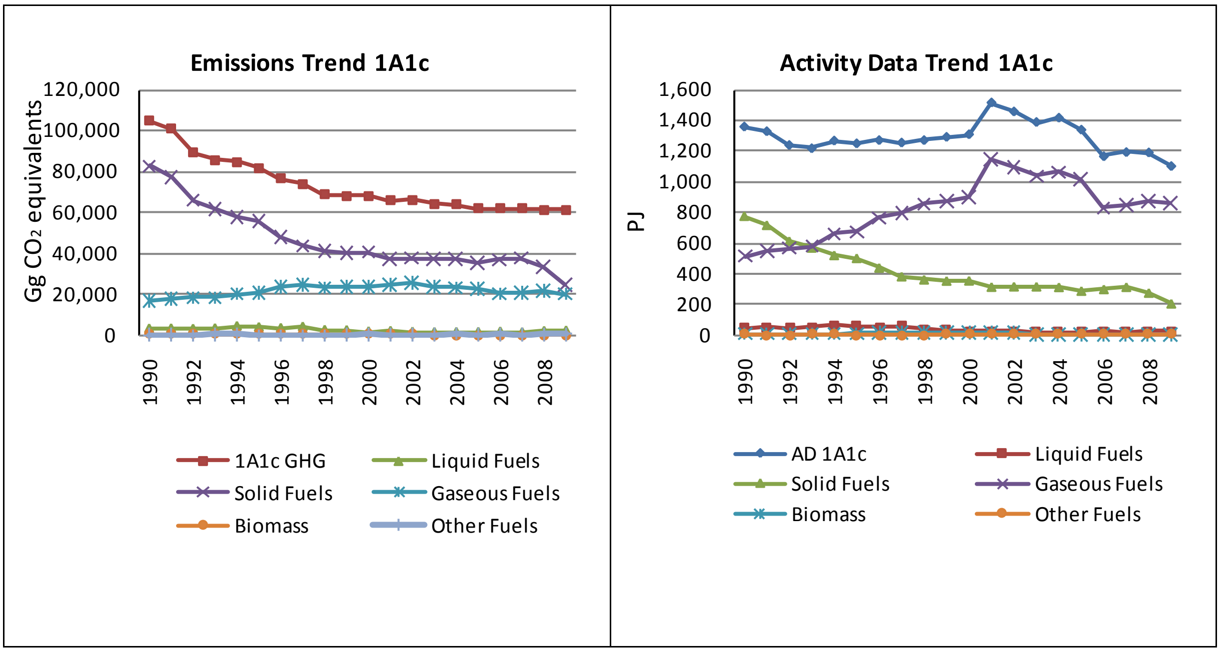



Figure 3.22 shows the relative importance of $CO_2$ emissions from the manufacture of solid fuels in total greenhouse gas emissions by Member State. The country shares range from the highest in the UKto the lowest in Greece (Luxembourg and Portugal do not have emissions from this key source category). Figure 3.23 shows the absolute contributions to EU-15 $CO_2$ emissions from the manufacture of solid fuels. Italy, Germany and the UK take about 80 % of all EU-15 emissions.

**Figure 3.22 Share of $CO_2$ emissions from the manufacture of solid fuels in total greenhouse gas emissions by Member State in 2009**

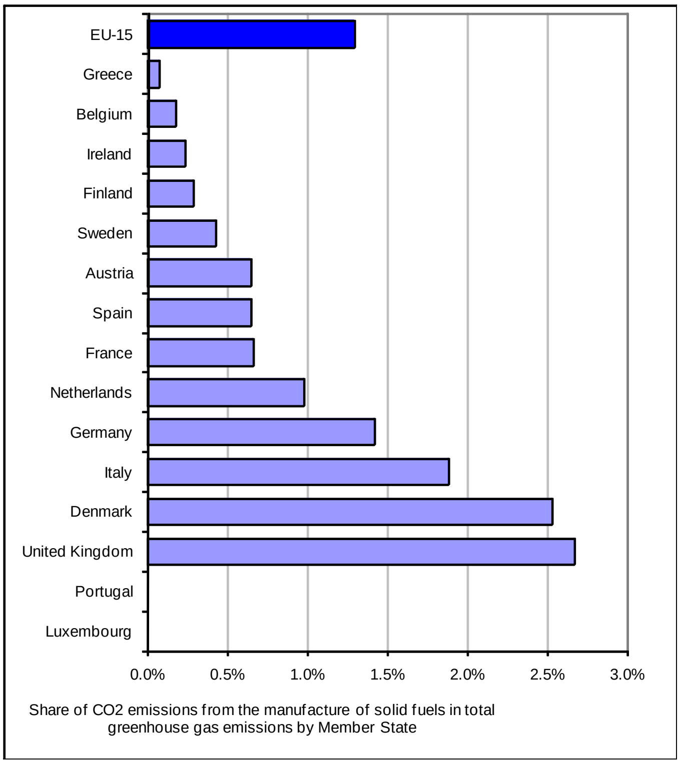
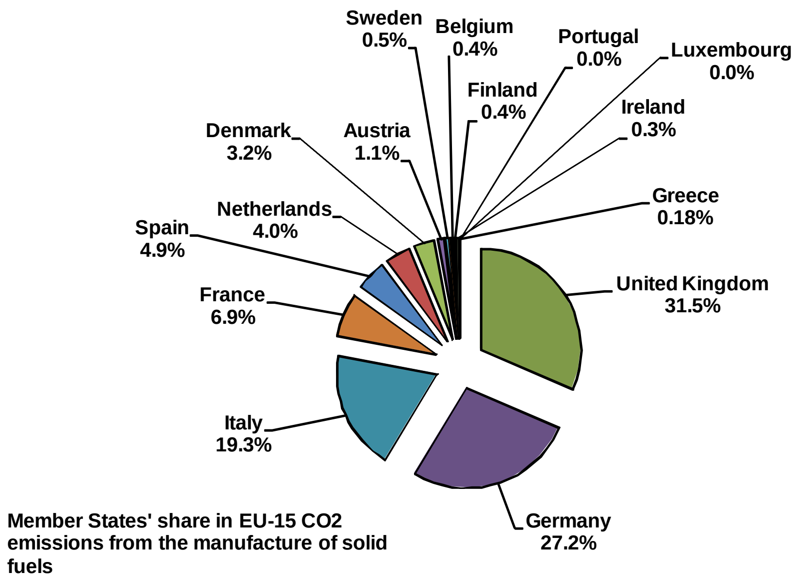



**Figure 3.23 Member States' share of $CO_2$ emissions from the manufacture of solid fuels in EU-15**



### 1A1c Manufacture of Solid Fuels and Other Energy Industries – Gaseous Fuels ($CO_2$)

$CO_2$ emissions from the combustion of gaseous fuels used for manufacturing solid fuels accounted for 51 % of total greenhouse gas emissions from 1A1c in 2009. Emissions in the EU-15 increased steadily by 20 % (Table 3.16) since 1990, although there has been a significant reduction in the last few years. About 53 % of the gross increase in EU-15 emissions between 1990 and 2009 was due to the UK alone.

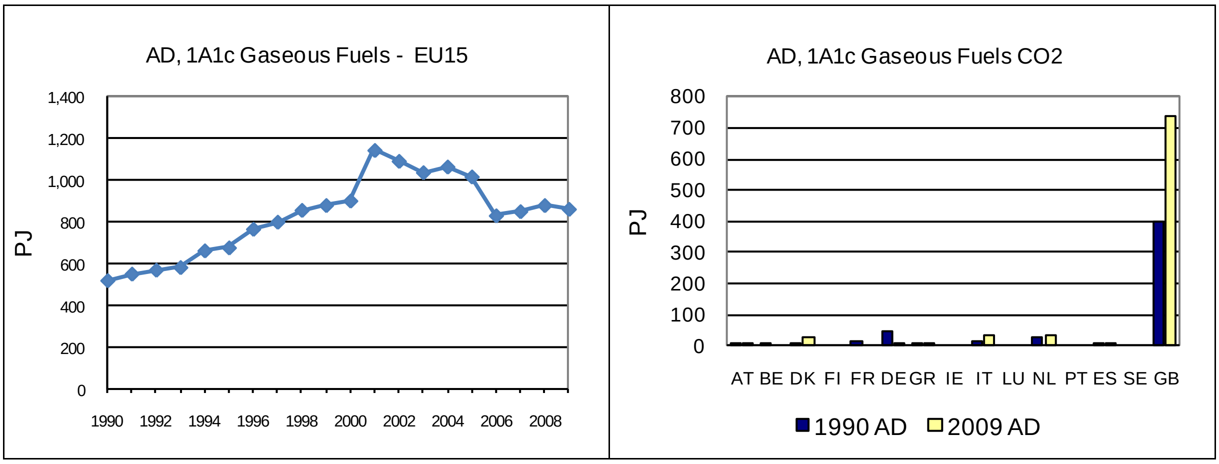
**Table 3.16 1A1c Manufacture of Solid Fuels and Other Energy Industries, gaseous fuels: Member States' contributions to $CO_2$ emissions and information on method applied and emission factor**

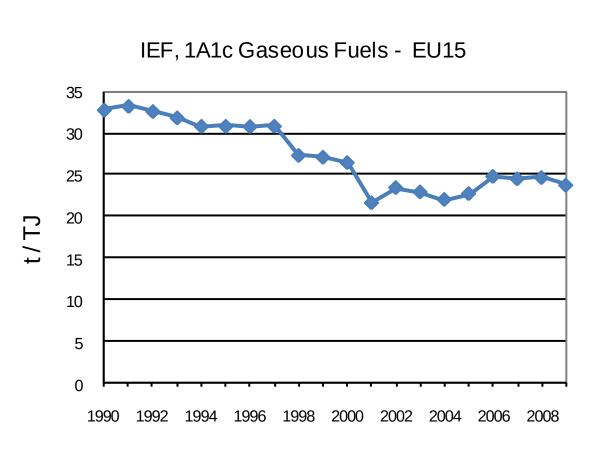
| Member State | $CO_2$ emissions in Gg | | | Share in EU15 emissions | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| Austria | 506 | 528 | 513 | 2.5% | -14 | -3% | 7 | 1% | T2 | CS |
| Belgium | 3 | 1 | NO | - | -1 | -100% | -3 | -100% | CS,T3 | PS |
| Denmark | 527 | 1,614 | 1,542 | 7.6% | -72 | -4% | 1,014 | 192% | CR | CS |
| Finland | NO | NO | NO | - | - | - | - | - | NA | NA |
| France | 654 | 0 | NO | - | - | - | -654 | - | CR | CS |
| Germany | 2,501 | 643 | 564 | 2.8% | -79 | -12% | -1,937 | -77% | CS | CS |
| Greece | 102 | 89 | 86 | 0.4% | -3 | -3% | -16 | -16% | T2 | PS |
| Ireland | NO | NO | NO | - | - | - | - | - | NO | NO |
| Italy | 615 | 2,145 | 2,018 | 9.9% | -127 | -6% | 1,403 | 228% | T3 | CS |
| Luxembourg | NO | NO | NO | - | - | - | - | - | NA | NA |
| Netherlands | 1,526 | 1,897 | 1,936 | 9.5% | 40 | 2% | 410 | 27% | T2 | CS |
| Portugal | NO | NO | NO | - | - | - | - | - | T2 | D,CR,PS |
| Spain | 213 | 232 | 229 | 1.1% | -3 | -1% | 17 | 8% | T2 | CS |
| Sweden | NO | NO | NO | - | - | - | - | - | NA | NA |
| United Kingdom | 10,320 | 14,504 | 13,519 | 66.2% | -985 | -7% | 3,199 | 31% | T2 | CS |
| **EU-15** | **16,968** | **21,651** | **20,408** | **100.0%** | **-1,243** | **-6%** | **3,440** | **20%** | | |

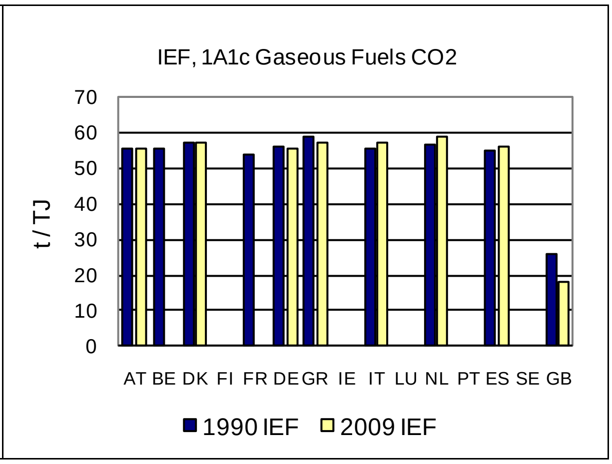
*Abbreviations explained in the Chapter 'Units and abbreviations'.*

Figure 3.24 shows the activity data and implied emission factors for $CO_2$. The use of gaseous fuels increased by 66 % between 1990 and 2009. The EU-15 implied emission factor has declined gradually since 1990. This was mainly due to a comprehensive review of emissions from the offshore oil & gas industry in the UK, which dominates the trend in emissions from this source category.

**Figure 3.24 1A1c Manufacture of Solid Fuels and Other Energy Industries, gaseous fuels: Activity Data and Implied Emission Factors for $CO_2$**






### 1A1c Manufacture of Solid Fuels and Other Energy Industries – Solid Fuels ($CO_2$)

$CO_2$ emissions from the combustion of solid fuels used for the manufacture of solid fuels accounted for 40 % of total greenhouse gas emissions from 1A1c in 2009. Emissions in the EU-15 declined by 70%, mainly during the 1990s (Table 3.17). This was almost-entirely due to a strong decline in emissions in Germany.

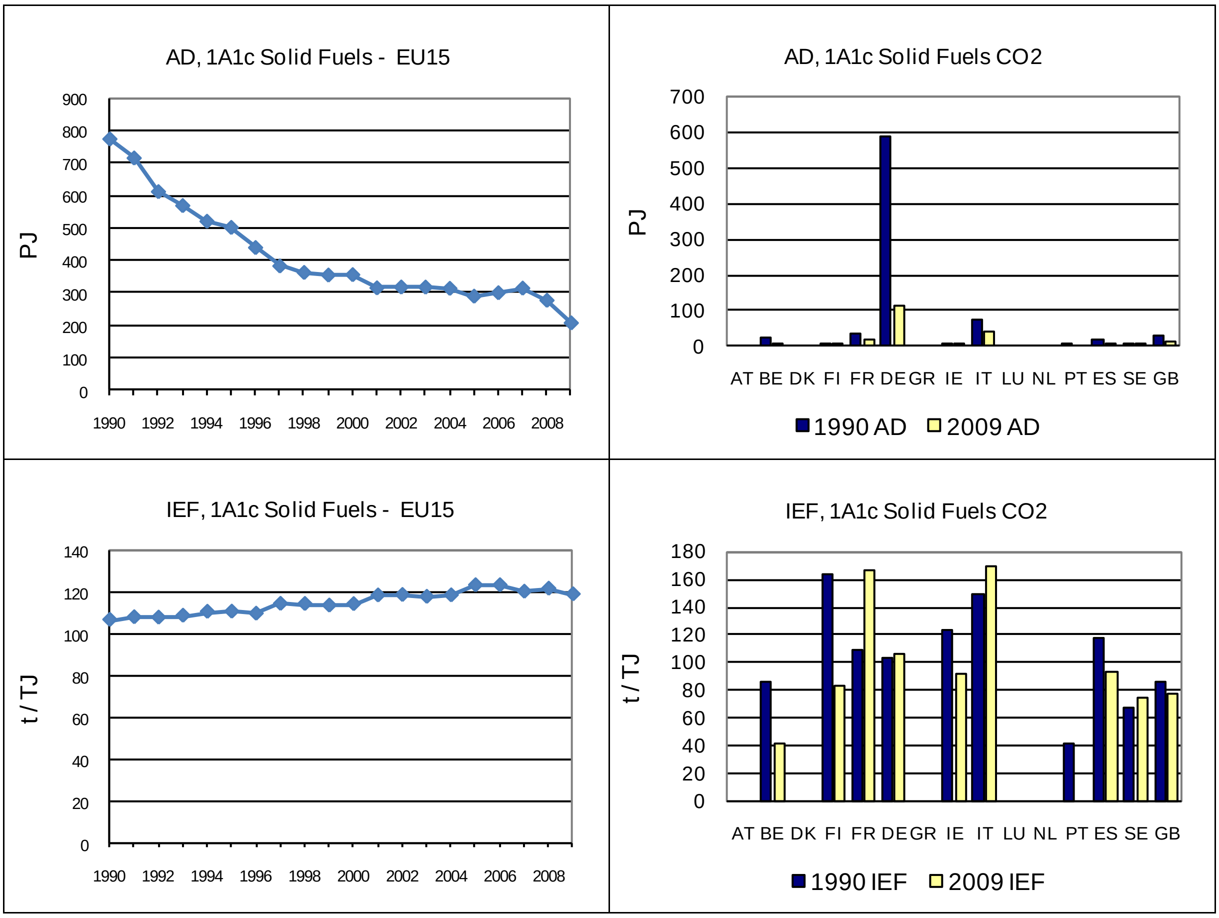
**Table 3.17 1A1c Manufacture of Solid Fuels and Other Energy Industries, solid fuels: Member States' contributions to $CO_2$ emissions and information on method applied and emission factor**

| Member State | $CO_2$ emissions in Gg | | | Share in EU15 emissions | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| Austria | NO | NO | NO | - | - | - | - | - | IE | IE |
| Belgium | 2,016 | 282 | 211 | 0.9% | -71 | -25% | -1,805 | -90% | CS,T3 | PS |
| Denmark | NO | NO | NO | - | - | - | - | - | NA | NA |
| Finland | 347 | 334 | 188 | 0.8% | -147 | -44% | -160 | -46% | T3 | CS |
| France | 4,034 | 3,215 | 2,986 | 12.1% | -229 | -7% | -1,048 | -26% | CR | CS |
| Germany | 60,327 | 14,542 | 12,068 | 48.9% | -2,474 | -17% | -48,259 | -80% | CS | CS |
| Greece | NO | NO | NO | - | - | - | - | - | NO | NO |
| Ireland | 100 | 124 | 145 | 0.6% | 21 | 17% | 45 | 45% | T1 | CS |
| Italy | 11,473 | 12,648 | 6,883 | 27.9% | -5,765 | -46% | -4,590 | -40% | T3 | CS |
| Luxembourg | NO | NO | NO | - | - | - | - | - | NA | NA |
| Netherlands | IE | NO | NO | - | - | - | - | - | NA | NA |
| Portugal | 25 | NO | NO | - | 0 | - | -25 | -100% | T2 | D,CR,PS |
| Spain | 1,847 | 938 | 808 | 3.3% | -130 | -14% | -1,040 | -56% | T2 | PS,CS |
| Sweden | 298 | 314 | 251 | 1.0% | -63 | -20% | -47 | -16% | T2 | CS |
| United Kingdom | 2,326 | 1,342 | 1,141 | 4.6% | -201 | -15% | -1,185 | -51% | T2 | CS |
| **EU-15** | **82,793** | **33,738** | **24,680** | **100.0%** | **-9,057** | **-27%** | **-58,113** | **-70%** | | |

*Emissions of the Netherlands are included in 1A2.A*
*Abbreviations explained in the Chapter 'Units and abbreviations'.*

Figure 3.25 shows the relevant activity data and implied emission factors. Solid fuels have fallen steadily to less than half of the 1990-level. The EU-15 implied emission factor has increased to reach 119 t/TJ in 2009. This increase is mainly due to a decline in the German share in EU-15 emissions and a parallel increase in the share of Italy, which has a significantly higher implied emission factor. The largest emitters in 2009 were Italy and Germany, jointly responsible for almost 80 % of all EU-15 emissions.

**Figure 3.25** **1A1c Manufacture of Solid Fuels and Other Energy Industries, solid fuels: Activity Data and Implied Emission Factors for $CO_2$**




### *3.2.2 Manufacturing industries and construction (CRF Source Category 1A2)*

Category 1A2 includes emissions from combustion of fuels in manufacturing industries and construction including fuel use of non public electricity and heat generation (autoproducers). According to the guidelines emissions from fuel combustion in coke ovens are reported under 1A1c except for Austria and the Netherlands, which report on site coke ovens of integrated iron and steel plants under category 1A2a. Some MS report emissions of blast furnace and coke oven gas combustion under categories 1A1a public electricity and heat production or 1A4 other sectors. Emissions from category 1A2 are specified by the sum of subsectors that correspond to the International Standard Industrial Classification of All Economic Activities (ISIC, see listing below). Emissions from transport used by industry are reported under category 1A3 Transport. Most MS report emissions arising from off-road and other mobile machinery used in industry (e.g. construction machinery) under category 1A2f. Emissions from non energy fuel use (e.g. reducing agents used in blast furnaces or natural gas used for ammonia production) are reported under category 2 Industrial Processes.

The following enumeration shows the correspondence of 1A2 sub categories and ISIC codes:

- 1 A 2 a Iron and Steel: ISIC Group 271 and Class 2731.
- 1 A 2 b Non-Ferrous Metals: ISIC Group 272 and Class 2732.
- 1 A 2 c Chemicals: ISIC Division 24.
- 1 A 2 d Pulp, Paper and Print: ISIC Divisions 21 and 22
- 1 A 2 e Food Processing, Beverages and Tobacco: ISIC Divisions 15 and 16.
- 1 A 2 f Other: Remaining emissions from fuel combustion in manufacturing industry.

In 2009 category 1A2 contributed to 453,142 Gg $CO_2$ equivalents of which 98.5% $CO_2$, 1.2% $N_2O$ and 0.3% $CH_4$.

Figure 3.26 shows the emission trends within source category 1A2, which is mainly dominated by $CO_2$ from 1A2f Other contributing by 58% and 1A2a Iron and steel by 15%. Some Member States still have difficulties to allocate emissions to all sub-categories under 1A2, which is a main reason for 1A2f being the largest sub-category within 1A2 source category.

**Figure 3.26 1A2 Manufacturing Industries and Construction: Total and $CO_2$ emission trends**

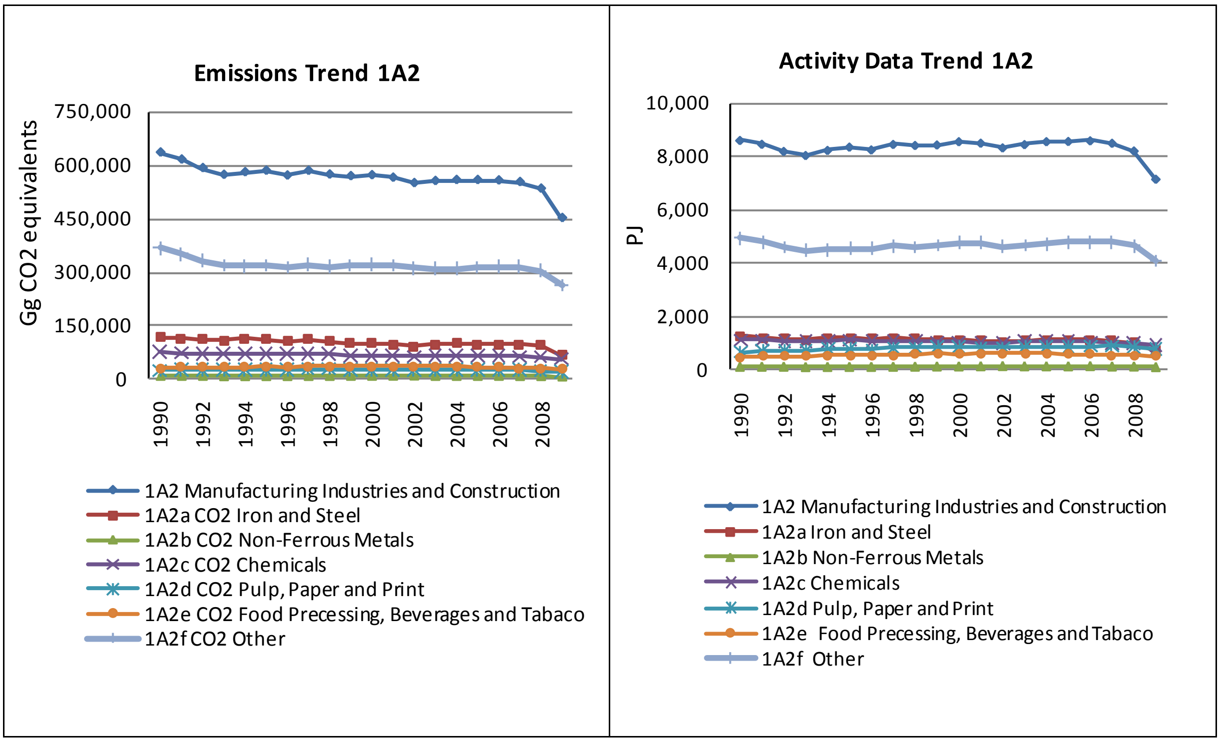



Table 3.18 summarises information by Member State on GHG emission trends and $CO_2$ emissions from 1A2 Manufacturing Industries and Construction.

**Table 3.18** **1A2 Manufacturing Industries and Construction: Member States' contributions to total GHG and $CO_2$ emissions**

| Member State | GHG emissions in 1990 (Gg $CO_2$ equivalents) | GHG emissions in 2009 (Gg $CO_2$ equivalents) | $CO_2$ emissions in 1990 (Gg) | CO2 emissions in 2009 (Gg) |
|---|---|---|---|---|
| Austria | 12,769 | 14,433 | 12,682 | 14,270 |
| Belgium | 32,370 | 19,385 | 32,231 | 19,239 |
| Denmark | 5,472 | 3,960 | 5,412 | 3,915 |
| Finland | 13,357 | 8,323 | 13,172 | 8,189 |
| France | 83,229 | 63,658 | 82,224 | 62,748 |
| Germany | 177,284 | 102,698 | 175,635 | 101,804 |
| Greece | 9,619 | 7,461 | 9,566 | 7,412 |
| Ireland | 3,962 | 4,548 | 3,943 | 4,525 |
| Italy | 88,152 | 57,754 | 86,480 | 56,433 |
| Luxembourg | 6,298 | 1,157 | 6,278 | 1,144 |
| Netherlands | 33,117 | 25,027 | 33,027 | 24,941 |
| Portugal | 9,259 | 8,428 | 9,153 | 8,279 |
| Spain | 46,777 | 58,844 | 46,279 | 57,759 |
| Sweden | 12,271 | 8,743 | 11,698 | 8,237 |
| United Kingdom | 101,893 | 68,724 | 99,942 | 67,392 |
| **EU-15** | **635,828** | **453,142** | **627,723** | **446,286** |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

$CO_2$ emissions from 1A2 Manufacturing Industries and Construction is the fourth largest key source in the EU-15 accounting for 12 % of total GHG emissions in 2009. Between 1990 and 2009, $CO_2$ emissions from manufacturing industries declined by 29 % in the EU-15. The emissions from this key source are due to fossil fuel consumption in manufacturing industries and construction, which was 29 % below 1990 levels in 2009. A shift from solid and liquid fuels to mainly natural gas took place and an increase of biomass and other fuels has been recorded.

Between 1990 and 2009, Germany shows by far the largest emission reductions in absolute terms. Also United Kingdom, France and Italy show emission reductions of more than ten million tonnes $CO_2$, whereas large emission increases occurred mainly in Spain. The main reason for the large decline in Germany was the restructuring of the industry and efficiency improvements after German reunification. Between 2008 and 2009 GHG emissions decrease by 15% with 1A2a iron and steel showing the strongest decline of -28% from all sub categories. Between 2008 and 2009 crude steel production of the EU-15 shows a decline by 30%24.

Table 3.19 provides information on the contribution of Member States to EU-15 recalculations in $CO_2$ from 1A2 Manufacturing Industries for 1990 and 2009 and main explanations for the largest recalculations in absolute terms. The biggest recalculations in 2009 were due to reallocations of $CO_2$ emissions of Germany. France and the UK revised their data sets and improved the methods.

24 Steel statistical yearbook 2010, worldsteel association, Brussels 2010.

**Table 3.19 1A2 Manufacturing Industries and Construction: Contribution of MS to EU-15 recalculations in $CO_2$ for 1990 and 2009 (difference between latest submission and previous submission in Gg of $CO_2$ equivalents and percent)**

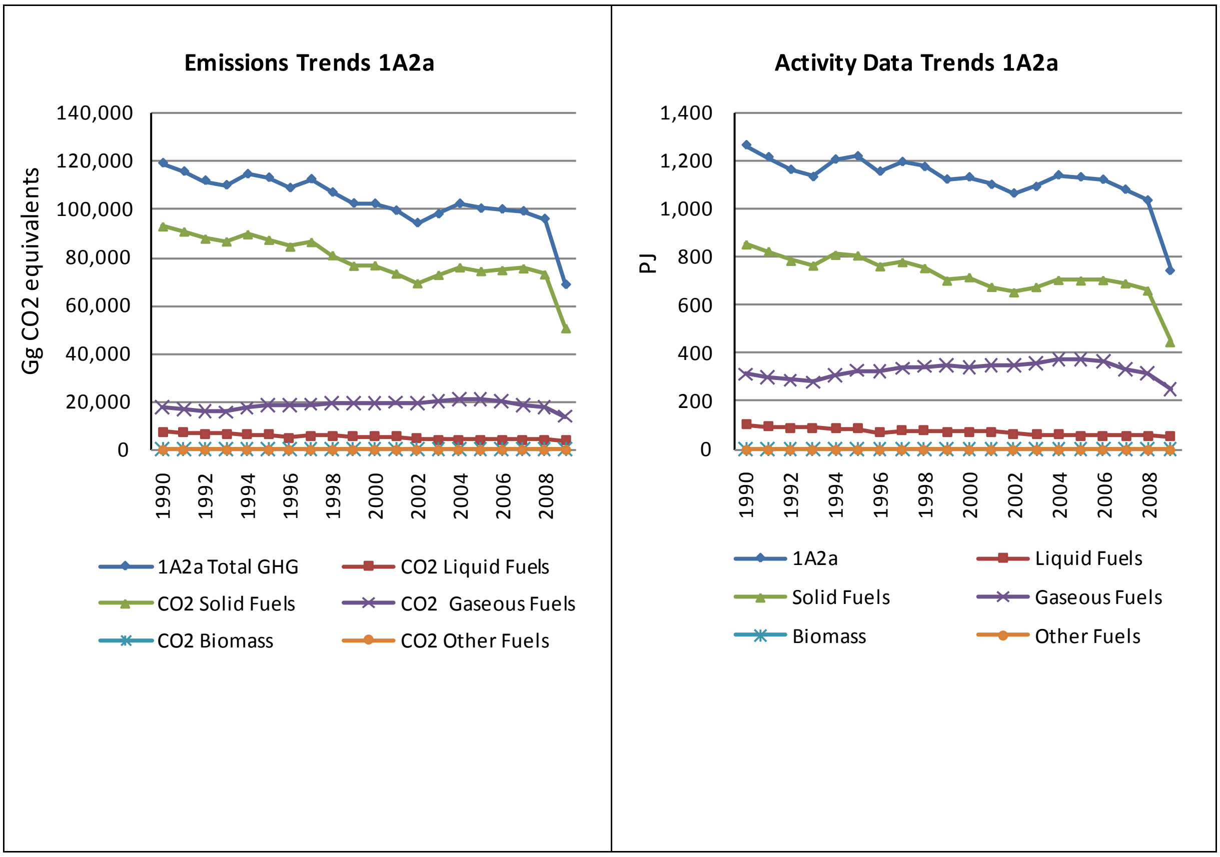
| | 1990 | | 2008 | | Main explanations |
|---|---|---|---|---|---|
| | Gg | Percent | Gg | Percent | |
| Austria | -3 | 0.0 | -182 | -1.1 | Revision of energy balance |
| Belgium | -787 | -2.4 | 980 | 3.7 | new methodology used for the calculation of emissions of CO2 in the iron and steel sector in the Flemish region. In the sector 1A2a emissions of cokesgrit are added for the complete timeseries and emissions of anthracite from 2005 on. |
| Denmark | -12 | -0.2 | -295 | -5.7 | The emission factor time-series for coal and residual oil have been improved based on EU ETS data. In addition emission factors for LPG, kerosene, refinery gas and natural gas applied in off-shore gas turbines have also been updated. Discussed in detail in NIR chapter 3.2.5. |
| Finland | 0 | 0.0 | 1 | 0.0 | New sources added (plants from ETS data). |
| France | -3,083 | -3.6 | -2,394 | -3.3 | Data consumption for the auto-production in industry have been corrected since 1990 due to a revision of data by SOes (french energy statistics) has been made. |
| Germany | 21,152 | 13.7 | 23,011 | 24.3 | - Reallocation of CO2 emissions from blast furnace gas combustion in sinter plants and rolling mills from source catagory 2C1 to source catagory 1A2a.<br>- new available data from national statistics |
| Greece | -159 | -1.6 | -52 | -0.6 | Updated AD. Alternative fuels (tires, etc) used in cement plants were reallocated to other fuels |
| Ireland | 3 | 0.1 | 161 | 2.9 | Revised allocation for fuels in energy balance for years 2005 to 2008. New fuel (non-renewable waste) in Submission 2011. |
| Italy | -49 | -0.1 | -19 | 0.0 | steam coal and natural gas emission factor update |
| Luxembourg | 1,115 | 21.6 | -187 | -11.6 | - An electicity producing plant (autoproducer) of the iron and steel industry allocated to 1A1a was reallocated to 1A2a, as recommended in ARR 2009 59. This plant used liquid, solid and gaseous fuels and operated from 1990-1997. From 1990-1995, there were no other plants producing electricity and using liquid fuels.<br>- Activity data was revised due to new energy statistics from National Statistics (STATEC), and due to the application of national densities and NCVs, which are now streamlined with STATEC. |
| Netherlands | 374 | 1.1 | 44 | 0.2 | improved final AD; reallocation from 1.A.4 to 1A2 for non-road |
| Portugal | -4 | 0.0 | -450 | -4.5 | - Fuel consumption from Lime Production was removed from the Cement Industry due to the fact that emission associated to combustion are now being estimated from direct measurement made in Lime production plants (1990-2009). Emission associated with combustion in this sector are now reporter with production in 2.A.2<br>- Revision of the teP/ton convertion factor for heating gas oil following recommendation given by DGEG's experts.<br>- Double counting rectification in several industrial sectors resulting from |
| Spain | 89 | 0.2 | -326 | -0.5 | - Activity included (fuel consumption) in the revision of the inventory fuel balance.<br>- For electric steel plants, the amount of natural gas that was allocated to processes (category 2.C.1) in the previous inventory edition has been reallocated to category 1.A.2.a (Combustion in iron and steel industries) |
| Sweden | -18 | -0.2 | -250 | -2.5 | Reallocation of some natural gas consumption to CRF 1.AD. Revised acitivity data for the construction sector. |
| UK | 1,050 | 1.1 | 2,818 | 3.7 | - Method of calculating activity data in lime production reviewed and improved. Also causes reallocation of petcoke and gas and coal and coke in other industry. Method improvement in cement industry affects activity data of lubricants<br>- National energy stats changes affected EFs for coal coke coke over gas and BF gas as based on reported emissions. EU ETS EFs now used from 2005 for Colliery methane and from 2008 for OPG and pet coke. Earlier years interpolated.<br>- Other industry timeseries affected by reallocation of burning oil and fuel oil and gas oil to the crown dependancies. Other activity data affected from 2005 onwards by changes to national energy statistics. |
| **EU-15** | **19,669** | **3.2** | **22,862** | **4.5** | |

### 3.2.2.1 Iron and Steel (1A2a) (EU-15)

This chapter provides information about emission trends, Member States contribution, activity data and emission factors for category 1A2a on a fuel base. $CO_2$ emissions from 1A2a Iron and Steel accounted for 15 % of 1A2 source category and 1.8 % of total GHG emissions in 2009.

Figure 3.27 shows the emission trend within the category 1A2a, which is mainly dominated by $CO_2$ emissions from solid fuels. Between 1990 to 2008 total emissions decreased by 19 %, mainly due to improved efficiency of restructured iron and steel plants and the increased share of gaseous fuels. The strong decline of 28% between 2008 and 2009 correlates with crude steel production which was 30% less in 2009. Between 1990 and 2008 emissions from solid fuels decreased by 46 % and from liquid fuels by 47 %. As follow up increasing emissions were reported for gaseous fuels (+3 %) until 2008. Some Member States report emissions from blast furnace gas under categories 1A1a or other subcategories of 1A2 where it is used for energy recovery in the respective industrial branches. Emissions from coke ovens of integrated iron and steel plants are sometimes not reported in the respective category 1A1c but included in this category. Emissions from blast furnace and coke oven gas flaring without energy recovery are partly reported under category 1B1b. The methodology of splitting emissions from blast furnaces into energy related and process related emissions reported under category 2C1 does not follow a specific standard. E.g. Germany reports 44% of total $CO_2$ emissions from categories 1A2a and 2C1 under this category and France reports 83% in 2009. However, the main driver of category 1A2a $CO_2$ emissions is blast furnace iron (BFI) production which decreased from about 99 mio tonnes to 91 mio tonnes in 2008 (www.worldsteel.org statistics) whereas total steel production increased since 1990 from about 149 mio tonnes to 167 mio tonnes in 2008 (www.worldsteel.org statistics) and fell down to 117 mio t in the year 2009.

**Figure 3.27 1A2a Iron and Steel: Total, $CO_2$ and $N_2O$ emission and activity trends**



Between 1990 and 2008, $CO_2$ emissions from 1A2a Iron and Steel decreased by 19 % in the EU-15 (Table 3.20), mainly due to decreases in Belgium, France, Italy and the United Kingdom. Between 2008 and 2009 emissions decreased by another 28%.

**Table 3.20 1A2a Iron and Steel: Member States' contributions to $CO_2$ emissions**

| Member State | $CO_2$ emissions in Gg | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | |
|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) |
| Austria | 4,944 | 6,202 | 5,218 | 7.6% | -985 | -16% | 273 | 6% |
| Belgium | 13,426 | 10,401 | 4,067 | 5.9% | -6,334 | -61% | -9,359 | -70% |
| Denmark | 118 | 97 | 89 | 0.1% | -8 | -9% | -29 | -25% |
| Finland | 2,494 | 3,259 | 2,296 | 3.4% | -963 | -30% | -198 | -8% |
| France | 18,260 | 14,364 | 10,685 | 15.6% | -3,679 | -26% | -7,575 | -41% |
| Germany | 15,582 | 15,257 | 11,564 | 16.9% | -3,692 | -24% | -4,017 | -26% |
| Greece | 475 | 189 | 160 | 0.2% | -30 | -16% | -316 | -66% |
| Ireland | 175 | 2 | 2 | 0.0% | 0 | 0% | -173 | -99% |
| Italy | 18,272 | 13,192 | 8,551 | 12.5% | -4,641 | -35% | -9,721 | -53% |
| Luxembourg | 5,418 | 497 | 326 | 0.5% | -171 | -34% | -5,092 | -94% |
| Netherlands | 4,011 | 4,808 | 4,075 | 6.0% | -732 | -15% | 65 | 2% |
| Portugal | 623 | 173 | 139 | 0.2% | -34 | -20% | -484 | -78% |
| Spain | 8,535 | 6,696 | 5,689 | 8.3% | -1,007 | -15% | -2,846 | -33% |
| Sweden | 1,638 | 2,088 | 1,123 | 1.6% | -966 | -46% | -515 | -31% |
| United Kingdom | 24,101 | 18,108 | 14,480 | 21.2% | -3,628 | -20% | -9,621 | -40% |
| **EU-15** | **118,072** | **95,334** | **68,464** | **100.0%** | **-26,870** | **-28%** | **-49,609** | **-42%** |

## 1A2a Iron and Steel - Liquid Fuels ($CO_2$)

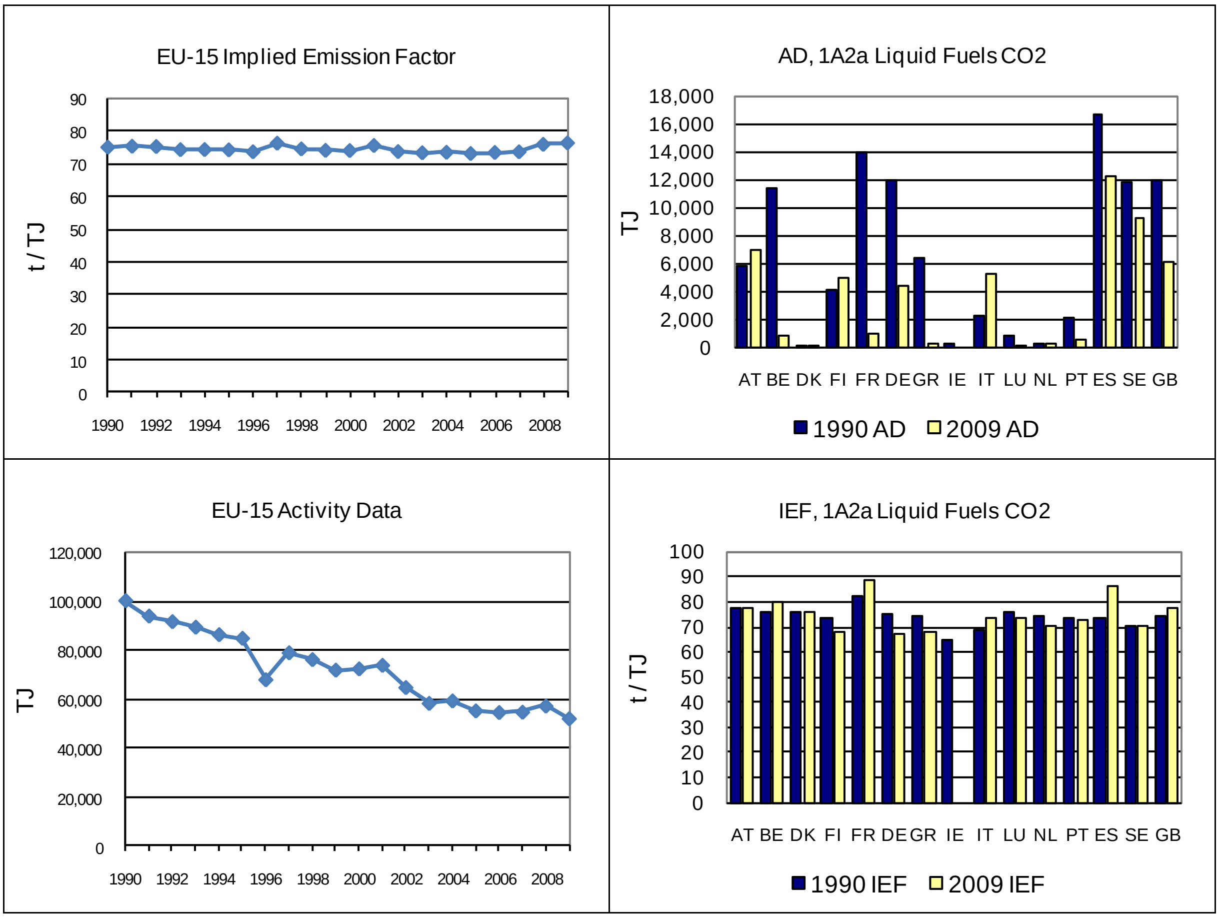
In 2009 $CO_2$ from liquid fuels had a share of 6 % within this category compared to 6 % in 1990. Between 1990 and 2008 emissions decreased by 42 % (Table 3.21). Significant absolute decreases could be achieved in Belgium, France and Germany whereas Austria reported considerable increases until 2008. This activity mainly consists of residual fuel oil used for iron ore reduction in blast furnaces.

**Table 3.21 1A2a Iron and Steel, liquid fuels: Member States' contributions to $CO_2$ emissions and information on method applied and emission factor**

| Member State | $CO_2$ emissions in Gg | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| Austria | 448 | 795 | 547 | 13.7% | -248 | -31% | 99 | 22% | T2 | CS,PS |
| Belgium | 878 | 60 | 68 | 1.7% | 8 | 13% | -810 | -92% | T3 | PS |
| Denmark | 12 | 2 | 2 | 0.0% | 0 | -9% | -10 | -85% | CR | CS,CR,D |
| Finland | 303 | 354 | 342 | 8.5% | -12 | -3% | 39 | 13% | T3 | CS |
| France | 1,153 | 108 | 83 | 2.1% | -25 | -23% | -1,071 | -93% | CR | CS |
| Germany | 900 | 245 | 292 | 7.3% | 46 | 19% | -608 | -68% | CS | CS |
| Greece | 475 | 17 | 14 | 0.3% | -3 | -18% | -461 | -97% | T2 | PS |
| Ireland | 16 | NO | NO | - | - | - | -16 | -100% | NO | NA |
| Italy | 153 | 278 | 384 | 9.6% | 106 | 38% | 231 | 150% | T2 | CS |
| Luxembourg | 59 | 12 | 4 | 0.1% | -9 | -70% | -55 | -94% | T1,T2 | CS,D |
| Netherlands | 21 | 17 | 16 | 0.4% | 0 | -2% | -4 | -21% | T2 | CS |
| Portugal | 154 | 47 | 44 | 1.1% | -3 | -6% | -110 | -71% | T2 | D,CR,PS |
| Spain | 1,224 | 1,132 | 1,067 | 26.7% | -65 | -6% | -157 | -13% | T2 | PS,C |
| Sweden | 828 | 905 | 652 | 16.3% | -252 | -28% | -176 | -21% | T2,T3 | CS,PS |
| United Kingdom | 894 | 389 | 481 | 12.0% | 92 | 24% | -413 | -46% | T2 | CS |
| **EU-15** | **7,520** | **4,361** | **3,996** | **100.0%** | **-365** | **-8%** | **-3,524** | **-47%** | | |

Figure 3.28 shows activity data and implied emission factors for $CO_2$ for EU-15 and the Member States. Liquid fuel consumption in the EU-15 decreased by 48 % between 1990 and 2009. The $CO_2$ implied emission factor of EU-15 was 76,44 t/TJ in 2009.

**Figure 3.28 1A2a Iron and Steel, Liquid fuels: Activity Data and Implied Emission Factors for $CO_2$**




## 1A2a Iron and Steel - Solid Fuels ($CO_2$)

In 2009, $CO_2$ from solid fuels had a share of 73 % within this category and 78 % in 1990. Between 1990 and 2008 the emissions decreased by 22 % (Table 3.22) and fell by another 33 % in 2009. Between 1990 and 2008 Belgium, France, Italy, Spain and the United Kingdom showed major decreases. Between 2008 to 2009, the member states show decreases between 16 % and 64 %.

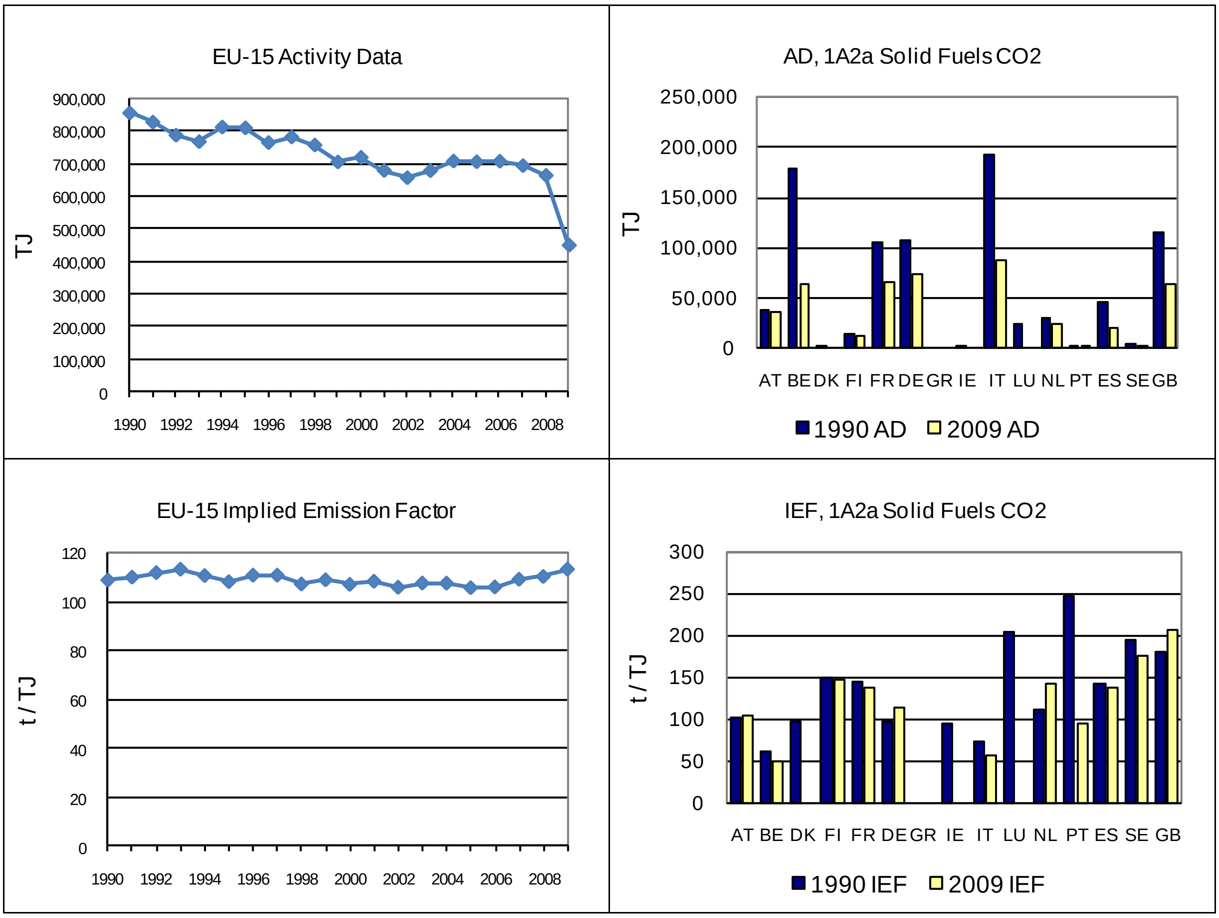
**Table 3.22** **1A2a Iron and Steel, solid fuels: Member States' contributions to $CO_2$ emissions and information on method applied and emission factor**

| Member State | $CO_2$ emissions in Gg | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| Austria | 3,846 | 4,367 | 3,623 | 7.2% | -744 | -17% | -223 | -6% | T2 | CS,PS |
| Belgium | 11,062 | 8,692 | 3,110 | 6.2% | -5,583 | -64% | -7,953 | -72% | T3 | PS |
| Denmark | 4 | NO | NO | - | - | - | -4 | -100% | CR | CS,D |
| Finland | 2,084 | 2,783 | 1,862 | 3.7% | -921 | -33% | -222 | -11% | T3 | CS,PS |
| France | 15,113 | 12,346 | 9,161 | 18.1% | -3,185 | -26% | -5,952 | -39% | CR | CS |
| Germany | 10,236 | 11,101 | 8,222 | 16.3% | -2,879 | -26% | -2,013 | -20% | CS | CS |
| Greece | NO | NO | NO | - | - | - | - | - | NO | NO |
| Ireland | 115 | NO | NO | - | - | - | -115 | -100% | NO | NA |
| Italy | 13,842 | 8,526 | 5,001 | 9.9% | -3,525 | -41% | -8,841 | -64% | T2 | CS |
| Luxembourg | 4,959 | NO | NO | - | - | - | -4,959 | -100% | NA | NA |
| Netherlands | 3,323 | 4,162 | 3,499 | 6.9% | -663 | -16% | 176 | 5% | T2 | CS |
| Portugal | 466 | 25 | 14 | 0.0% | -10 | - | -452 | -97% | T2 | D,CR,PS |
| Spain | 6,524 | 3,669 | 2,710 | 5.4% | -959 | -26% | -3,814 | -58% | T2 | PS,CS,C |
| Sweden | 785 | 1,122 | 426 | 0.8% | -697 | -62% | -359 | -46% | T2,T3 | CS,PS |
| United Kingdom | 20,744 | 16,237 | 12,914 | 25.6% | -3,323 | -20% | -7,830 | -38% | T2 | CS |
| **EU-15** | **93,103** | **73,030** | **50,542** | **100.0%** | **-22,488** | **-31%** | **-42,561** | **-46%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

Figure 3.29 shows activity data and implied emission factors for $CO_2$ for EU-15 and the Member States. The largest emitters are France, Germany, Italy and the UK; together they cause almost 70 % of the $CO_2$ emissions from solid fuels in 1A2a. Solid fuel combustion in the EU-15 decreased by 23 % between 1990 and 2008 and by another 33% in 2009. The implied emission factor in 2009 of EU-15 was 113.2 t/TJ. Belgium and Italy report fuel consumption under this category which was not used for the calculation of the $CO_2$ emissions and thus results untypically low $CO_2$ emission factors.

**Figure 3.29** **1A2a Iron and Steel, solid fuels: Activity Data and Implied Emission Factors for $CO_2$**




## 1A2a Iron and Steel - Gaseous Fuels ($CO_2$)

In 2009 $CO_2$ from gaseous fuels had a share of 20 % within source category 1A2a (compared to 15 % in 1990). Between 1990 and 2008 the emissions increased by 3 % and decreased by 22% in 2009 (Table 3.23).

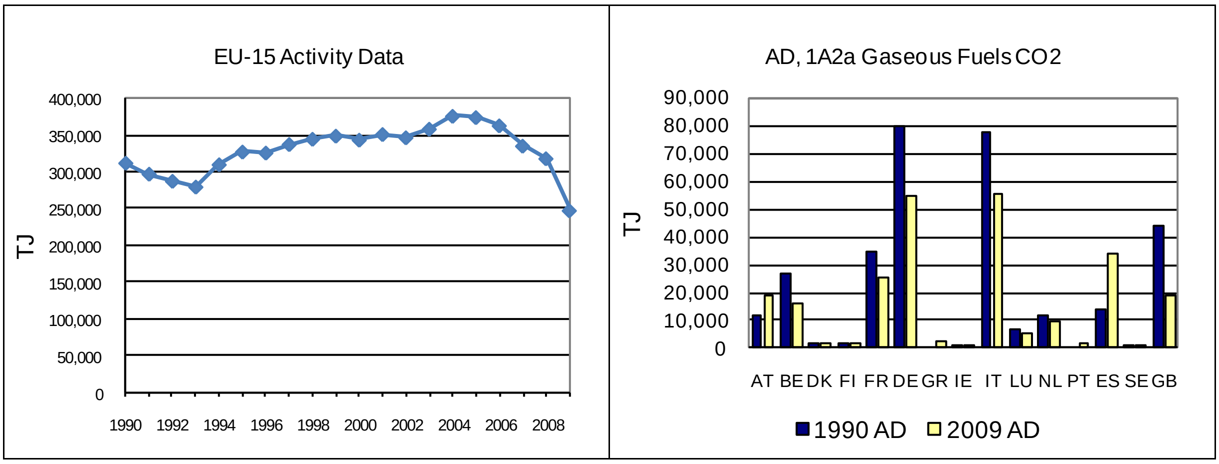
**Table 3.23** **1A2a Iron and Steel, gaseous fuels: Member States' contributions to $CO_2$ emissions and information on method applied and emission factor**

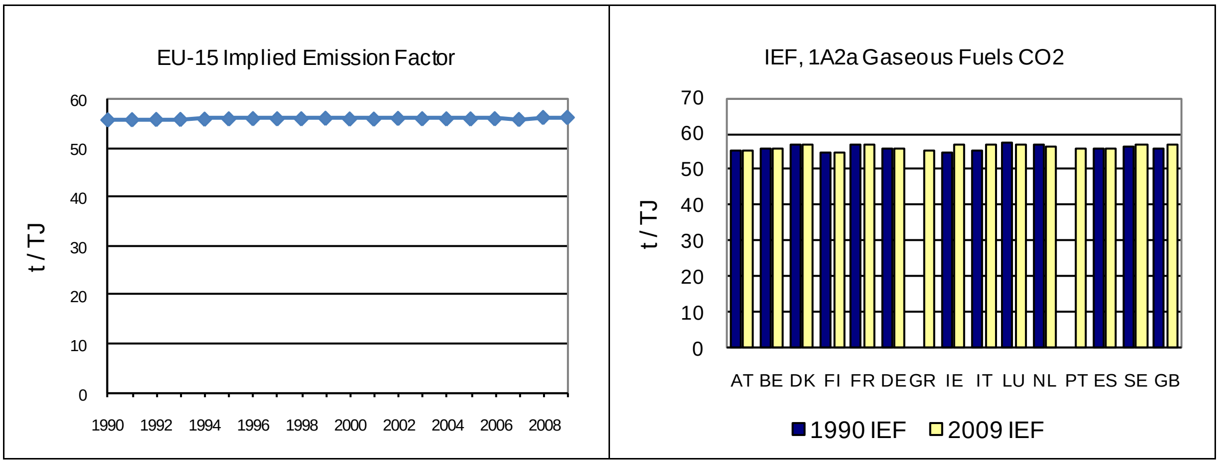
| Member State | $CO_2$ emissions in Gg | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| Austria | 650 | 1,041 | 1,047 | 7.5% | 7 | 1% | 397 | 61% | T2 | CS,PS |
| Belgium | 1,485 | 1,648 | 890 | 6.4% | -759 | -46% | -596 | -40% | T3 | PS |
| Denmark | 102 | 95 | 87 | 0.6% | -8 | -9% | -15 | -15% | CR | CS |
| Finland | 107 | 122 | 92 | 0.7% | -30 | -24% | -15 | -14% | T3 | CS |
| France | 1,994 | 1,911 | 1,441 | 10.4% | -469 | -25% | -552 | -28% | CR | CS |
| Germany | 4,446 | 3,910 | 3,050 | 21.9% | -860 | -22% | -1,396 | -31% | CS | CS |
| Greece | NO | 173 | 146 | 1.0% | -27 | -16% | 146 | - | T2 | CS |
| Ireland | 44 | 2 | 2 | 0.0% | 0 | 0% | -41 | -95% | T1 | CS |
| Italy | 4,276 | 4,388 | 3,165 | 22.7% | -1,222 | -28% | -1,111 | -26% | T2 | CS |
| Luxembourg | 400 | 484 | 322 | 2.3% | -162 | -34% | -78 | -20% | T2 | CS |
| Netherlands | 667 | 629 | 560 | 4.0% | -69 | -11% | -107 | -16% | T2 | CS |
| Portugal | NO | 100 | 80 | 0.6% | -21 | -21% | 80 | - | T2 | D,CR,PS |
| Spain | 786 | 1,895 | 1,912 | 13.7% | 17 | 1% | 1,126 | 143% | T2 | CS |
| Sweden | 25 | 61 | 45 | 0.3% | -16 | -27% | 20 | 79% | T2 | CS |
| United Kingdom | 2,463 | 1,482 | 1,084 | 7.8% | -397 | -27% | -1,378 | -56% | T2 | CS |
| **EU-15** | **17,446** | **17,942** | **13,925** | **100.0%** | **-4,017** | **-22%** | **-3,521** | **-20%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

Figure 3.30 shows activity data and implied emission factors for $CO_2$ for EU-15 and the Member States. The largest emissions are reported by France, Germany, Italy and Spain which contribute 69 % to $CO_2$ emissions from gaseous fuels in 1A2a. Gaseous fuel consumption in the EU-15 increased by 2 % between 1990 and 2008 and decreased by 22 % in 2009. The implied emission factor of EU-15 was 56.4 t/TJ in 2009.

**Figure 3.30** **1A2a Iron and Steel, gaseous fuels: Activity Data and Implied Emission Factors for $CO_2$**



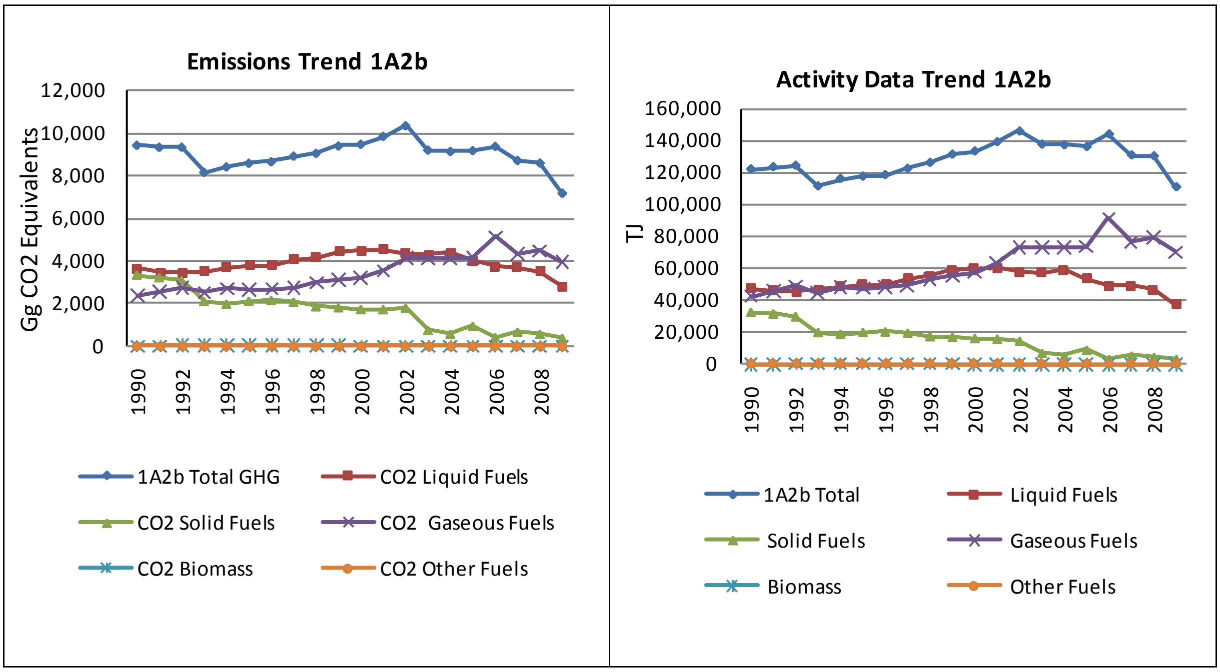



## 3.2.2.2 Non Ferrous Metals (1A2b) (EU-15)

In this chapter information is provided about emission trends, Member States contribution, activity data and emission factors for category 1A2b by fuels. $CO_2$ emissions from 1A2b Non-Ferrous Metals accounted for 1.6 % of 1A2 source category and 0.2 % of total GHG emissions in 2009.

Figure 3.31 shows the emission trend within the category 1A2b, which is in 2009 mainly dominated by $CO_2$ emissions from liquid and gaseous fuels. The share of solid fuels emissions decreased from 35 % in 1990 to 5 % in 2009. Total GHG emissions were 24 % below 1990 levels in 2009. Increasing emissions were reported for $CO_2$ from gaseous fuels (+66 %).

**Figure 3.31 1A2b Non ferrous Metals: Total and $CO_2$ emission trends**




EU-15 $CO_2$ emissions from 1A2b were 24 % below 1990 levels in 2009. In absolute terms, France and Germany reported the highest decreases, while Spain, Ireland and Italy reported substantial increases in this period (Table 3.24).

**Table 3.24 1A2b Non ferrous Metals: Member States' contributions to $CO_2$ emissions**

| Member State | $CO_2$ emissions in Gg | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | |
|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) |
| Austria | 132 | 257 | 269 | 3.8% | 13 | 5% | 138 | 104% |
| Belgium | 624 | 460 | 408 | 5.7% | -53 | -11% | -216 | -35% |
| Denmark | 15 | 9 | 8 | 0.1% | -1 | -9% | -8 | -49% |
| Finland | 336 | 105 | 90 | 1.3% | -15 | -14% | -247 | -73% |
| France | 2,723 | 1,836 | 1,413 | 19.7% | -423 | -23% | -1,310 | -48% |
| Germany | 1,601 | 219 | 176 | 2.4% | -43 | -20% | -1,426 | -89% |
| Greece | 608 | 741 | 534 | 7.4% | -207 | -28% | -74 | -12% |
| Ireland | 809 | 1,534 | 1,223 | 17.1% | -311 | -20% | 414 | 51% |
| Italy | 738 | 1,096 | 1,021 | 14.2% | -75 | -7% | 283 | 38% |
| Luxembourg | 28 | 51 | 45 | - | -6 | -12% | 17 | 61% |
| Netherlands | 216 | 245 | 175 | 2.4% | -70 | -28% | -41 | -19% |
| Portugal | IE,NO | IE | IE | 0.0% | - | - | - | - |
| Spain | 1,433 | 1,936 | 1,727 | 24.1% | -209 | -11% | 294 | 20% |
| Sweden | 128 | 87 | 83 | 1.2% | -4 | -5% | -45 | -35% |
| United Kingdom | IE,NO | IE,NO | IE,NO | - | - | - | - | - |
| **EU-15** | **9,391** | **8,574** | **7,171** | **100.0%** | **-1,403** | **-16%** | **-2,220** | **-24%** |

*UK includes emissions under 1A2f.*
*Portugal includes emissions under 1A2f.*
*Abbreviations explained in the Chapter 'Units and abbreviations'.*

### 3.2.2.3 1A2b Non-Ferrous Metals - Solid Fuels ($CO_2$)

In 2009 $CO_2$ from solid fuels had a share of 5 % within source category 1A2b category (compared to 35 % in 1990). Between 1990 and 2009 the emissions decreased by 89 % (Table 3.25). Greece, Portugal and the United Kingdom reported emissions as 'Included elsewhere' and the Netherlands, Luxembourg, Denmark and Sweden as 'Not occurring'. Substantial decreases between 1990 and 2009 were reported by France and Germany.

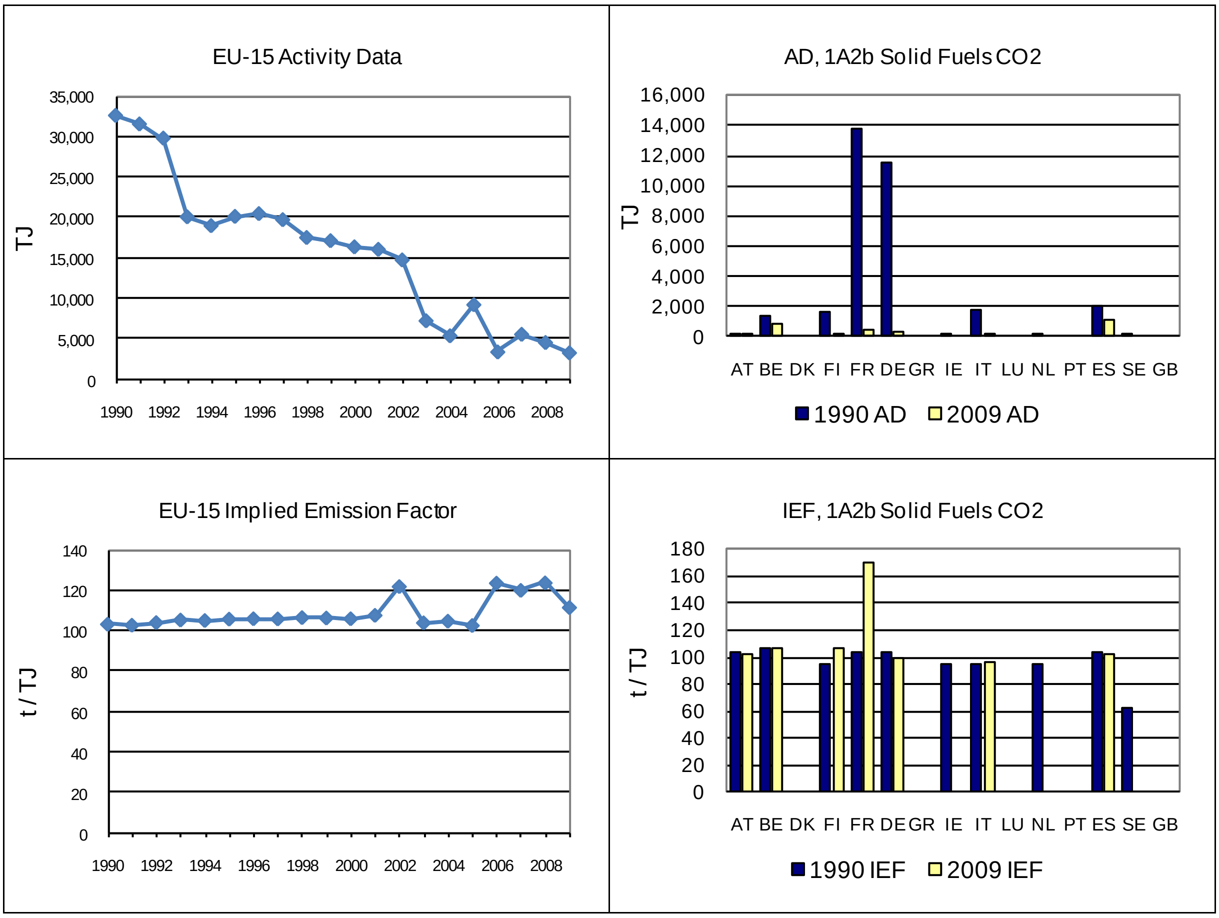
**Table 3.25 1A2b Non ferrous Metals, solid fuels: Member States' contributions to $CO_2$ emissions and information on method applied and emission factor**

| Member State | $CO_2$ emissions in Gg | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| Austria | 22 | 14 | 16 | 4.4% | 2 | 12% | -6 | -27% | T2 | CS |
| Belgium | 146 | 89 | 89 | 24.2% | 0 | 0% | -57 | -39% | T1 | D |
| Denmark | NO | NO | NO | - | - | - | - | - | NA | NA |
| Finland | 155 | 23 | 17 | 4.7% | -6 | -26% | -138 | -89% | T3 | CS |
| France | 1,436 | 202 | 72 | 19.5% | -130 | -64% | -1,364 | -95% | CR | CS |
| Germany | 1,206 | 46 | 35 | 9.5% | -11 | -24% | -1,171 | -97% | CS | CS |
| Greece | IE | IE | IE | - | - | - | - | - | IE | IE |
| Ireland | 4 | NO | NA | - | - | - | -4 | -100% | NO | NO |
| Italy | 163 | 27 | 23 | 6.4% | -3 | -13% | -139 | -86% | T2 | CS |
| Luxembourg | NO | NO | NO | - | - | - | - | - | NA | NA |
| Netherlands | 0 | NO | NO | - | - | - | -0.4 | -100% | NA | NA |
| Portugal | IE | IE | IE | - | - | - | - | - | T2 | D,CR |
| Spain | 211 | 163 | 115 | 31.3% | -48 | -29% | -96 | -46% | T2 | CS |
| Sweden | 7 | NO | NO | - | - | - | -7 | -100% | NA | NA |
| United Kingdom | IE | IE | IE | - | - | - | - | - | NA | NA |
| **EU-15** | **3,351** | **564** | **367** | **100.0%** | **-197** | **-35%** | **-2,984** | **-89%** | | |

*UK includes emissions under 1A2f.*
*Portugal includes emissions under 1A2f because the separation of AD between ferrous and non-ferrous industry not available.*
*Greece includes emissions in the Industrial processes sector (as non-energy use of fuels).*
*Abbreviations explained in the Chapter 'Units and abbreviations'.*

Figure 3.32 shows activity data and implied emission factors for $CO_2$ comparing the EU-15 average and the Member States. The largest emissions are reported by Belgium, France and Spain; together they cause 75 % of the $CO_2$ emissions from solid fuels in 2009. Consumption of solid fuels in the EU-15 decreased by 90 % between 1990 and 2009. The implied emission factor of EU-15 was 111.5 t/TJ in 2009. The high implied emission factor of France in 2009 is caused by the high share of of blast furnace and steel plants gases with an emission factor of 268 kg $CO_2$/ GJ and 183 kg $CO_2$/ GJ respectively. This also implies the peak in the EU-15 implied emission factor for 2002. The strong decline in 1993 AD is mainly due to a high decrease reported by France.

**Figure 3.32** **1A2b Non ferrous Metals, solid fuels: Activity Data and Implied Emission Factors for $CO_2$**




## 1A2b Non-Ferrous Metals - Gaseous Fuels ($CO_2$)

In 2009 $CO_2$ from gaseous fuels had a share of 55 % within source category 1A2b (compared to 25 % in 1990). Between 1990 and 2009 the emissions increased by 66 % (Table 3.26). Between 1990 and 2009 the highest absolute increases occurred in Ireland, Italy and France.

**Table 3.26** **1A2b Non ferrous Metals, gaseous fuels: Member States' contributions to $CO_2$ emissions and information on method applied and emission factor**

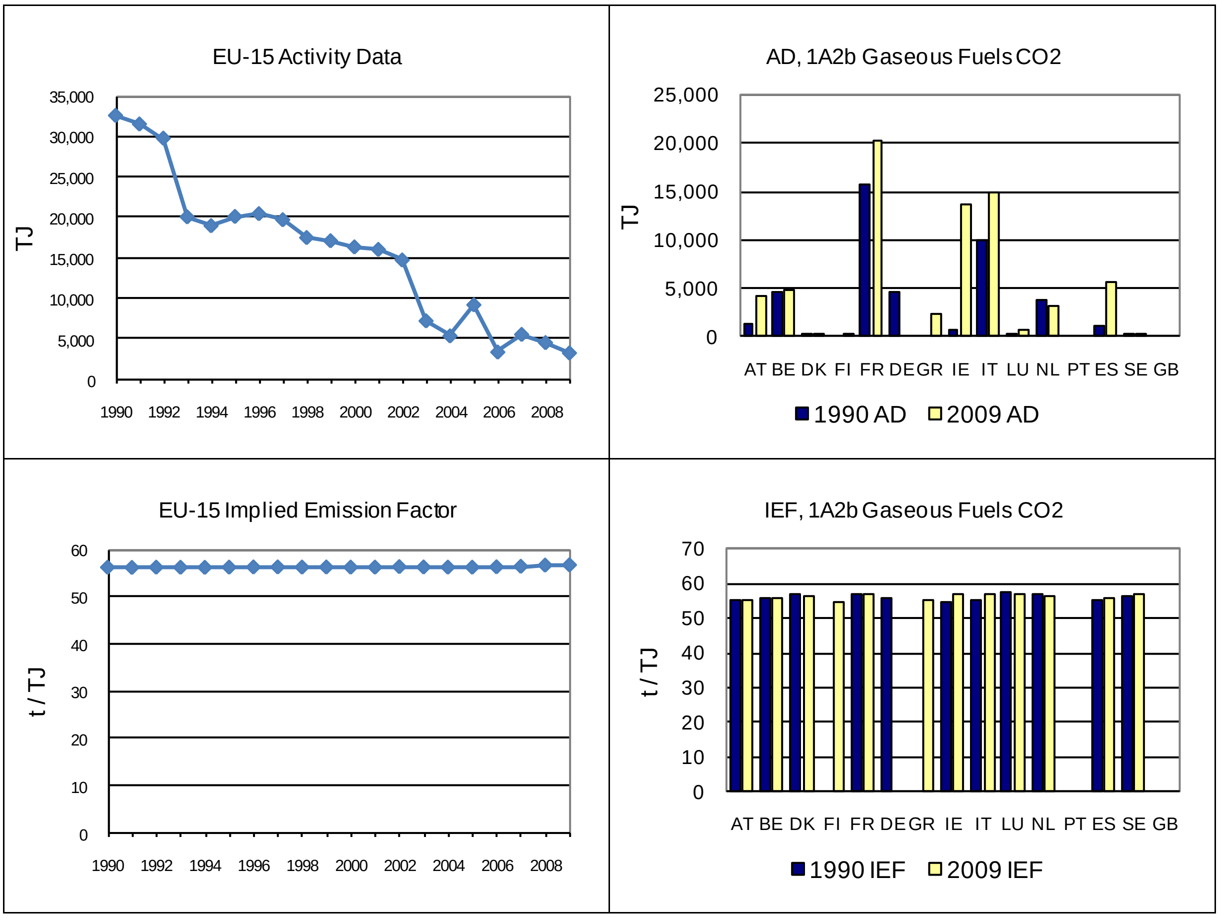
| Member State | $CO_2$ emissions in Gg | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| Austria | 75 | 219 | 232 | 5.8% | 13 | 6% | 157 | 210% | T2 | CS |
| Belgium | 260 | 302 | 266 | 6.7% | -36 | -12% | 6 | 3% | 0.0 | 0.0 |
| Denmark | 7 | 7 | 7 | 0.2% | -1 | -9% | -1 | -11% | CR | CS |
| Finland | NO | 1 | 2 | 0.1% | 2 | 316% | 2 | - | T3 | CS |
| France | 895 | 1,418 | 1,152 | 29.0% | -266 | -19% | 257 | 29% | CR | CS |
| Germany | 253 | IE | IE | 0.0% | - | - | -253 | -100% | NA | NA |
| Greece | NO | 138 | 130 | 3.3% | -8 | -6% | 130 | - | T2 | CS |
| Ireland | 39 | 834 | 782 | 19.7% | -52 | - | 744 | 1928% | T1 | CS |
| Italy | 558 | 883 | 852 | 21.4% | -32 | -4% | 294 | 53% | T2 | CS |
| Luxembourg | 13 | 51 | 45 | 1.1% | -6 | -12% | 32 | - | T2 | CS |
| Netherlands | 213 | 245 | 175 | 4.4% | -70 | -28% | -38 | -18% | T2 | CS |
| Portugal | NO | IE | IE | - | - | - | - | - | T2 | D,CR |
| Spain | 66 | 372 | 316 | 7.9% | -55 | -15% | 250 | 381% | T2 | CS |
| Sweden | 10 | 18 | 18 | 0.5% | -1 | -3% | 8 | 72% | T2 | CS |
| United Kingdom | IE | IE | IE | - | - | - | - | - | NA | NA |
| **EU-15** | **2,390** | **4,490** | **3,977** | **100.0%** | **-512** | **-11%** | **1,588** | **66%** | | |

*UK includes emissions under 1A2f.*
*Portugal includes emissions under 1A2f because the separation of AD between ferrous and non-ferrous industry not available.*

*Germany reported emissions under 1A2f other (unspecified industrial power plants) because of confidential data.*
*Abbreviations explained in the Chapter 'Units and abbreviations'.*

Figure 3.33 shows activity data and $CO_2$ implied emission factors for EU-15 and the Member States. The largest emissions are reported by France, Ireland and Italy; together they cause around 70 % of the $CO_2$ emissions in 2009 from gaseous fuels in 1A2b. Consumption of gaseous fuels in the EU-15 rose by 65 % between 1990 and 2009. The implied emission factor of EU-15 was 56.7 t/TJ in 2009. The jump in 2006 AD is mainly due to Ireland which reports a high increase in 2006 and Spain which reports a high decrease in 2007.

**Figure 3.33 1A2b Non ferrous Metals, gaseous fuels: Activity Data and Implied Emission Factors for $CO_2$**

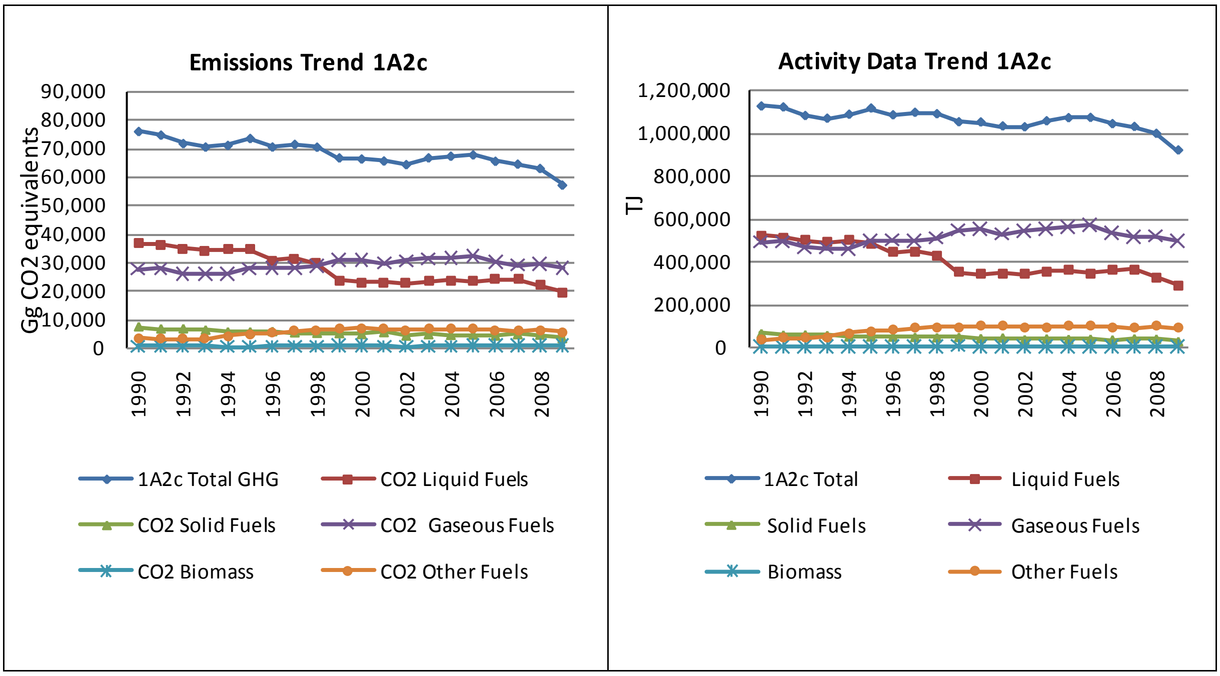


### 3.2.2.4 Chemicals (1A2c) (EU-15)

In this chapter information about emission trends, Member States contribution, activity data and emission factors is provided for category 1A2c on a fuel base. $CO_2$ emissions from 1A2c Chemicals accounted for 12.6 % of 1A2 category and 1.5 % of total GHG emissions in 2009.

Figure 3.34 shows the emission trend within the category 1A2c, which is mainly dominated by $CO_2$ emissions from liquid and gaseous fuels. Total emissions decreased by 25 %, mainly due to decreases in emissions from liquid (-47 %) fuels. Increasing emissions were reported for gaseous fuels (+2 %) and other fuels (+ 61 %).

**Figure 3.34 1A2c Chemicals: Total and $CO_2$ emission and activity trends**




Between 1990 and 2009, $CO_2$ emissions from 1A2c Chemicals decreased by 25 % in the EU-15 (

Table 3.27), mainly due to decreases in Italy, the Netherlands and France; Spain reported a substantial emission increase in this period. Between 2008 and 2009 emissions decreased substantially in Italy, the Netherlands and Spain.

**Table 3.27 1A2c Chemicals: Member States' contributions to $CO_2$ emissions**

| Member State | $CO_2$ emissions in Gg | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | |
|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) |
| Austria | 883 | 1,381 | 1,271 | 2.2% | -110 | -8% | 389 | 44% |
| Belgium | 6,585 | 7,231 | 6,650 | 11.7% | -581 | -8% | 65 | 1% |
| Denmark | 348 | 298 | 272 | 0.5% | -26 | -9% | -75 | -22% |
| Finland | 1,286 | 955 | 697 | 1.2% | -258 | -27% | -589 | -46% |
| France | 19,408 | 16,325 | 16,227 | 28.5% | -99 | -1% | -3,181 | -16% |
| Germany | IE | IE | IE | - | - | - | - | - |
| Greece | 1,153 | 750 | 840 | 1.5% | 89 | 12% | -313 | -27% |
| Ireland | 411 | 368 | 346 | 0.6% | -22 | -6% | -65 | -16% |
| Italy | 20,052 | 10,633 | 8,481 | 14.9% | -2,153 | -20% | -11,571 | -58% |
| Luxembourg | 178 | 183 | 136 | 0.2% | -47 | -26% | -42 | -24% |
| Netherlands | 17,133 | 12,476 | 11,589 | 20.4% | -887 | -7% | -5,544 | -32% |
| Portugal | 1,479 | 1,727 | 1,219 | 2.1% | -508 | -29% | -260 | -18% |
| Spain | 5,658 | 9,203 | 8,145 | 14.3% | -1,058 | -11% | 2,487 | 44% |
| Sweden | 1,128 | 1,192 | 1,062 | 1.9% | -130 | -11% | -67 | -6% |
| United Kingdom | IE,NO | IE,NO | IE,NO | - | - | - | - | - |
| **EU-15** | **75,700** | **62,723** | **56,933** | **100.0%** | **-5,789** | **-9%** | **-18,767** | **-25%** |

*Emissions of Germany and the UK are included in 1A2f.*
*Abbreviations explained in the Chapter 'Units and abbreviations'.*

## 1A2c Chemicals - Liquid Fuels ($CO_2$)

In 2009, $CO_2$ from liquid fuels had a share of 34 % within source category 1A2c (compared to 48 % in 1990). Between 1990 and 2009, the emissions decreased by 47 % (Table 3.28). Several EU-15 Member States reported decreasing $CO_2$ emissions from this source category with Italy showing the highest reduction in absolute terms. Germany and the UK include emissions under 1A2f.

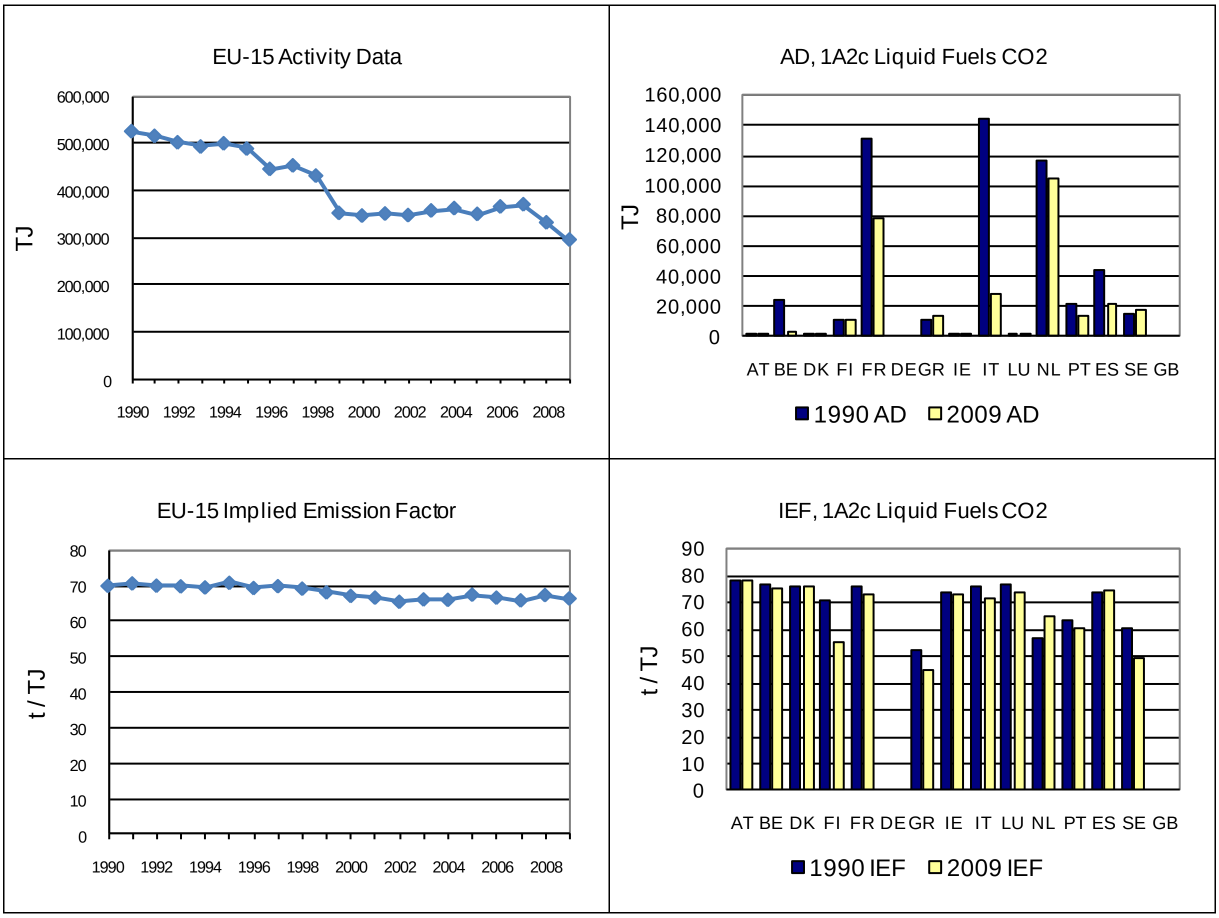
**Table 3.28 1A2c Chemicals, liquid fuels: Member States' contributions to $CO_2$ emissions and information on method applied and emission factor**

| Member State | $CO_2$ emissions in Gg | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| Austria | 82 | 45 | 61 | 0.3% | 16 | 35% | -21 | -26% | T2 | CS,PS |
| Belgium | 1,835 | 421 | 206 | 1.1% | -216 | -51% | -1,630 | -89% | T1 | D |
| Denmark | 165 | 21 | 19 | 0.1% | -2 | -9% | -146 | -88% | CR | CS,CR,D |
| Finland | 772 | 717 | 635 | 3.3% | -82 | -11% | -137 | -18% | T3 | CS |
| France | 10,044 | 6,118 | 5,726 | 29.4% | -391 | -6% | -4,318 | -43% | CR | CS |
| Germany | IE | IE | IE | - | - | - | - | - | NA | NA |
| Greece | 584 | 653 | 613 | 3.1% | -40 | -6% | 29 | 5% | T2 | PS |
| Ireland | 131 | 160 | 158 | 0.8% | -2 | -1% | 27 | 21% | T1 | CS |
| Italy | 10,956 | 2,834 | 2,013 | 10.3% | -821 | -29% | -8,943 | -82% | T2 | CS |
| Luxembourg | 121 | 6 | 2 | 0.0% | -3 | -57% | -118 | -98% | T1,T2 | CS,D |
| Netherlands | 6,570 | 7,249 | 6,799 | 34.9% | -450 | -6% | 229 | 3% | T2 | CS |
| Portugal | 1,372 | 1,385 | 809 | 4.2% | -576 | -42% | -563 | -41% | T2 | D,CR |
| Spain | 3,276 | 1,688 | 1,589 | 8.2% | -100 | -6% | -1,688 | -52% | T2 | CS,CR |
| Sweden | 889 | 947 | 848 | 4.4% | -99 | -10% | -41 | -5% | T2 | CS |
| United Kingdom | IE | IE | IE | - | - | - | - | - | NA | NA |
| **EU-15** | **36,797** | **22,245** | **19,479** | **100.0%** | **-2,766** | **-12%** | **-17,319** | **-47%** | | |

*Emissions of the UK and Germany are included in 1A2f*
*Abbreviations explained in the Chapter 'Units and abbreviations'.*

Figure 3.35 shows activity data and implied emission factors for $CO_2$ comparing the EU-15 average and the Member States. The largest contributions are reported by France, Italy and the Netherlands; together they cause around 75 % of the $CO_2$ emissions from liquid fuels in 1A2c. Fuel combustion in the EU-15 decreased by 44 % between 1990 and 2009. The implied emission factor of EU-15 was 66.4 /TJ in 2009. The low implied emission factor of Greece is because non-energy use is included in activity data. The lower implied emission factor of the Netherlands is because chemical gases are included in liquid fuels Sweden reports methane and methane based gas mixtures together with liquid fuels which implies a rather low IEF too. The decline in 1999 AD is due strong decreases reported by France and Italy.

**Figure 3.35** **1A2c Chemicals, liquid fuels: Activity Data and Implied Emission Factors for $CO_2$**



### 1A2c Chemicals - Solid Fuels ($CO_2$)

In 2009, solid fuels had a share of 6 % within source category 1A2c (compared to 10 % in 1990). Between 1990 and 2009, the emissions decreased by 54 % (Table 3.29). In absolute terms France and the Netherlands reported a significant decrease during this period. Germany and the UK include emissions from this source category in source category 1A2f.

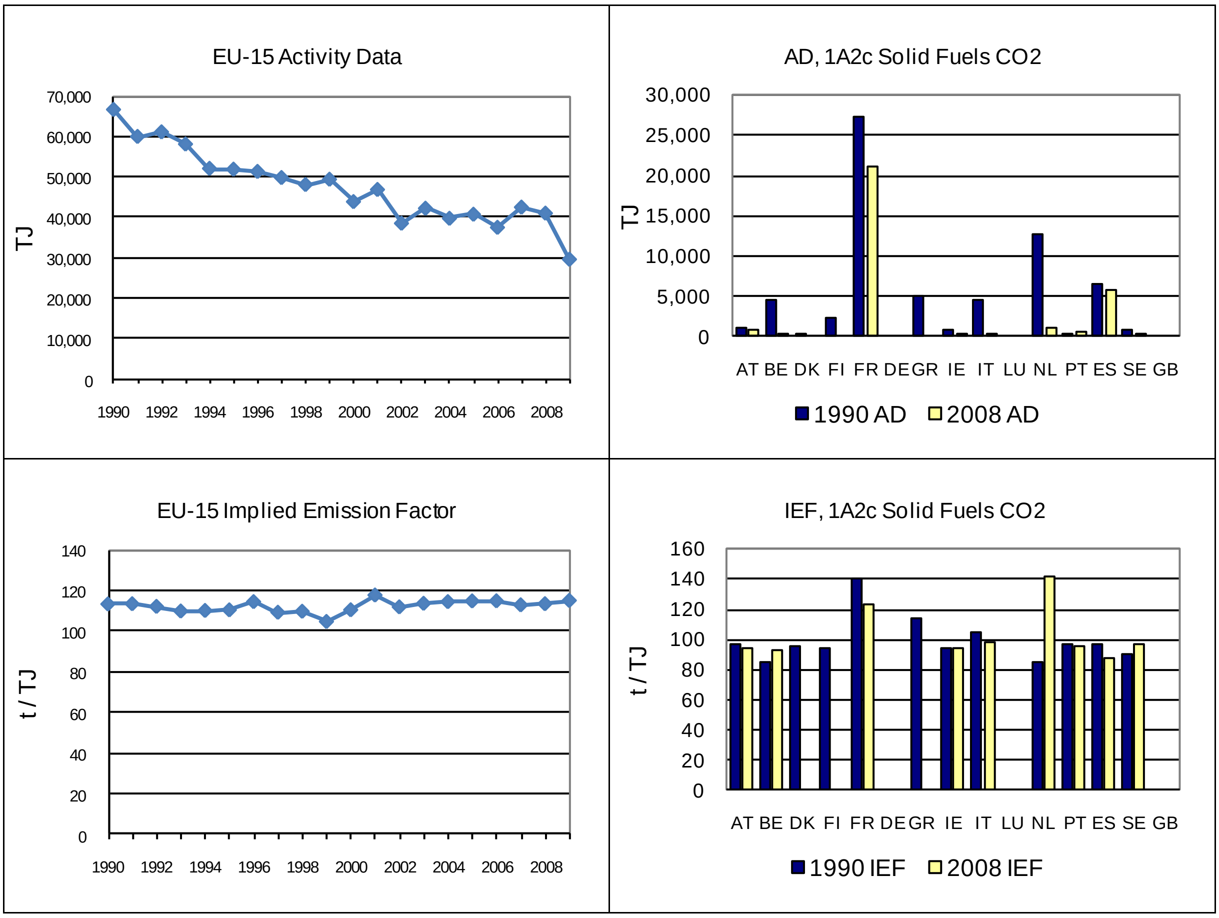
**Table 3.29 1A2c Chemicals, solid fuels: Member States' contributions to $CO_2$ emissions and information on method applied and emission factor**

| Member State | $CO_2$ emissions in Gg | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| Austria | 107 | 71 | 70 | 2.0% | -1 | -2% | -38 | -35% | T2 | CS,PS |
| Belgium | 397 | 3 | 3 | 0.1% | 0 | -9% | -394 | -99% | T1 | D |
| Denmark | 7 | NO | NO | - | - | - | -7 | -100% | NA | NA |
| Finland | 214 | 0.2 | NA | - | -0.2 | -100% | -214 | -100% | NA | NA |
| France | 3,825 | 3,557 | 2,600 | 75.9% | -957 | -27% | -1,226 | -32% | CR | CS |
| Germany | IE | IE | IE | - | - | - | - | - | NA | NA |
| Greece | 569 | NO | NO | - | - | - | -569 | -100% | NO | NO |
| Ireland | 72 | 16 | 13 | 0.4% | -3 | -17% | -59 | -81% | T1 | CS |
| Italy | 478 | 24 | 15 | 0.4% | -9 | -38% | -463 | -97% | T2 | CS |
| Luxembourg | NO | NO | NO | - | - | - | - | - | NA | NA |
| Netherlands | 1,087 | 231 | 144 | 4.2% | -87 | -38% | -944 | -87% | T2 | CS |
| Portugal | 44 | 61 | 51 | 1.5% | -10 | -17% | 7 | 15% | T2 | D,CR |
| Spain | 642 | 665 | 506 | 14.8% | -158 | -24% | -136 | -21% | T2 | CS,CR,PS |
| Sweden | 79 | 27 | 23 | 0.7% | -4 | - | -56 | -71% | T2 | CS |
| United Kingdom | IE | IE | IE | - | - | - | - | - | NA | NA |
| **EU-15** | **7,523** | **4,654** | **3,424** | **100.0%** | **-1,230** | **-26%** | **-4,098** | **-54%** | | |

*Emissions of Germany and the UK are inlcuded in 1A2f.*
*Abbreviations explained in the Chapter 'Units and abbreviations'.*

Figure 3.36 shows activity data and implied emission factors for $CO_2$ for EU-15 and the Member States. The largest emissions are reported by France and Spain; together they cause 91 % of the $CO_2$ emissions from solid fuels in 1A2c. Solid fuel combustion in the EU-15 decreased by -55 % between 1990 and 2009. The implied emission factor of EU-15 was 115.0 t/TJ in 2009. The Netherlands include chemical waste gas within this category which implies the change in their IEF.

**Figure 3.36** 1A2c Chemicals, solid fuels:Activity Data and Implied Emission Factors for $CO_2$



### 1A2c Chemicals – Gaseous Fuels ($CO_2$)

In 2009, $CO_2$ from gaseous fuels had a share of 49 % within source category 1A2c (compared to 36 % in 1990). Between 1990 and 2009, the emissions increased by 2 % (Table 3.30). Between 1990 and 2009 only Finland, Ireland and the Netherlands reported decreases. The highest increases occurred in Spain and France. Germany and the United Kingdom include emissions from this source category in source category 1A2f.

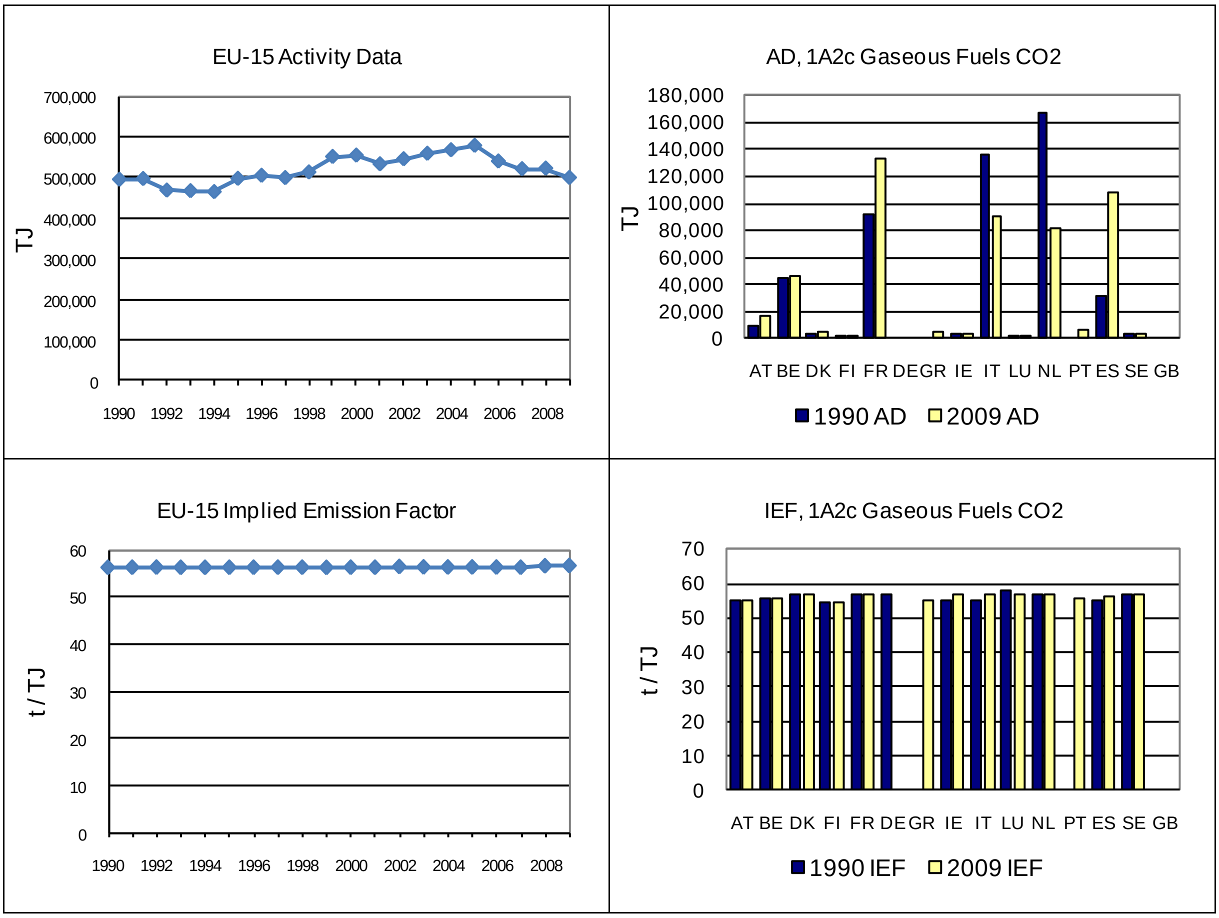
**Table 3.30 1A2c Chemicals, gaseous fuels: Member States' contributions to $CO_2$ and information on method applied and emission factor**

| Member State | $CO_2$ emissions in Gg | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| Austria | 519 | 969 | 886 | 3.1% | -83 | -9% | 367 | 71% | T2 | CS |
| Belgium | 2,519 | 3,048 | 2,604 | 9.2% | -444 | -15% | 85 | 3% | T1 | D |
| Denmark | 175 | 277 | 253 | 0.9% | -24 | -9% | 78 | 44% | CR | CS |
| Finland | 98 | 104 | 52 | 0.2% | -52 | -50% | -47 | -47% | T3 | CS |
| France | 5,270 | 6,233 | 7,584 | 26.9% | 1,351 | 22% | 2,313 | 44% | CR | CS |
| Germany | IE | IE | IE | - | - | - | - | - | NA | NA |
| Greece | NO | 98 | 227 | 0.8% | 129 | 132% | 227 | - | T2 | CS |
| Ireland | 208 | 192 | 175 | 0.6% | -17 | -9% | -33 | -16% | T1 | CS |
| Italy | 7,561 | 6,152 | 5,146 | 18.2% | -1,006 | -16% | -2,416 | -32% | T2 | CS |
| Luxembourg | 57 | 177 | 133 | 0.5% | -44 | -25% | 76 | 132% | T2 | CS |
| Netherlands | 9,476 | 4,996 | 4,646 | 16.5% | -350 | -7% | -4,829 | -51% | T2 | CS |
| Portugal | NO | 216 | 305 | 1.1% | 89 | 41% | 305 | - | T2 | D,CR |
| Spain | 1,739 | 6,843 | 6,049 | 21.4% | -794 | -12% | 4,311 | 248% | T2 | CS |
| Sweden | 155 | 165 | 156 | 0.6% | -10 | -6% | 1 | 1% | T2 | CS |
| United Kingdom | IE | IE | IE | - | - | - | - | - | NA | NA |
| **EU-15** | **27,778** | **29,470** | **28,216** | **100.0%** | **-1,254** | **-4%** | **438** | **2%** | | |

*Emissions of Germany and the UK are included in 1A2f.*
*Abbreviations explained in the Chapter 'Units and abbreviations'.*

Figure 3.37 shows activity data and implied emission factors for $CO_2$ for EU-15 and the Member States. The largest emissions are reported by Belgium, France, Italy, the Netherlands and Spain; together they cause 92 % of the $CO_2$ emissions from gaseous fuels in 1A2c. Gaseous fuel consumption in the EU-15 rose by 1 % between 1990 and 2009. The implied emission factor of EU-15 was 56.5 t/TJ in 2009.

**Figure 3.37 1A2c Chemicals, gaseous fuels: Activity Data and Implied Emission Factors for $CO_2$**



### 1A2c Chemicals - Other Fuels ($CO_2$)

In 2009 , $CO_2$ from other fuels had a share of 10 % within source category 1A2c (compared to 5 % in 1990). Between 1990 and 2009, the emissions increased by 61 % (Table 3.31). Several Member States reported emissions as 'Not occurring' or 'Not applicable', Germany included emissions in 1A2f. The major absolute increase was reported by Belgium between 1990 and 2009. Belgium reports recovered fuels from cracking units or other processes under this category; Italy reports gaseous fuels resulting from the petrochemical production processes.

**Table 3.31 1A2c Chemicals, other fuels: Member States' contributions to $CO_2$ emissions and information on method applied and emission factor**

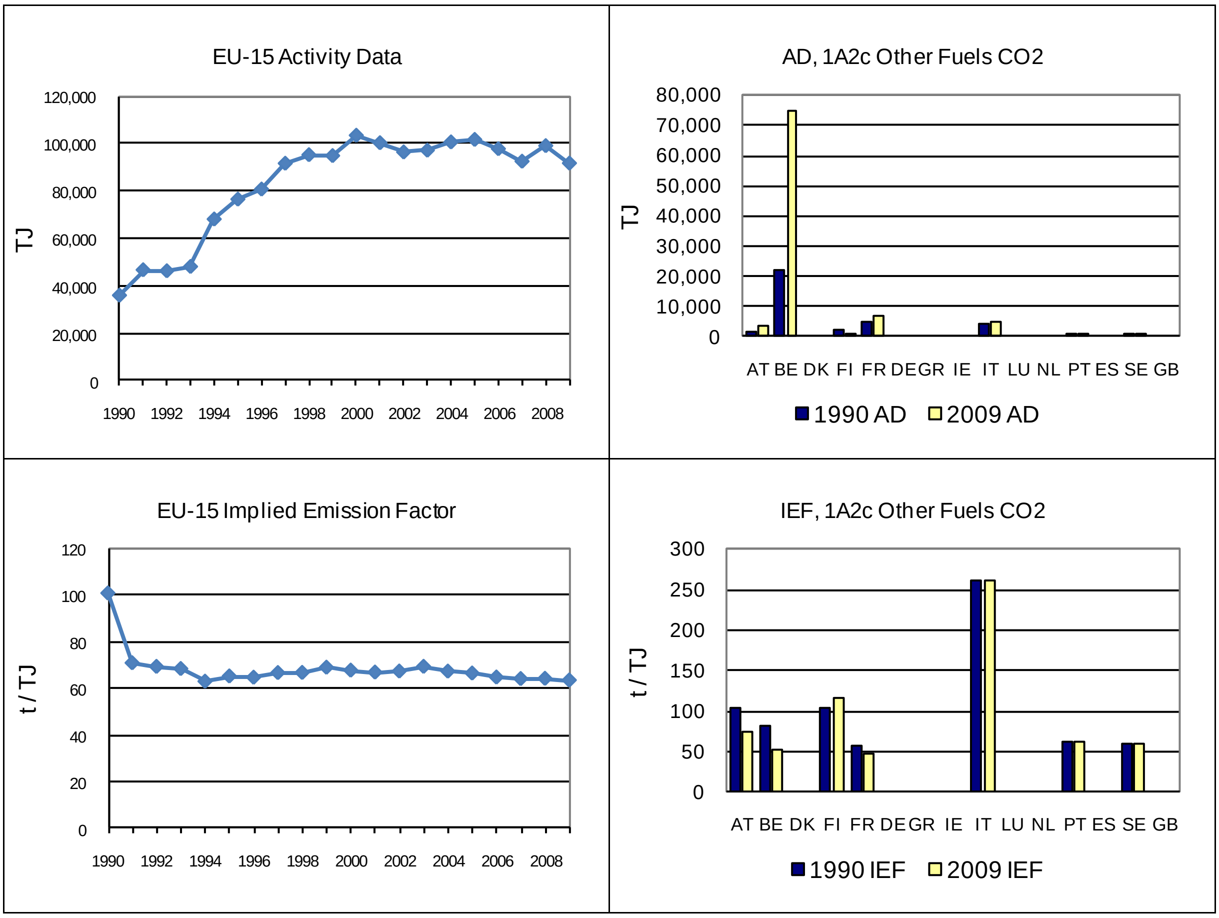
| Member State | $CO_2$ emissions in Gg | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| Austria | 174 | 296 | 254 | 4.4% | -42 | -14% | 80 | 46% | T2 | D,PS |
| Belgium | 1,834 | 3,758 | 3,837 | 66.0% | 79 | 2% | 2,004 | 109% | T3 | PS |
| Denmark | NO | NO | NO | - | - | - | - | - | NA | NA |
| Finland | 202 | 134 | 10 | 0.2% | -124 | -93% | -192 | -95% | T3 | CS |
| France | 268 | 418 | 317 | 5.5% | -101 | -24% | 49 | - | CR | CS |
| Germany | IE | IE | IE | - | - | - | - | - | NA | NA |
| Greece | NO | NO | NO | - | - | - | - | - | NO | NO |
| Ireland | NO | NO | NO | - | - | - | - | - | NO | NO |
| Italy | 1,057 | 1,623 | 1,307 | 22.5% | -316 | -19% | 251 | 24% | T2 | CS |
| Luxembourg | NO | NO | NO | - | - | - | - | - | NA | NA |
| Netherlands | NO | NO | NO | - | - | - | - | - | NA | NA |
| Portugal | 63 | 64 | 54 | 0.9% | -10 | -16% | -9 | -14% | T2 | D,CR |
| Spain | NA | 7 | NA | - | -7 | -100% | - | - | NA | NA |
| Sweden | 6 | 53 | 35 | 0.6% | -18 | -34% | 29 | 523% | T2 | CS |
| United Kingdom | NO | NO | NO | - | - | - | - | - | NA | NA |
| **EU-15** | **3,603** | **6,353** | **5,815** | **100.0%** | **-539** | **-8%** | **2,212** | **61%** | | |

*Emissions of Germany are included in 1A2f.*
*Emissions of the UK are included in 1A2f.*
*Abbreviations explained in the Chapter 'Units and abbreviations'.*

Figure 3.38 shows activity data and implied emission factors for $CO_2$ for EU-15 and the Member States. The largest emissions are reported by Belgium and Italy; together they cause 88 % of the $CO_2$ emissions from other fuels in 1A2c. Other fuel consumption in the EU-15 increased by 156 % between 1990 and 2009. The implied emission factor of EU-15 was 63.5 t/TJ in 2009.

The high implied emission factor 1990 is due to new naphta cracking plants in Belgium which started operation in 1991 and which use recovered fuels with a high share of hydrogen gas. Therefore the IEF of Belgium is much lower for the years after 1990. Because Belgium contributes to 66 % of EU-15 emissions in 2009 it strongly affects the EU-15 IEF. Italy reports a rather high IEF of 260.4 t $CO_2$/TJ. Italy informed that the emission factor refers to gaseous fuels resulting from the petrochemical production processes. These fuels are comparable with blast furnaces gas and steel gas for their proper characteristics.

**Figure 3.38** **1A2c Chemicals, other fuels: Activity Data and Implied Emission Factors for $CO_2$**

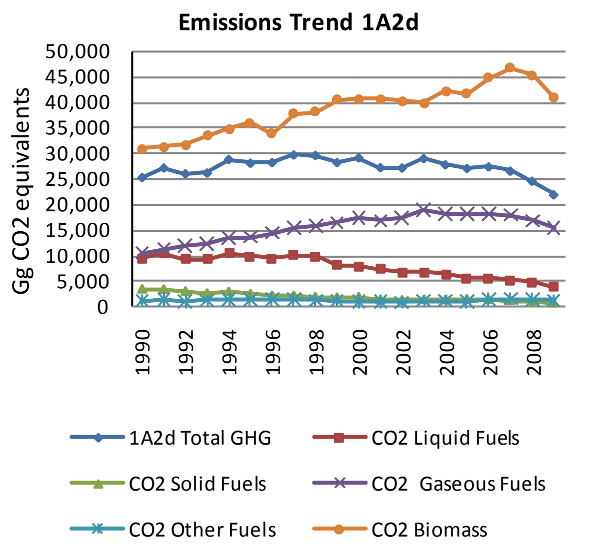


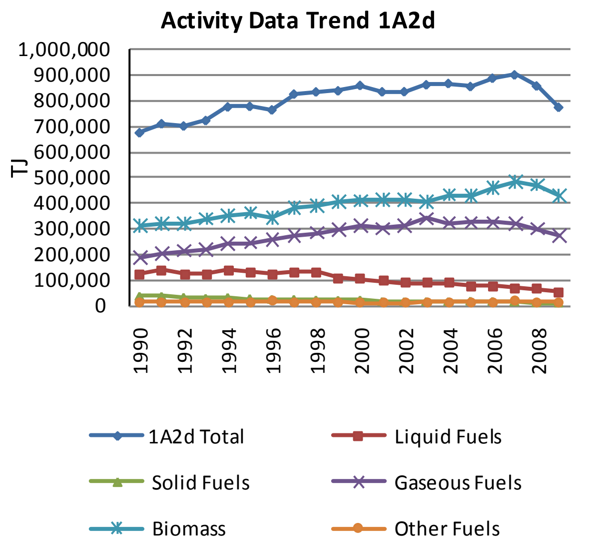
### 3.2.2.5 Pulp, Paper and Print (1A2d) (EU-15)

In this chapter information about emission trends, Member States contribution, activity data and emission factors is provided for category 1A2d by fuels. $CO_2$ emissions from 1A2d Pulp, Paper and Print accounted for 4.7 % of 1A2 source category and 0.6 % of total GHG emissions in 2009.

Figure 3.39 shows the emission trend within the category 1A2d, which is mainly dominated by $CO_2$ emissions from gaseous and liquid fuels. Total GHG emissions decreased by 13 %. The share of gaseous fuels (and of biomass) is gradually increasing since 1990.

**Figure 3.39 1A2d Pulp, Paper and Print: Total and $CO_2$ emission trends**




Between 1990 and 2009, $CO_2$ emissions from 1A2d Pulp, Paper and Print decreased by 14 % in the EU-15 (Table 3.32), mainly due to decreases in Finland, France, Sweden and the Netherlands. Between 2008 and 2009 emissions decreased by 11 %. Luxembourg reported emissions as 'Not occurring' and "Included elsewhere", the UK includes emissions under 1A2f.

**Table 3.32 1A2d Pulp, Paper and Print: Member States' contributions to $CO_2$ emissions**

| Member State | $CO_2$ emissions in Gg | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | |
|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) |
| Austria | 2,213 | 2,198 | 2,194 | 10.3% | -4 | 0% | -19 | -1% |
| Belgium | 637 | 514 | 466 | 2.2% | -48 | -9% | -171 | -27% |
| Denmark | 348 | 170 | 156 | 0.7% | -15 | -9% | -193 | -55% |
| Finland | 5,336 | 3,853 | 3,191 | 15.0% | -661 | -17% | -2,145 | -40% |
| France | 4,990 | 4,069 | 3,441 | 16.1% | -628 | -15% | -1,549 | -31% |
| Germany | 4 | 19 | 14 | 0.1% | -5 | -27% | 11 | 292% |
| Greece | 301 | 240 | 197 | 0.9% | -43 | -18% | -104 | -35% |
| Ireland | 28 | 13 | 12 | 0.1% | -1 | -10% | -17 | -58% |
| Italy | 3,076 | 4,289 | 3,802 | 17.8% | -487 | -11% | 726 | 24% |
| Luxembourg | IE,NO | 13 | 16 | 0.1% | 3 | 21% | 16 | - |
| Netherlands | 1,743 | 1,211 | 1,091 | 5.1% | -120 | -10% | -653 | -37% |
| Portugal | 743 | 620 | 649 | 3.0% | 29 | 5% | -95 | -13% |
| Spain | 3,211 | 5,207 | 4,734 | 22.2% | -474 | -9% | 1,522 | 47% |
| Sweden | 2,186 | 1,549 | 1,369 | 6.4% | -181 | -12% | -817 | -37% |
| United Kingdom | IE,NO | IE,NO | IE,NO | - | - | - | - | - |
| **EU-15** | **24,819** | **23,967** | **21,332** | **100.0%** | **-2,635** | **-11%** | **-3,487** | **-14%** |

*Emissions of the UK are included in 1A2f.*
*Abbreviations explained in the Chapter 'Units and abbreviations'.*

## 1A2d Pulp, Paper and Print - Liquid ($CO_2$)

In 2009 $CO_2$ from liquid fuels had a share of 18 % within source category 1A2d (compared to 38 % in 1990). Between 1990 and 2008 the emissions decreased by 59 % (Table 3.33). Between 1990 and 2009 all Member States reported decreasing $CO_2$ emissions from this source category.

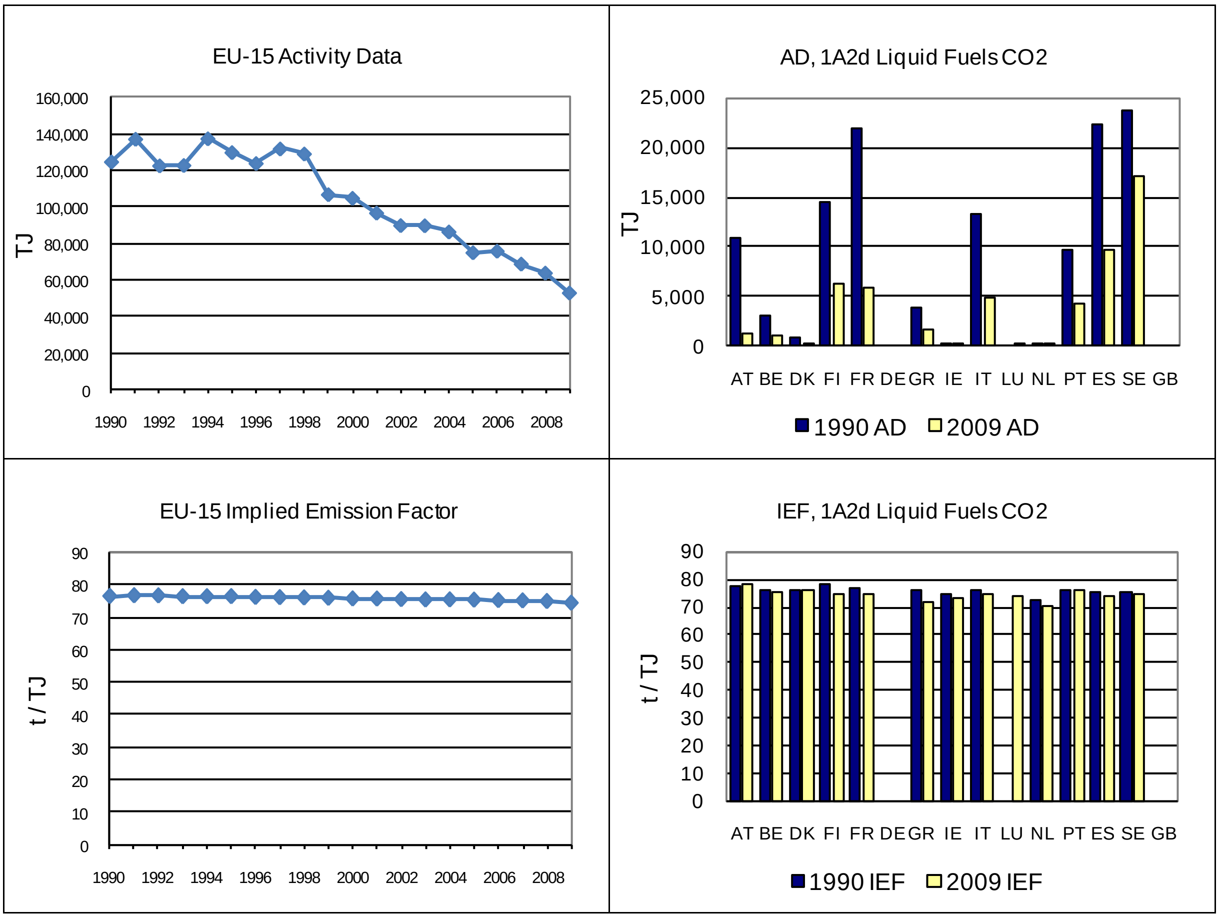
**Table 3.33 1A2d Pulp, Paper and Print, liquid fuels: Member States' contributions to $CO_2$ emissions and information on method applied and emission factor**

| Member State | $CO_2$ emissions in Gg | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| Austria | 853 | 83 | 103 | 2.6% | 20 | 24% | -750 | -88% | T2 | CS,PS |
| Belgium | 232 | 130 | 90 | 2.3% | -40 | -31% | -142 | -61% | T1 | D |
| Denmark | 65 | 9 | 8 | 0.2% | -1 | -9% | -57 | -88% | CR | CS,CR,D |
| Finland | 1,132 | 651 | 476 | 12.2% | -175 | -27% | -656 | -58% | T3 | CS |
| France | 1,685 | 474 | 439 | 11.2% | -35 | -7% | -1,246 | -74% | CR | CS |
| Germany | IE | IE | IE | - | - | - | - | - | NA | NA |
| Greece | 297 | 162 | 119 | 3.0% | -43 | -27% | -178 | -60% | T2 | PS |
| Ireland | 28 | 7 | 6 | 0.2% | -1 | -9% | -22 | -77% | T1 | CS |
| Italy | 1,015 | 609 | 365 | 9.3% | -244 | -40% | -650 | -64% | T2 | CS |
| Luxembourg | IE | 1 | 1 | 0.02% | -1 | -54% | 1 | - | T2 | CS |
| Netherlands | 20 | 2 | 1 | 0.0% | -1 | -54% | -19 | -95% | T2 | CS |
| Portugal | 743 | 385 | 328 | 8.4% | -57 | -15% | -416 | -56% | T2 | D,CR |
| Spain | 1,692 | 825 | 712 | 18.2% | -113 | -14% | -980 | -58% | T2 | PS,C |
| Sweden | 1,786 | 1,423 | 1,268 | 32.4% | -155 | -11% | -518 | -29% | T2 | CS |
| United Kingdom | IE | IE | IE | - | - | - | - | - | NA | NA |
| **EU-15** | **9,549** | **4,762** | **3,916** | **100.0%** | **-847** | **-18%** | **-5,634** | **-59%** | | |

*Emissions of Germany and the UK are included in 1A2f.*
*Abbreviations explained in the Chapter 'Units and abbreviations'.*

Figure 3.40 shows activity data and implied emission factors for $CO_2$ for EU-15 and the Member States. The largest emissions are reported by Finland, France, Italy, Spain and Sweden; together they cause 83% of the $CO_2$ emissions from liquid fuels in 1A2d. Fuel consumption in the EU-15 decreased by 58 % between 1990 and 2009. The implied emission factor of EU-15 was 74.6 t/TJ in 2009.

**Figure 3.40 1A2d Pulp, Paper and Print, liquid fuels: Activity Data and Implied Emission Factors for $CO_2$**




## 1A2d Pulp, Paper and Print - Solid Fuels ($CO_2$)

In 2009 $CO_2$ from solid fuels had a share of 4 % within source category 1A2d (compared to 14 % in 1990). Between 1990 and 2009 the emissions decreased by 78 % (Table 3.34). Only six of the EU-15 Member States reported $CO_2$ emissions from this source category for the years 2008 and 2009.

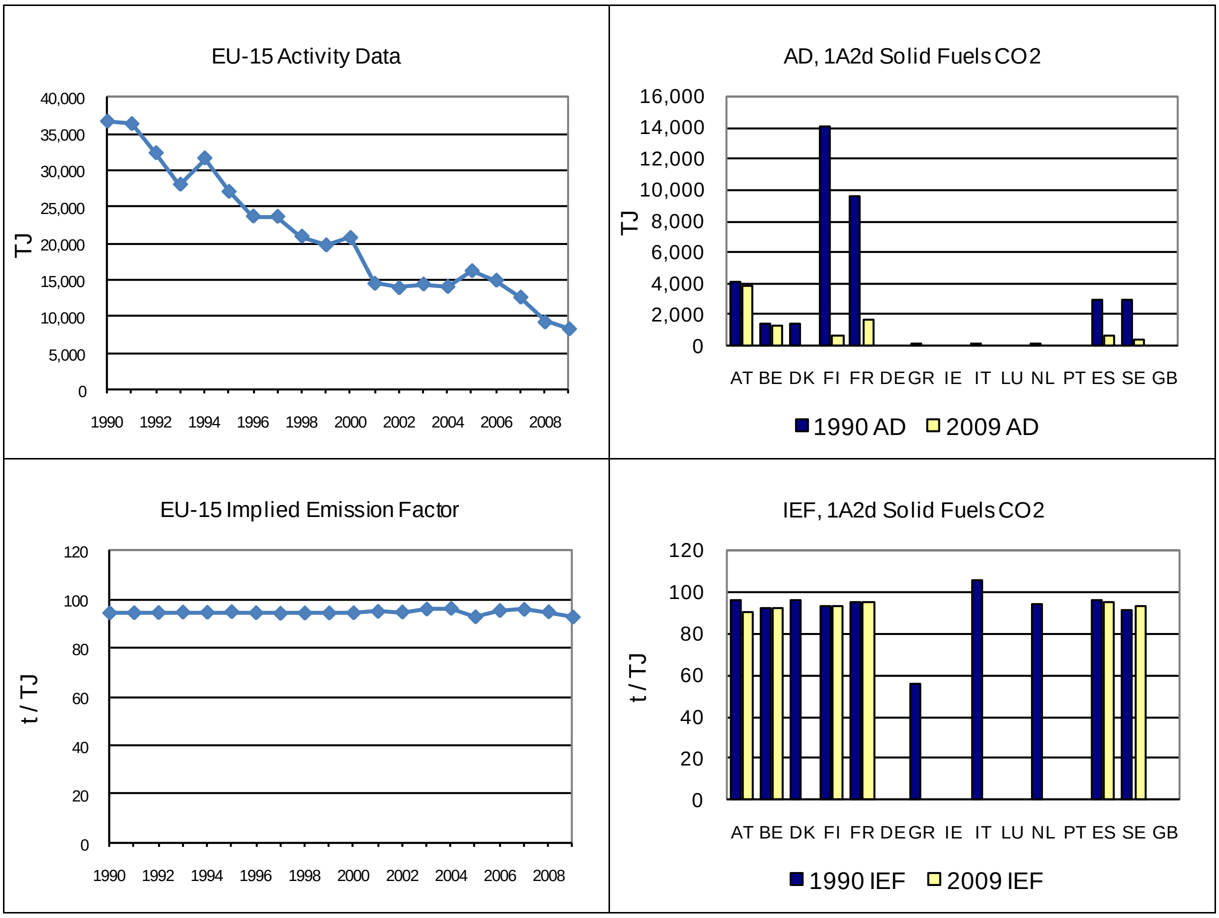
**Table 3.34 1A2d Pulp, Paper and Print, solid fuels: Member States' contributions to $CO_2$ emissions and information on method applied and emission factor**

| Member State | $CO_2$ emissions in Gg | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| Austria | 397 | 330 | 345 | 44.8% | 15 | 4% | -53 | -13% | T2 | CS,PS |
| Belgium | 125 | 118 | 114 | 14.8% | -5 | -4% | -11 | -9% | T1 | D |
| Denmark | 140 | NO | NO | - | - | - | -140 | -100% | NA | NA |
| Finland | 1,318 | 63 | 54 | 7.0% | -9 | -15% | -1,264 | -96% | T3 | CS |
| France | 908 | 259 | 161 | 20.9% | -98 | -38% | -747 | -82% | CR | CS |
| Germany | IE | IE | IE | - | - | - | - | - | NA | NA |
| Greece | 5 | NO | NO | - | - | - | -5 | -100% | NO | NO |
| Ireland | NO | NO | NO | - | - | - | - | - | d template | d template |
| Italy | 6 | NO | NO | - | - | - | -6 | -100% | T2 | CS |
| Luxembourg | NO | NO | NO | - | - | - | - | - | NA | NA |
| Netherlands | 8 | NO | NO | - | - | - | -8 | -100% | NA | NA |
| Portugal | NO | NO | NO | - | - | - | - | - | d template | d template |
| Spain | 286 | 62 | 59 | 7.7% | -3 | -5% | -227 | -79% | T2 | PS,C |
| Sweden | 263 | 43 | 38 | 4.9% | -6 | -13% | -225 | -86% | T2 | CS |
| United Kingdom | IE | IE | IE | - | - | - | - | - | NA | NA |
| **EU-15** | **3,456** | **876** | **770** | **100.0%** | **-106** | **-12%** | **-2,686** | **-78%** | | |

*Emissions of Germany and the UK are included in 1A2f.*
*Abbreviations explained in the Chapter 'Units and abbreviations'.*

Figure 3.41 shows activity data and implied emission factors for $CO_2$ for EU-15 and the Member States. The largest emissions are reported by Austria, Belgium and France; together they cause around 80 % of the $CO_2$ emissions from solid fuels in 1A2d. Solid fuel consumption in the EU-15 decreased by 77 % between 1990 and 2009. The implied emission factor of EU-15 was 92.6 t/TJ in 2009.

**Figure 3.41 1A2d Pulp, Paper and Print, solid fuels:Activity Data and Implied Emission Factors for $CO_2$**



## 1A2d Pulp, Paper and Print - Gaseous Fuels ($CO_2$)

In 2009, $CO_2$ from gaseous fuels had a share of 70 % within source category 1A2d (compared to 42 % in 1990). Between 1990 and 2009, the emissions increased by 45 % (Table 3.35). In all EU-15 Member States emissions increased between 1990 and 2008 except for in Belgium, Finland, the Netherlands and Sweden. Germany and the United Kingdom include emissions in 1A2f.

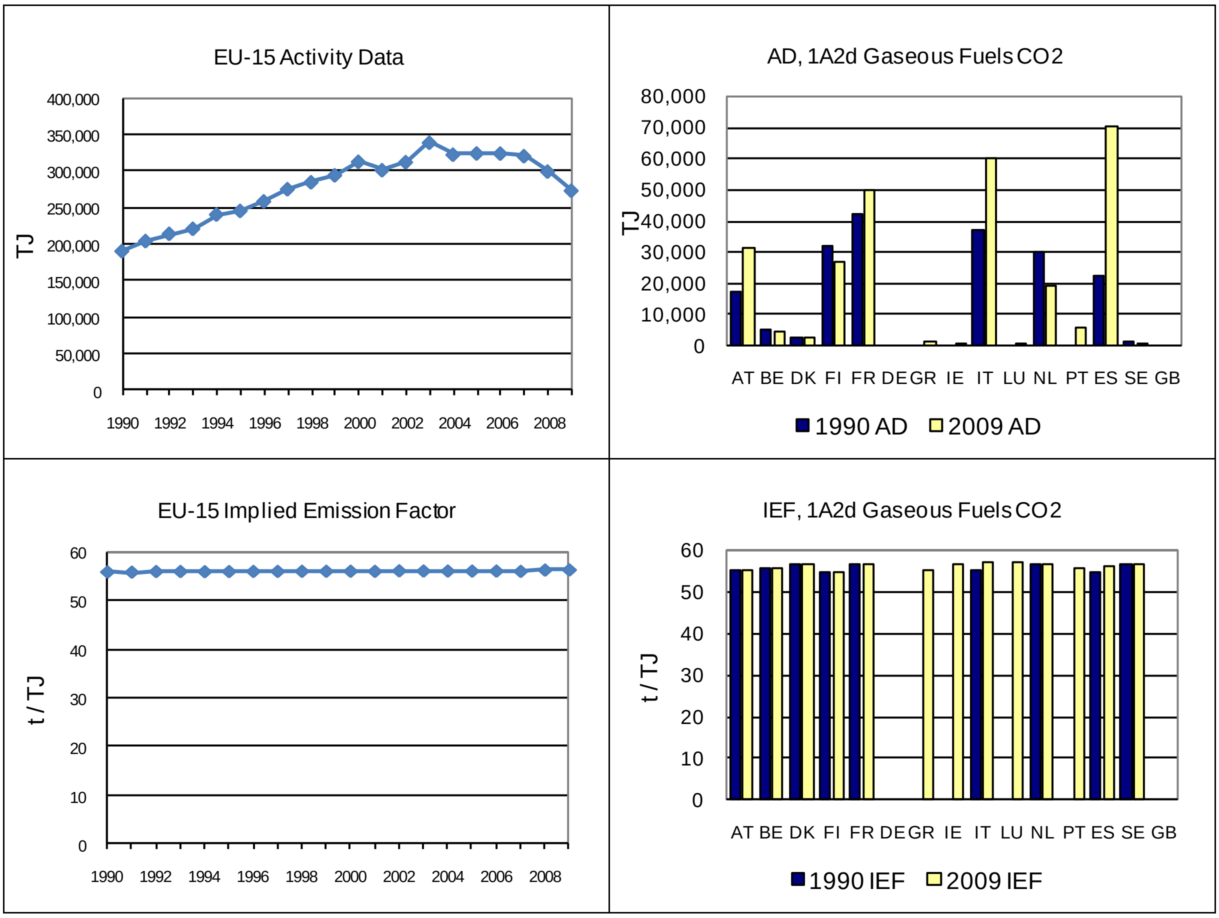
**Table 3.35 1A2d Pulp, Paper and Print, gaseous fuels: Member States' contributions to $CO_2$ emissions and information on method applied and emission factor**

| Member State | $CO_2$ emissions in Gg | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| Austria | 943 | 1,776 | 1,738 | 11.3% | -39 | -2% | 795 | 84% | T2 | CS |
| Belgium | 280 | 266 | 250 | 1.6% | -16 | -6% | -31 | -11% | T1 | D |
| Denmark | 143 | 161 | 147 | 1.0% | -14 | -9% | 5 | 3% | CR | CS |
| Finland | 1,748 | 1,761 | 1,473 | 9.6% | -289 | -16% | -275 | -16% | T3 | CS |
| France | 2,398 | 3,332 | 2,839 | 18.4% | -493 | -15% | 442 | 18% | CR | CS |
| Germany | IE | IE | IE | - | - | - | - | - | NA | NA |
| Greece | NO | 78 | 79 | 0.5% | 1 | 1% | 79 | - | T2 | CS |
| Ireland | NO | 6 | 5 | 0.0% | -1 | - | 5 | - | T1 | CS |
| Italy | 2,055 | 3,680 | 3,438 | 22.3% | -242 | -7% | 1,383 | 67% | T2 | CS |
| Luxembourg | IE | 12 | 15 | 0.1% | 4 | 30% | 15 | - | T2 | CS |
| Netherlands | 1,715 | 1,209 | 1,089 | 7.1% | -119 | -10% | -626 | -36% | T2 | CS |
| Portugal | NO | 235 | 321 | 2.1% | 86 | 37% | 321 | - | T2 | D,CR |
| Spain | 1,233 | 4,320 | 3,963 | 25.7% | -357 | -8% | 2,730 | 221% | T2 | CS |
| Sweden | 66 | 38 | 35 | 0.2% | -3 | -8% | -31 | -47% | T2 | CS |
| United Kingdom | IE | IE | IE | - | - | - | - | - | NA | NA |
| **EU-15** | **10,580** | **16,874** | **15,392** | **100.0%** | **-1,482** | **-9%** | **4,812** | **45%** | | |

*Emissions of Germany and UK are included in 1A2f.*
*Abbreviations explained in the Chapter 'Units and abbreviations'.*

Figure 3.42 shows activity data and implied emission factors for $CO_2$ comparing the EU-15 average and the Member States. The largest emissions are reported by Austria, Finland, France, Italy and Spain; together they cause 87 % of the $CO_2$ emissions from gaseous fuels in 1A2d. Gaseous fuel consumption in the EU-15 rose by 44 % between 1990 and 2009. The implied emission factor of EU-15 was 56.3 t/TJ in 2009.

**Figure 3.42** 1A2d Pulp, Paper and Print, gaseous fuels: Activity Data and Implied Emission Factors for $CO_2$

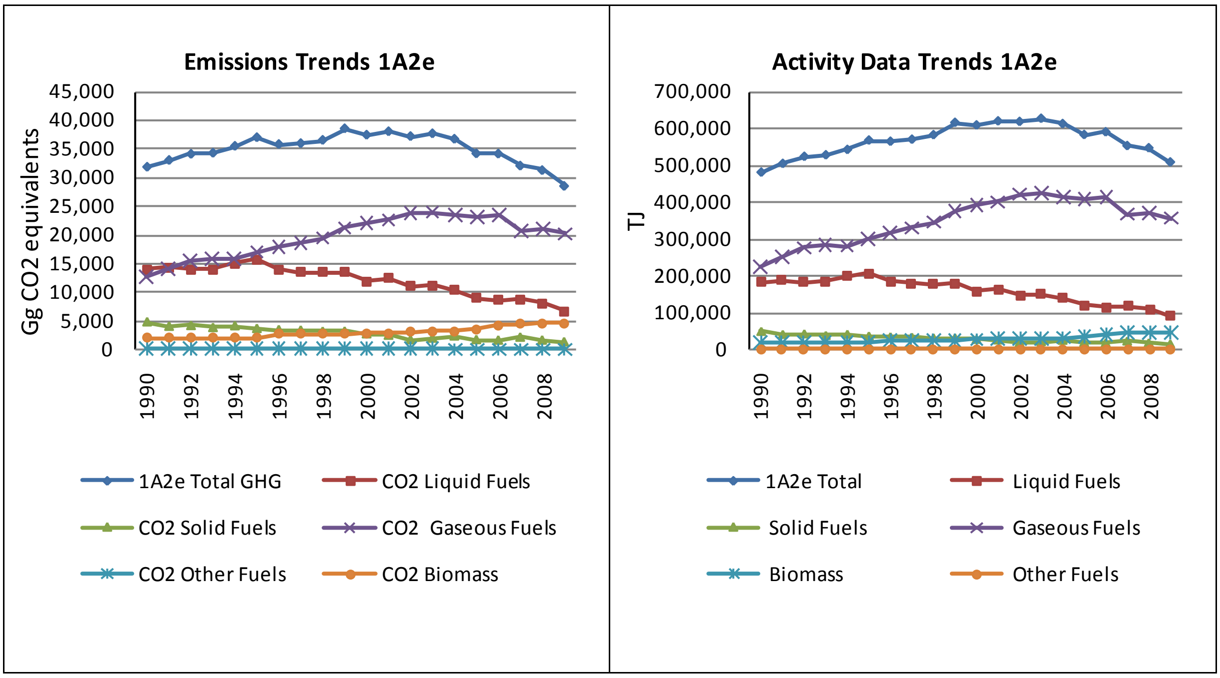



### 3.2.2.6 Food Processing, Beverages and Tobacco (1A2e) (EU-15)

In this chapter information about emission trends, Member States contribution, activity data and emission factors is provided for category 1A2e by fuels. $CO_2$ emissions from 1A2e Food Processing, Beverages and Tobacco accounted for 6.2 % of 1A2 source category and for 0.8 % of total GHG emissions in 2009.

Figure 3.43 shows the emission trend within the category 1A2e, which is mainly dominated by $CO_2$ emissions from gaseous and liquid fuels. Total GHG emissions decreased by 10 % between 1990 and 2009. Emissions from gaseous fuels increased by 60 %, whereas emissions from all other fossil fuel types decreased.

**Figure 3.43 1A2e Food Processing, Beverages and Tobacco: Total and $CO_2$ emission trends**




Between 1990 and 2009, $CO_2$ emissions from 1A2e Food Processing, Beverages and Tobacco decreased by 11 % in the EU-15 (Table 3.36). Large increases in France and Italy were offset by large decreases in Germany, the Netherlands and Belgium. Between 2008 and 2008 emissions decreased by 9 %.

**Table 3.36 1A2e Food Processing, Beverages and Tobacco: Member States' contributions to $CO_2$ emissions**

| Member State | $CO_2$ emissions in Gg | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | |
|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) |
| Austria | 870 | 883 | 887 | 3.1% | 3 | 0% | 17 | 2% |
| Belgium | 2,990 | 2,052 | 1,885 | 6.7% | -167 | -8% | -1,105 | -37% |
| Denmark | 1,477 | 1,072 | 922 | 3.3% | -149 | -14% | -555 | -38% |
| Finland | 815 | 155 | 138 | 0.5% | -17 | -11% | -678 | -83% |
| France | 8,465 | 10,484 | 9,839 | 34.8% | -645 | -6% | 1,374 | 16% |
| Germany | 1,989 | 165 | 163 | 0.6% | -3 | -2% | -1,826 | -92% |
| Greece | 902 | 652 | 588 | 2.1% | -64 | -10% | -314 | -35% |
| Ireland | 1,018 | 1,101 | 1,075 | 3.8% | -26 | -2% | 57 | 6% |
| Italy | 3,853 | 5,568 | 4,660 | 16.5% | -907 | -16% | 807 | 21% |
| Luxembourg | 16 | 14 | 17 | 0.1% | 3 | 21% | 1 | 5% |
| Netherlands | 4,079 | 3,609 | 3,268 | 11.6% | -341 | -9% | -812 | -20% |
| Portugal | 822 | 940 | 899 | 3.2% | -41 | -4% | 77 | 9% |
| Spain | 3,373 | 3,775 | 3,452 | 12.2% | -323 | -9% | 79 | 2% |
| Sweden | 948 | 490 | 487 | 1.7% | -3 | -1% | -461 | -49% |
| United Kingdom | IE,NO | IE,NO | IE,NO | - | - | - | - | - |
| **EU-15** | **31,617** | **30,959** | **28,279** | **100.0%** | **-2,680** | **-9%** | **-3,338** | **-11%** |

*Emissions of the UK are inlcuded in 1A2f.*
*Abbreviations explained in the Chapter 'Units and abbreviations'.*

### 1A2e Food Processing, Beverages and Tobacco - Liquid ($CO_2$)

In 2009 $CO_2$ from liquid fuels decreased to a share of 23 % within source category 1A2e (compared to 44 % in 1990). Between 1990 and 2009, the emissions decreased by 52 % (Table 3.37). Between 1990 and 2009 all Member States except for Ireland showed reduction of emissions.

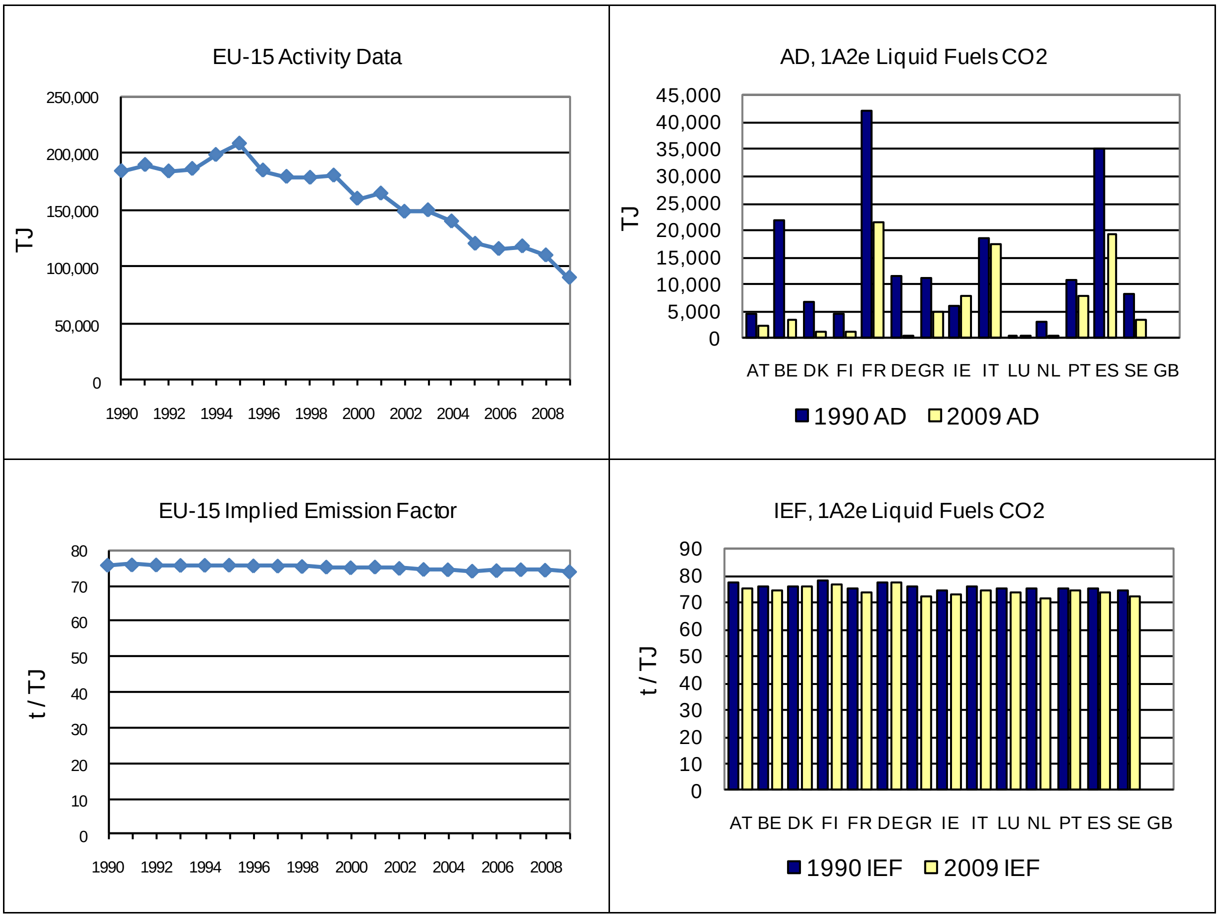
**Table 3.37 1A2e Food Processing, Beverages and Tobacco, liquid fuels: Member States' contributions to $CO_2$ emissions and information on method applied and emission factor**

| Member State | $CO_2$ emissions in Gg | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| Austria | 345 | 189 | 181 | 2.7% | -9 | -5% | -164 | -48% | T2 | CS,PS |
| Belgium | 1,671 | 417 | 242 | 3.6% | -175 | -42% | -1,429 | -86% | T1 | D |
| Denmark | 513 | 94 | 86 | 1.3% | -8 | -9% | -427 | -83% | CR | CS,CR,D |
| Finland | 353 | 95 | 84 | 1.3% | -11 | -11% | -269 | -76% | T3 | CS |
| France | 3,179 | 1,817 | 1,577 | 23.7% | -239 | -13% | -1,601 | -50% | CR | CS |
| Germany | 889 | 21 | 18 | 0.3% | -3 | -15% | -871 | -98% | CS | CS |
| Greece | 847 | 451 | 340 | 5.1% | -111 | -25% | -507 | -60% | T2 | PS |
| Ireland | 433 | 592 | 583 | 8.8% | -9 | -1% | 151 | 35% | T1 | CS |
| Italy | 1,421 | 1,999 | 1,293 | 19.4% | -705 | -35% | -128 | -9% | T2 | CS |
| Luxembourg | 12 | 6 | 6 | 0.1% | 1 | 14% | -6 | -48% | T1,T2 | CS,D |
| Netherlands | 235 | 15 | 7 | 0.1% | -8 | -55% | -228 | -97% | T2 | CS |
| Portugal | 820 | 601 | 578 | 8.7% | -22 | -4% | -242 | -30% | T2 | D,CR |
| Spain | 2,633 | 1,609 | 1,415 | 21.2% | -193 | -12% | -1,218 | -46% | T2 | CR |
| Sweden | 596 | 260 | 251 | 3.8% | -9 | -3% | -345 | -58% | T2 | CS |
| United Kingdom | IE | IE | IE | - | - | - | - | - | NA | NA |
| **EU-15** | **13,947** | **8,165** | **6,662** | **100.0%** | **-1,503** | **-18%** | **-7,285** | **-52%** | | |

*Emissions of the UK are included in 1A2f.*
*Abbreviations explained in the Chapter 'Units and abbreviations'.*

Figure 3.44 shows activity data and implied emission factors for $CO_2$ comparing the EU-15 average and the Member States. The largest emissions are reported by France, Italy and Spain; together they cause 64 % of the $CO_2$ emissions from liquid fuels in 1A2e. Fuel consumption in the EU-15 decreased by 51 % between 1990 and 2009. The implied emission factor of EU-15 was 74.0 t/TJ in 2009.

**Figure 3.44** 1A2e Food Processing, Beverages and Tobacco, liquid fuels: Activity Data and Implied Emission Factors for $CO_2$




## 1A2e Food Processing Beverages and Tobacco - Solid ($CO_2$)

In 2009 solid fuels had a share of 5 % within source category 1A2e (compared to 15 % in 1990). Between 1990 and 2009 the emissions decreased by 72 % (Table 3.38) and all Member States reported decreasing $CO_2$ emissions from this source category.

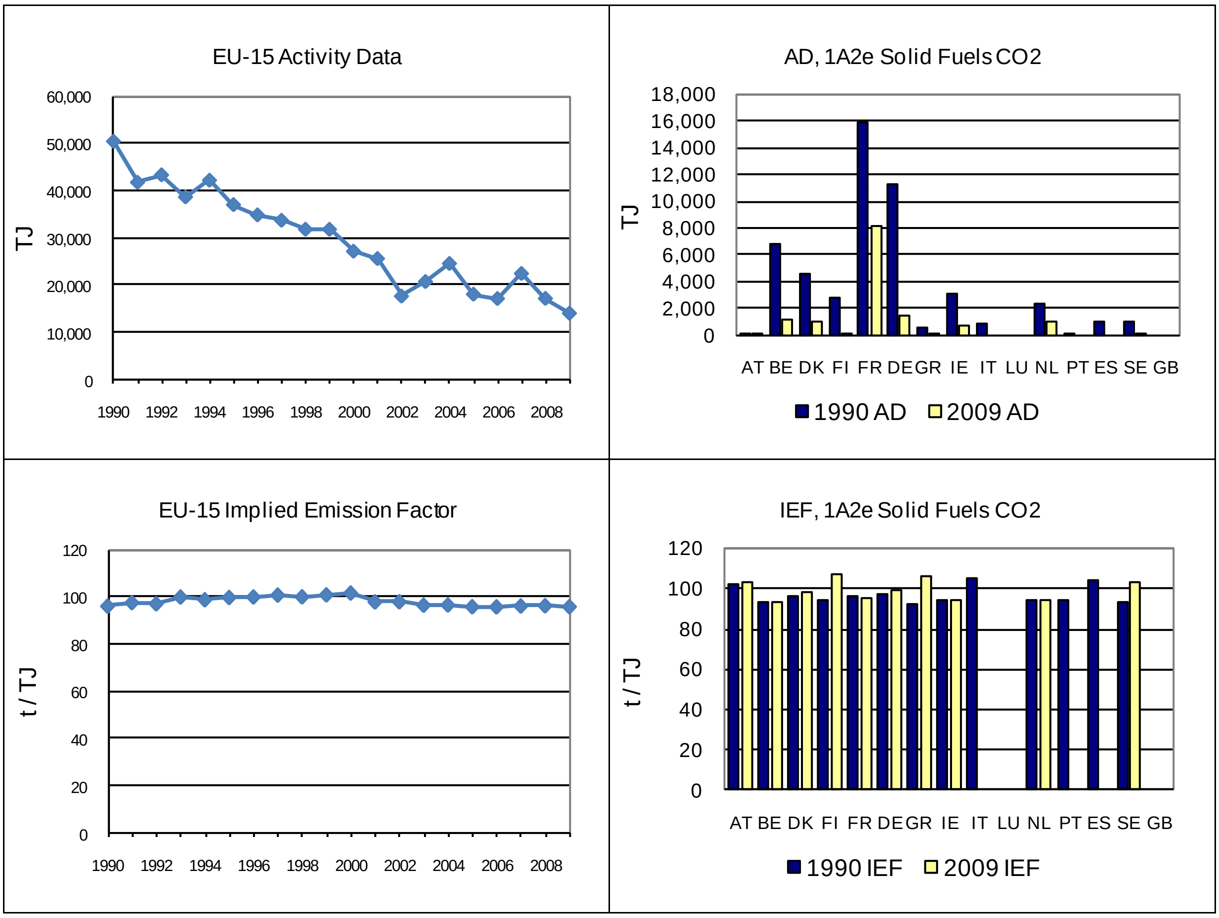
**Table 3.38** **1A2e Food Processing, Beverages and Tobacco, solid fuels: Member States' contributions to $CO_2$ emissions and information on method applied and emission factor**

| Member State | $CO_2$ emissions in Gg | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| Austria | 18 | 12 | 14 | 1.0% | 2 | 16% | -4 | -23% | T2 | CS,PS |
| Belgium | 638 | 125 | 105 | 7.8% | -21 | -16% | -533 | -84% | T1 | D |
| Denmark | 444 | 178 | 105 | 7.9% | -73 | -41% | -339 | -76% | CR | CS,D |
| Finland | 257 | 3 | 3 | 0.2% | 0 | 0% | -254 | -99% | T3 | CS |
| France | 1,525 | 849 | 770 | 57.5% | -79 | -9% | -755 | -49% | CR | CS |
| Germany | 1,100 | 145 | 145 | 10.8% | 0 | 0% | -955 | -87% | CS | CS |
| Greece | 56 | 9 | 15 | 1.1% | 7 | 78% | -40 | -72% | T2 | PS |
| Ireland | 292 | 86 | 71 | 5.3% | -15 | -17% | -220 | -76% | T1 | CS |
| Italy | 86 | NO | NO | - | - | - | -86 | -100% | NA | NA |
| Luxembourg | NO | NO | NO | - | - | - | - | - | NA | NA |
| Netherlands | 227 | 109 | 100 | 7.4% | -10 | -9% | -128 | -56% | T2 | CS |
| Portugal | 1 | NO | NO | - | - | - | -1 | -100% | T2 | D,CR |
| Spain | 109 | 114 | NA | - | -114 | -100% | -109 | -100% | NA | NA |
| Sweden | 90 | 15 | 10 | 0.8% | -5 | -33% | -80 | -89% | T2 | CS |
| United Kingdom | IE | IE | IE | - | - | - | - | - | NA | NA |
| **EU-15** | **4,841** | **1,645** | **1,338** | **100.0%** | **-306** | **-19%** | **-3,503** | **-72%** | | |

*Emissions of the UK are included in 1A2f.*
*Abbreviations explained in the Chapter 'Units and abbreviations'.*

Figure 3.45 shows activity data and implied emission factors for $CO_2$ for EU-15 and the Member States. The largest emissions are reported by France which contributes 58 % of the $CO_2$ emissions from solid fuels in 1A2e. Fuel consumption in the EU-15 decreased by 72 % between 1990 and 2009. The implied emission factor of EU-15 was 95.8 t/TJ in 2009.

**Figure 3.45** **1A2e Food Processing, Beverages and Tobacco, solid fuels: Activity Data and Implied Emission Factors for $CO_2$**



### 1A2e Food Processing Beverages and Tobacco - Gaseous ($CO_2$)

In 2009 $CO_2$ from gaseous fuels had a share of 71 % within source category 1A2e (compared to 40 % in 1990). Between 1990 and 2009 the emissions increased by 60 % (Table 3.39). Between 1990 and 2009 most Member States reported increasing $CO_2$ emissions from this source category. Major absolute increases occurred in Spain, France and Italy. Germany and the UK report emissions in 1A2f.

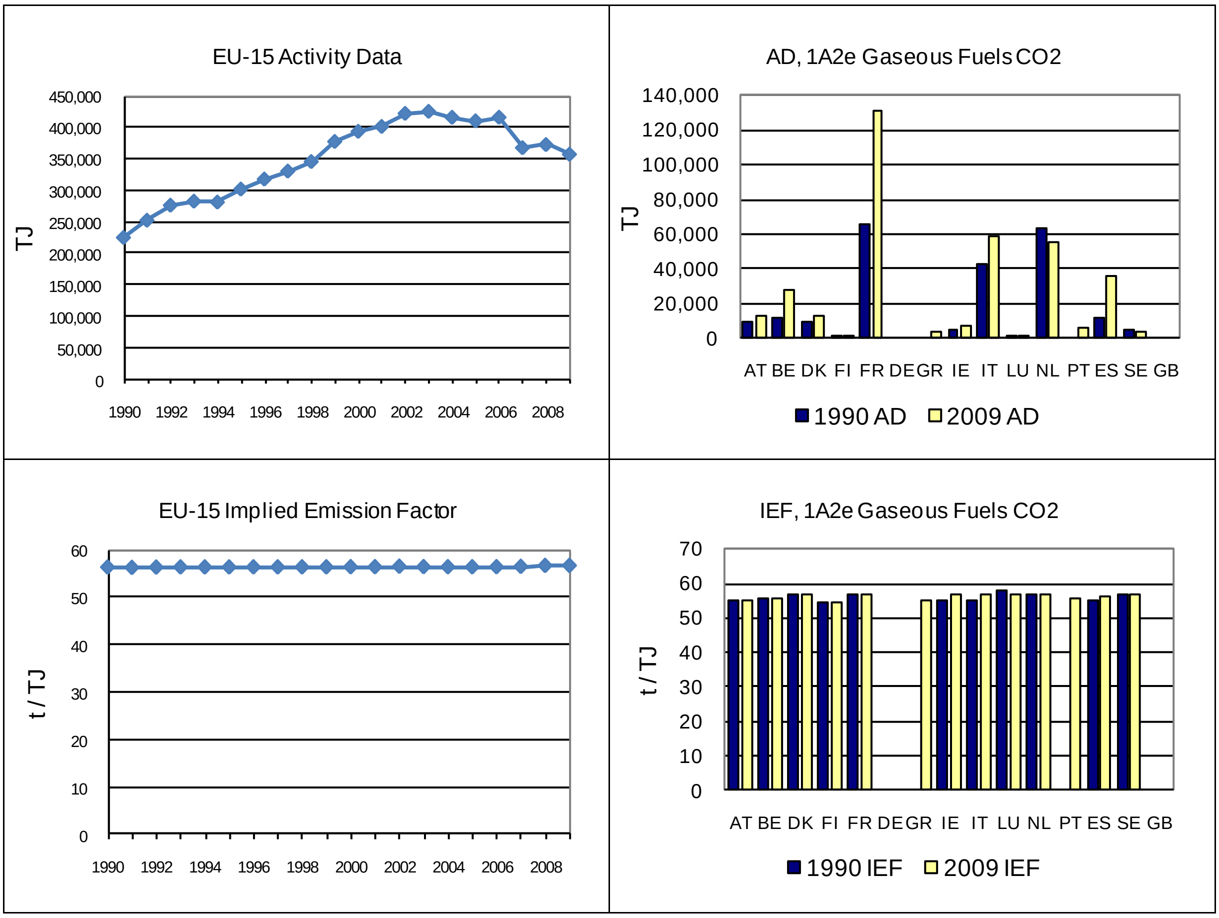
**Table 3.39 1A2e Food Processing, Beverages and Tobacco, gaseous fuels: Member States' contributions to $CO_2$ emissions and information on method applied and emission factor**

| Member State | $CO_2$ emissions in Gg | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| Austria | 507 | 682 | 692 | 3.4% | 10 | 2% | 185 | 37% | T2 | CS |
| Belgium | 681 | 1,510 | 1,538 | 7.6% | 29 | 2% | 858 | 126% | T1 | D |
| Denmark | 520 | 800 | 731 | 3.6% | -69 | -9% | 211 | 41% | CR | CS |
| Finland | 67 | 12 | 12 | 0.1% | 0 | 2% | -55 | -82% | T3 | CS |
| France | 3,762 | 7,819 | 7,492 | 37.0% | -327 | -4% | 3,730 | 99% | CR | CS |
| Germany | IE | IE | IE | - | - | - | - | - | NA | NA |
| Greece | NO | 192 | 233 | 1.2% | 41 | 21% | 233 | ###### | T2 | CS |
| Ireland | 294 | 423 | 420 | 2.1% | -3 | -1% | 127 | 43% | T1 | CS |
| Italy | 2,346 | 3,569 | 3,367 | 16.64% | -202 | -6% | 1,021 | 43% | T2 | CS |
| Luxembourg | 4 | 8 | 11 | 0.05% | 2.1 | 25% | 7 | 177% | T2 | CS |
| Netherlands | 3,617 | 3,484 | 3,161 | 15.6% | -323 | -9% | -456 | -13% | T2 | CS |
| Portugal | NO | 339 | 321 | 1.6% | -19 | -6% | 321 | - | T2 | D,CR |
| Spain | 631 | 2,052 | 2,036 | 10.1% | -16 | -1% | 1,405 | 223% | T2 | CS |
| Sweden | 254 | 215 | 226 | 1.1% | 11 | 5% | -28 | -11% | T2 | CS |
| United Kingdom | IE | IE | IE | - | - | - | - | - | NA | NA |
| **EU-15** | **12,682** | **21,104** | **20,240** | **100.0%** | **-864** | **-4%** | **7,558** | **60%** | | |

*Emissions of Germany and the UK are included in 1A2f.*
*Abbreviations explained in the Chapter 'Units and abbreviations'.*

Figure 3.46 shows activity data and implied emission factors for $CO_2$ for EU-15 and the Member States. The largest emissions are reported by France, Italy, the Netherlands and Spain; together they cause about 79 % of the $CO_2$ emissions from gaseous fuels in 1A2e. Fuel consumption in the EU-15 rose by 59 % between 1990 and 2009. The implied emission factor of EU-15 was 56.7 t/TJ in 2009.

**Figure 3.46** **1A2e Food Processing, Beverages and Tobacco, gaseous fuels: Activity Data and Implied Emission Factors for $CO_2$**

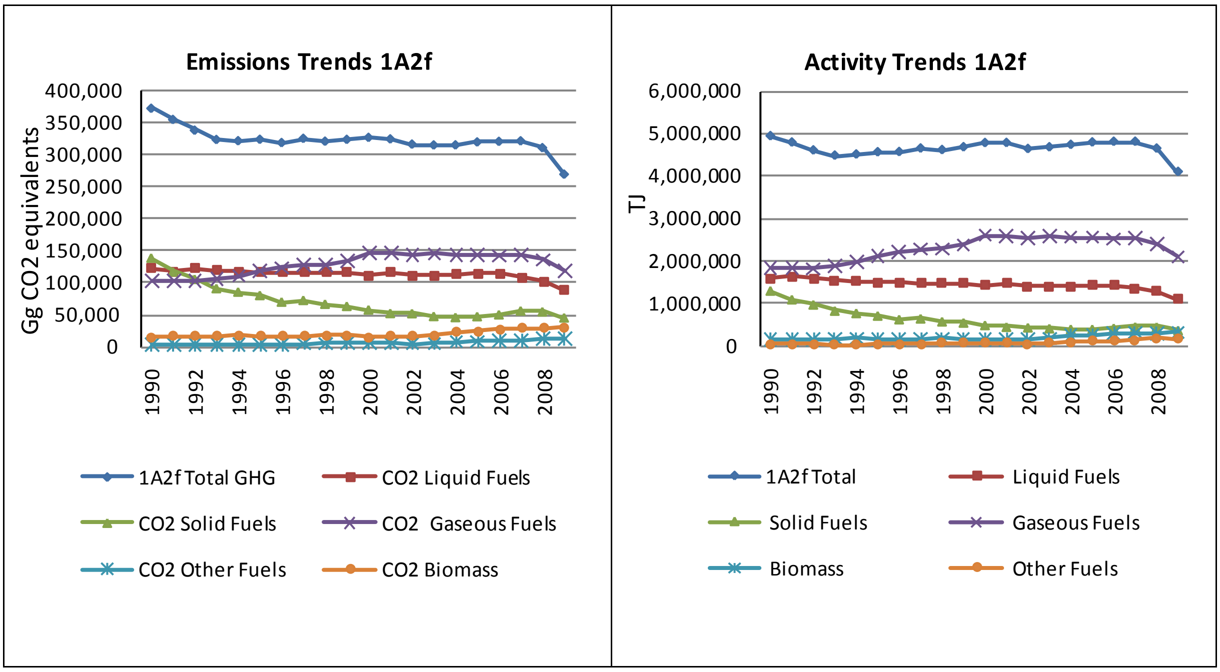


### 3.2.2.7 Other (1A2f) (EU-15)

In this chapter information about emission trends, Member States contribution, activity data and emission factors is provided for category 1A2f by fuels. $CO_2$ emissions from 1A2f Other accounted for 58.3 % for 1A2 source category and for 7.1 % of total GHG emissions in 2009.

Figure 3.47 shows the emission trend within the category 1A2f, which is mainly dominated by $CO_2$ emissions from gaseous and liquid fuels; the decrease in the early 1990s was mainly due to a decline of solid fuel consumption. Total GHG emissions decreased by 28 %, mainly due to decreases in emissions from solid (-67 %) and liquid (-28 %) fuels.

**Figure 3.47 1A2f Other: Total and $CO_2$ emission trends**




Between 1990 and 2009, $CO_2$ emissions from 1A2f Other decreased by 28 % in the EU-15 (Table 3.40), mainly due to decreases in Germany (-43 %) and the United Kingdom (-30 %). Spanish emissions increased by 41 % in the same period.

**Table 3.40 1A2f Other: Member States' contributions to $CO_2$ emissions**

| Member State | $CO_2$ emissions in Gg | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | |
|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) |
| Austria | 3,641 | 4,893 | 4,431 | 1.7% | -462 | -9% | 791 | 22% |
| Belgium | 7,969 | 6,836 | 5,763 | 2.2% | -1,073 | -16% | -2,207 | -28% |
| Denmark | 3,105 | 3,259 | 2,468 | 0.9% | -791 | -24% | -637 | -21% |
| Finland | 2,904 | 2,309 | 1,778 | 0.7% | -531 | -23% | -1,126 | -39% |
| France | 28,378 | 23,612 | 21,142 | 8.0% | -2,469 | -10% | -7,236 | -25% |
| Germany | 156,459 | 101,867 | 89,886 | 34.0% | -11,981 | -12% | -66,573 | -43% |
| Greece | 6,126 | 6,683 | 5,094 | 1.9% | -1,590 | -24% | -1,033 | -17% |
| Ireland | 1,502 | 2,666 | 1,867 | 0.7% | -799 | -30% | 365 | 24% |
| Italy | 40,489 | 38,007 | 29,918 | 11.3% | -8,089 | -21% | -10,571 | -26% |
| Luxembourg | 638 | 663 | 605 | 0.2% | -59 | -9% | -33 | -5% |
| Netherlands | 5,844 | 5,194 | 4,743 | 1.8% | -451 | -9% | -1,101 | -19% |
| Portugal | 5,487 | 6,151 | 5,374 | 2.0% | -778 | -13% | -113 | -2% |
| Spain | 24,070 | 39,053 | 34,014 | 12.9% | -5,039 | -13% | 9,944 | 41% |
| Sweden | 5,670 | 4,495 | 4,114 | 1.6% | -382 | -8% | -1,557 | -27% |
| United Kingdom | 75,841 | 60,030 | 52,912 | 20.0% | -7,118 | -12% | -22,929 | -30% |
| **EU-15** | **368,123** | **305,718** | **264,107** | **100.0%** | **-41,610** | **-14%** | **-104,016** | **-28%** |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

## 1A2f Other - Liquid Fuels($CO_2$)

In 2009 liquid fuels had a share of 33 % within source category 1A2f (compared to 33 % in 1990). Between 1990 and 2009 the emissions decreased by 28 % (Table 3.41). Between 1990 and 2009 the highest absolute decreases were achieved by Germany and the United Kingdom. The highest absolute increases were reported from Greece and Spain.

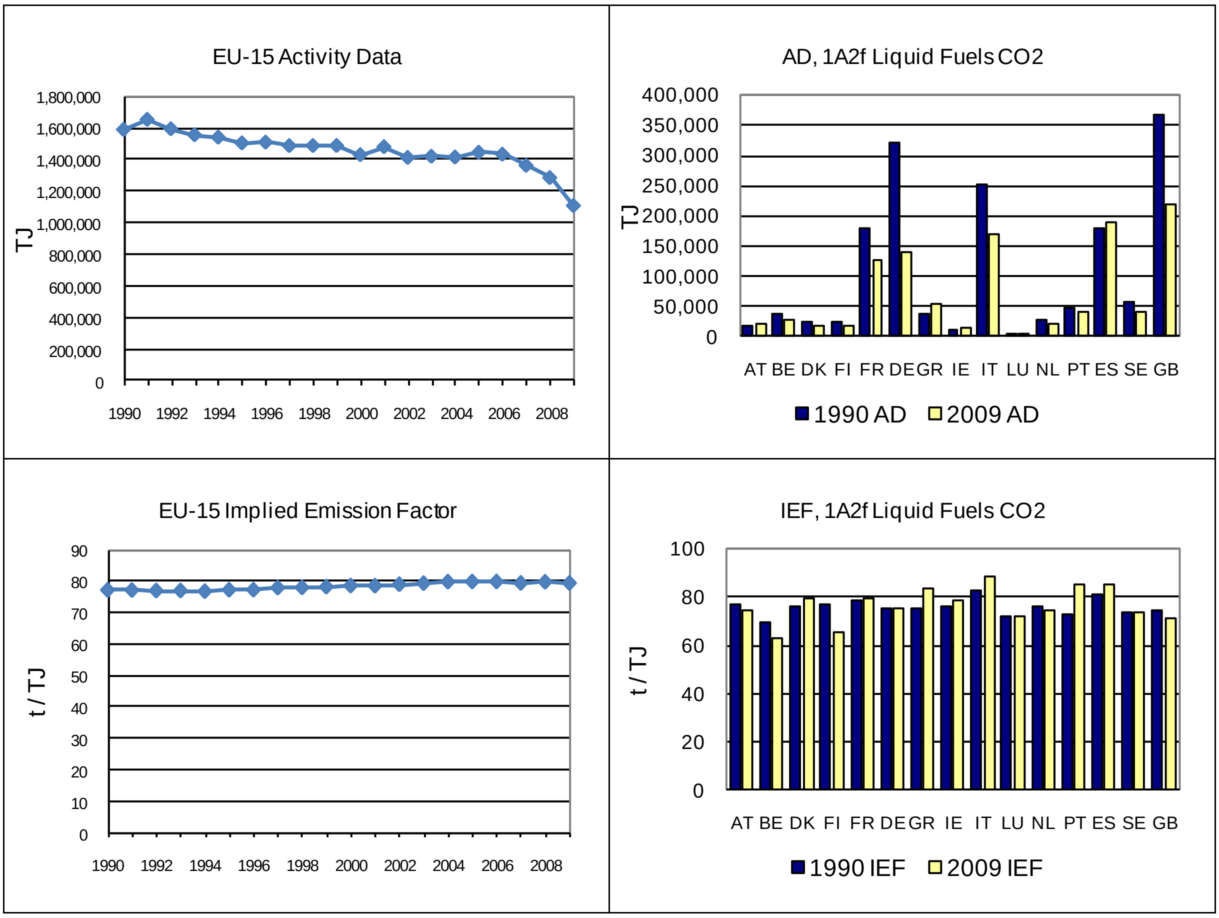
**Table 3.41 1A2f Other, liquid fuels: Member States' contributions to $CO_2$ emissions and information on method applied and emission factor**

| Member State | $CO_2$ emissions in Gg | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| Austria | 1,373 | 1,848 | 1,636 | 1.9% | -212 | -11% | 263 | 19% | T2 | CS,PS |
| Belgium | 2,690 | 2,326 | 1,724 | 2.0% | -602 | -26% | -967 | -36% | T1 | D |
| Denmark | 1,851 | 1,963 | 1,555 | 1.8% | -408 | -21% | -295 | -16% | CR | CS,CR,D |
| Finland | 1,809 | 1,355 | 1,112 | 1.3% | -243 | -18% | -697 | -39% | CS,M,T3 | CS |
| France | 14,268 | 11,482 | 10,201 | 11.6% | -1,281 | -11% | -4,067 | -29% | CR | CS |
| Germany | 24,094 | 12,046 | 10,694 | 12.2% | -1,352 | -11% | -13,401 | -56% | CS | CS |
| Greece | 2,828 | 5,287 | 4,495 | 5.1% | -792 | -15% | 1,667 | 59% | T2 | PS |
| Ireland | 824 | 1,630 | 1,052 | 1.2% | -578 | -35% | 228 | 28% | T1 | CS |
| Italy | 20,965 | 19,484 | 15,086 | 17.2% | -4,398 | -23% | -5,879 | -28% | T2 | CS |
| Luxembourg | 81 | 137 | 75 | 0.1% | -61 | -45% | -5 | -7% | T1,T2 | CS,D |
| Netherlands | 2,126 | 1,760 | 1,633 | 1.9% | -127 | -7% | -493 | -23% | T2 | CS |
| Portugal | 3,371 | 3,864 | 3,432 | 3.9% | -433 | -11% | 60 | 2% | T2 | D,CR |
| Spain | 14,565 | 18,145 | 16,205 | 18.5% | -1,939 | -11% | 1,640 | 11% | T2,T3 | CS,CR |
| Sweden | 4,263 | 3,146 | 3,062 | 3.5% | -84 | -3% | -1,201 | -28% | T1,T2 | CS |
| United Kingdom | 27,375 | 17,683 | 15,811 | 18.0% | -1,872 | -11% | -11,564 | -42% | T2 | CS |
| **EU-15** | **122,484** | **102,156** | **87,773** | **100.0%** | **-14,383** | **-14%** | **-34,711** | **-28%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

Figure 3.48 shows activity data and implied emission factors for $CO_2$ for EU-15 and the Member States. The largest emissions are reported by France, Germany, Italy, Spain and the United Kingdom; together they cause 59 % of the $CO_2$ emissions from liquid fuels in 1A2f. Fuel consumption in the EU-15 decreased by 9 % between 1990 and 2009. The implied emission factor of EU-15 was 79.7 t/TJ in 2009.

**Figure 3.48** 1A2f Other, liquid fuels: Activity Data and Implied Emission Factors for $CO_2$




## 1A2f Other - Solid ($CO_2$)

In 2009 $CO_2$ from solid fuels had a share of 17 % within source category 1A2f (compared to 37 % in 1990). Between 1990 and 2009 the emissions decreased by 67 % (Table 3.42). Between 1990 and 2009 all Member States reported (partly significant) decreases of emissions; the highest absolute decreases were reported by Germany and the UK. Between 2008 and 2009 EU-15 emissions decreased by 17 %.

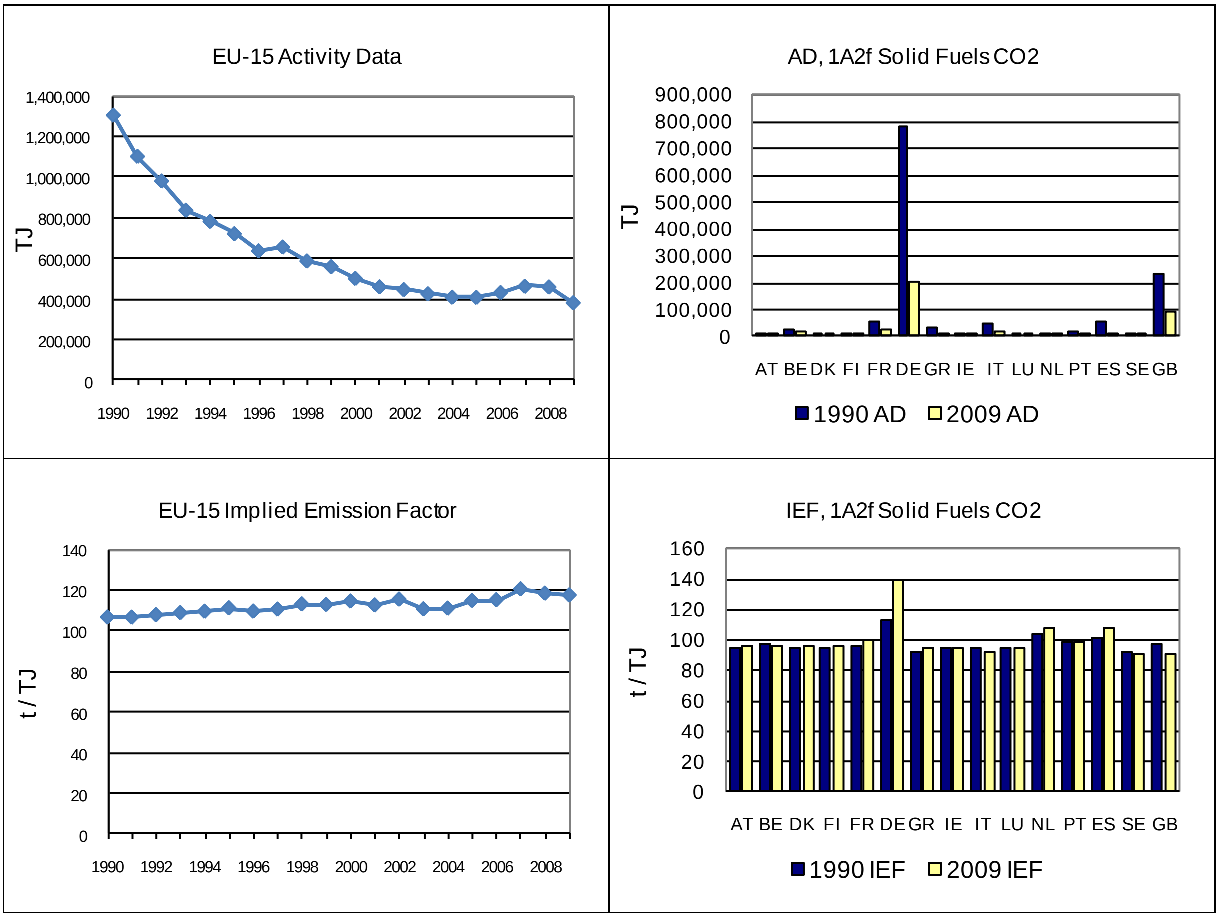
**Table 3.42 1A2f Other, solid fuels: Member States' contributions to $CO_2$ emissions and information on method applied and emission factor**

| Member State | $CO_2$ emissions in Gg | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| Austria | 625 | 621 | 527 | 1.2% | -94 | -15% | -99 | -16% | T2 | CS,PS |
| Belgium | 2,537 | 1,518 | 1,412 | 3.1% | -107 | -7% | -1,126 | -44% | T1 | D |
| Denmark | 843 | 558 | 240 | 0.5% | -318 | -57% | -603 | -72% | CR | CS,D |
| Finland | 815 | 512 | 289 | 0.6% | -223 | -44% | -526 | -65% | T3 | CS |
| France | 5,034 | 2,057 | 2,318 | 5.1% | 261 | 13% | -2,716 | -54% | CR | CS |
| Germany | 88,654 | 33,758 | 28,027 | 62.0% | -5,731 | -17% | -60,627 | -68% | CS | CS |
| Greece | 3,298 | 1,006 | 330 | 0.7% | -676 | -67% | -2,968 | -90% | T2 | PS |
| Ireland | 389 | 552 | 361 | 0.8% | -191 | -35% | -28 | -7% | T1 | CS |
| Italy | 4,233 | 2,434 | 1,909 | 4.2% | -525 | -22% | -2,324 | -55% | T2 | CS |
| Luxembourg | 333 | 184 | 209 | 0.5% | 24 | 13% | -124 | -37% | T1 | D |
| Netherlands | 388 | 181 | 169 | 0.4% | -12 | -7% | -219 | -57% | T2 | CS |
| Portugal | 2,103 | 193 | 33 | 0.1% | -160 | -83% | -2,070 | -98% | T2 | D,CR |
| Spain | 5,465 | 1,041 | 360 | 0.8% | -681 | -65% | -5,105 | -93% | T2 | CS,CR |
| Sweden | 1,229 | 1,087 | 783 | 1.7% | -305 | -28% | -447 | -36% | T2 | CS |
| United Kingdom | 22,858 | 8,992 | 8,270 | 18.3% | -722 | -8% | -14,588 | -64% | T2 | CS |
| **EU-15** | **138,805** | **54,694** | **45,234** | **100.0%** | **-9,460** | **-17%** | **-93,571** | **-67%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

Figure 3.49 shows activity data and implied emission factors for $CO_2$ for EU-15 and the Member States. The largest emissions are still reported by Germany and the United Kingdom; together they cause about 80 % of the $CO_2$ emissions from solid fuels in 1A2f. Fuel consumption in the EU-15 decreased by 70 % between 1990 and 2009. The implied emission factor of EU-15 was 117.4 t/TJ in 2009.

**Figure 3.49 1A2f Other, solid fuels: Activity Data and Implied Emission Factors for $CO_2$**



## 1A2f Other - Gaseous ($CO_2$)

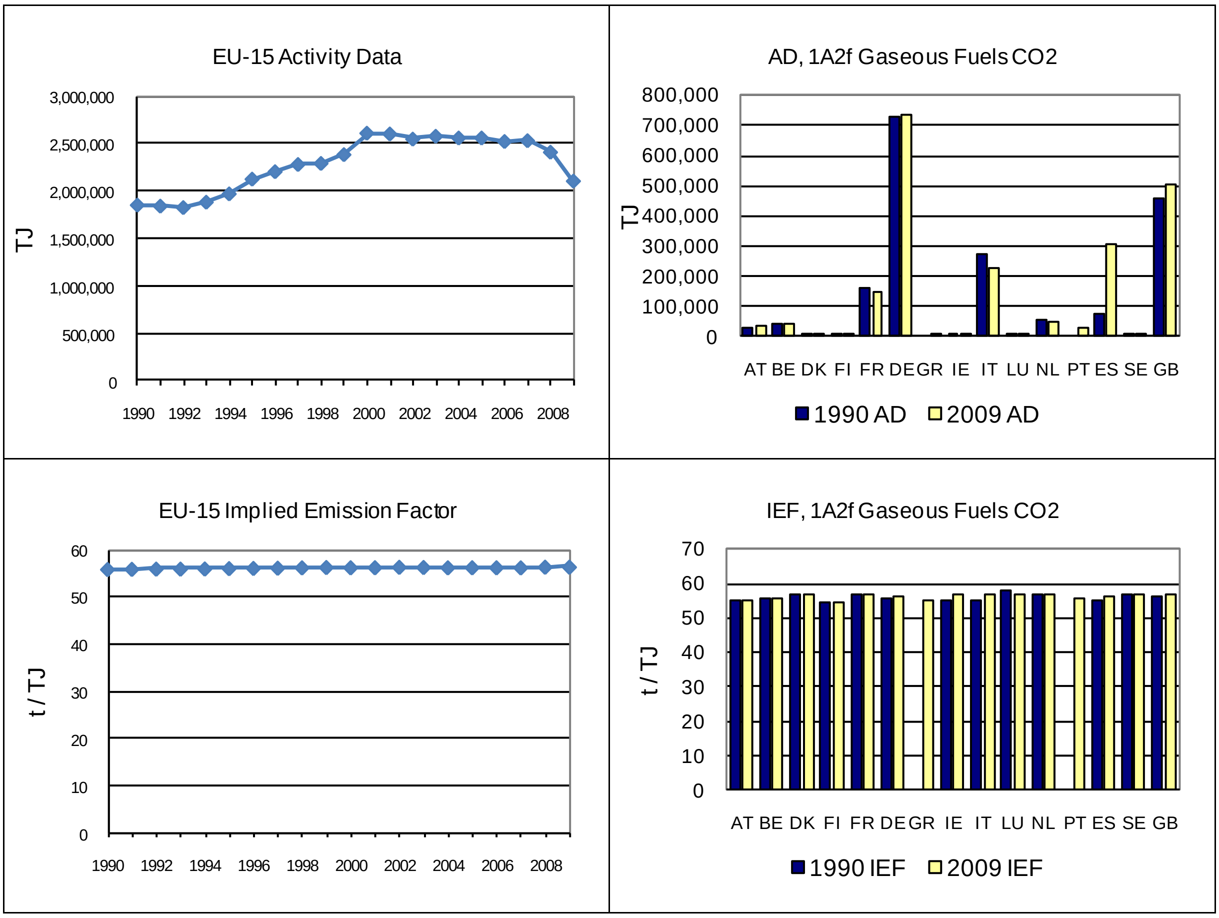
In 2009 $CO_2$ from gaseous fuels had a share of 44 % within source category 1A2f (compared to 28 % in 1990). Between 1990 and 2008, the emissions increased by 15 % (Table 3.43). Between 1990 and 2009, most Member States showed increasing emissions. Spain, the UK and Portugal showed the highest absolute increases.

**Table 3.43 1A2f Other, gaseous fuels: Member States' contributions to $CO_2$ emissions and information on method applied and emission factor**

| Member State | $CO_2$ emissions in Gg | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| Austria | 1,573 | 1,964 | 1,815 | 1.5% | -149 | -8% | 242 | 15% | T2 | CS |
| Belgium | 2,556 | 2,504 | 2,198 | 1.8% | -306 | -12% | -358 | -14% | T1 | D |
| Denmark | 385 | 661 | 605 | 0.5% | -57 | -9% | 220 | 57% | CR | CS |
| Finland | 171 | 198 | 141 | 0.1% | -57 | -29% | -29 | -17% | T3 | CS |
| France | 9,074 | 10,070 | 8,621 | 7.3% | -1,449 | -14% | -453 | -5% | CR | CS |
| Germany | 40,841 | 45,458 | 41,090 | 34.6% | -4,368 | -10% | 249 | 1% | CS | CS |
| Greece | NO | 369 | 252 | 0.2% | -118 | -32% | 252 | - | T2 | CS |
| Ireland | 289 | 484 | 425 | 0.4% | -59 | -12% | 136 | 47% | T1 | CS |
| Italy | 15,290 | 16,088 | 12,923 | 10.9% | -3,165 | -20% | -2,368 | -15% | T2 | CS |
| Luxembourg | 225 | 287 | 285 | 0.2% | -2 | -1% | 60 | 27% | T2 | CS |
| Netherlands | 3,331 | 3,253 | 2,942 | 2.5% | -311 | -10% | -389 | -12% | T2 | CS |
| Portugal | NO | 2,023 | 1,800 | 1.5% | -223 | -11% | 1,800 | - | T2 | D,CR |
| Spain | 4,039 | 19,509 | 16,997 | 14.3% | -2,511 | -13% | 12,958 | 321% | T2 | CS |
| Sweden | 178 | 219 | 217 | 0.2% | -2 | -1% | 38 | 22% | T1,T2 | CS |
| United Kingdom | 25,606 | 33,042 | 28,541 | 24.0% | -4,501 | -14% | 2,935 | 11% | T2 | CS |
| **EU-15** | **103,558** | **136,127** | **118,850** | **100.0%** | **-17,277** | **-13%** | **15,292** | **15%** | | |

Figure 3.50 shows activity data and implied emission factors for $CO_2$ for EU-15 and the Member States. The largest emissions are reported by Germany, Italy, Spain and the United Kingdom; together they cause 84 % of the $CO_2$ emissions from gaseous fuels in 1A2f. Fuel combustion in the EU-15 rose by 14 % between 1990 and 2009. The implied emission factor of EU-15 was 56.4 t/TJ in 2009.

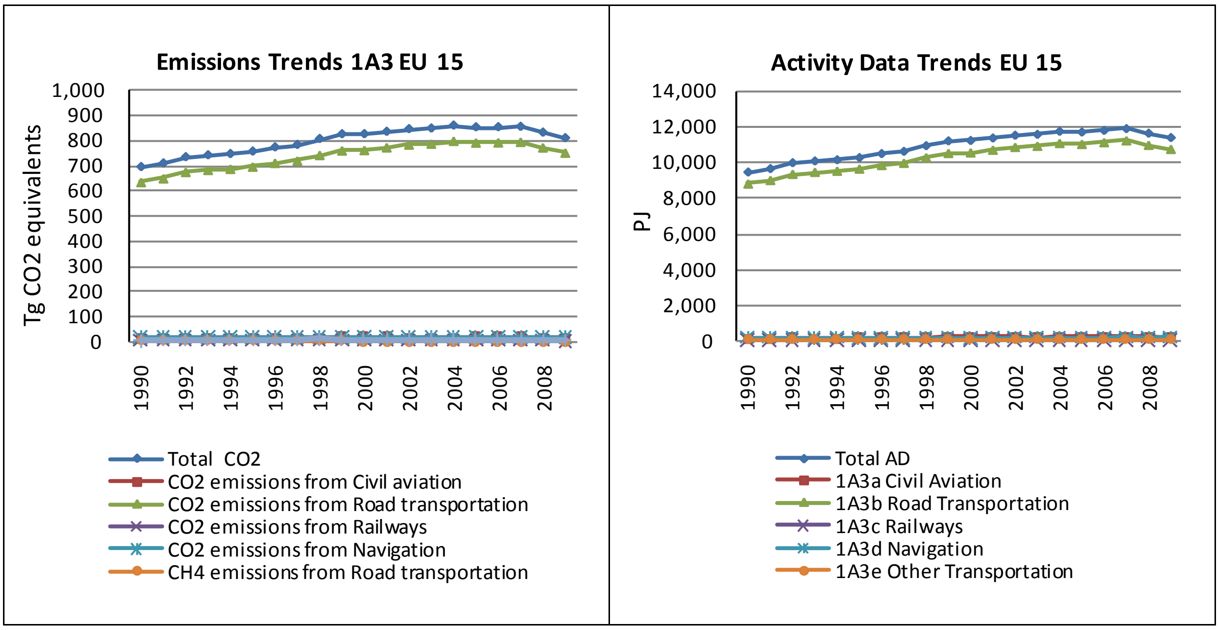
**Figure 3.50 1A2f Other, gaseous fuels: Activity Data and Implied Emission Factors for $CO_2$**



### 3.2.3 Transport (CRF Source Category 1A3) (EU-15)

Greenhouse gas emissions from 1A3 Transport are shown in Figure 3.51. $CO_2$ emissions from this source category account for 21.8 %, $CH_4$ for 0.03 %, $N_2O$ for 0.19 % of total GHG emissions. Between 1990 and 2009, greenhouse gas emissions from transport increased by 16.7% in the EU-15.

**Figure 3.51 1A3 Transport: Greenhouse gas emissions in $CO_2$ equivalents (Tg) and Activity Data in TJ**




This source category includes ten key categories:

- 1 A 3 a Civil Aviation: Jet Kerosene ($CO_2$)
- 1 A 3 b Road Transportation: Diesel oil ($CO_2$)
- 1 A 3 b Road Transportation: Diesel oil ($N_2O$)
- 1 A 3 b Road Transportation: Gasoline ($CO_2$)
- 1 A 3 b Road Transportation: Gasoline ($CH_4$)
- 1 A 3 b Road Transportation: LPG ($CO_2$)
- 1 A 3 c Railways: Liquid Fuels ($CO_2$)
- 1 A 3 d Navigation: Gas/Diesel Oil ($CO_2$)
- 1 A 3 d Navigation: Residual Oil ($CO_2$)

Table 3.44 shows total GHG, $CO_2$ and $N_2O$ emissions from 1A3 Transport.

**Table 3.44 1A3 Transport: Member States' contributions to $CO_2$ emissions and $N_2O$ emissions**

| Member State | GHG emissions in 1990 (Gg $CO_2$ equivalents) | GHG emissions in 2009 (Gg $CO_2$ equivalents) | $CO_2$ emissions in 1990 (Gg) | CO2 emissions in 2009 (Gg) | $N_2O$ emissions in 1990 (Gg $CO_2$ equivalents) | CO2 emissions in 2009 (Gg $CO_2$ equivalents) |
|---|---|---|---|---|---|---|
| Austria | 14,014 | 21,650 | 13,755 | 22,264 | 195 | 265 |
| Belgium | 20,468 | 26,723 | 20,099 | 27,341 | 254 | 231 |
| Denmark | 10,785 | 13,259 | 10,617 | 13,929 | 114 | 145 |
| Finland | 12,757 | 12,920 | 12,483 | 13,384 | 174 | 175 |
| France | 119,926 | 130,570 | 118,076 | 130,152 | 1,000 | 1,798 |
| Germany | 163,881 | 153,307 | 161,917 | 152,792 | 680 | 1,020 |
| Greece | 14,750 | 25,673 | 14,487 | 22,378 | 169 | 293 |
| Ireland | 5,135 | 13,121 | 5,039 | 14,058 | 59 | 128 |
| Italy | 102,897 | 119,258 | 101,269 | 122,252 | 903 | 1,106 |
| Luxembourg | 2,644 | 6,080 | 2,600 | 6,515 | 26 | 75 |
| Netherlands | 26,439 | 34,561 | 26,009 | 35,494 | 272 | 438 |
| Portugal | 10,075 | 18,862 | 9,917 | 18,736 | 79 | 196 |
| Spain | 55,123 | 94,467 | 54,283 | 100,261 | 527 | 959 |
| Sweden | 19,027 | 20,347 | 18,778 | 20,518 | 145 | 158 |
| United Kingdom | 115,820 | 119,189 | 113,795 | 122,734 | 1,391 | 1,372 |
| **EU-15** | **693,740** | **809,987** | **683,124** | **822,808** | **5,988** | **8,359** |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

Table 3.45 provides information on the contribution of Member States to EU-15 recalculations in $CO_2$ from 1A3 Transport for 1990 and 2008 and main explanations for the largest recalculations in absolute terms.

**Table 3.45 1A3 Transport: Contribution of MS to EU-15 recalculations in $CO_2$ for 1990 and 2008 (difference between latest submission and previous submission in Gg of $CO_2$ equivalents and percent)**

| | 1990 | | 2008 | | Main explanations |
|---|---|---|---|---|---|
| | Gg CO2 equiv. | Percent | Gg CO2 equiv. | Percent | |
| Austria | 3 | 0.0 | 9 | 0.0 | Revised model parameters |
| Belgium | 0 | 0.0 | -14 | -0.1 | AD for road transport revised in the Walloon region (preparation of input data for Copert IV, for inventory years 2007-2009). AD in the sector 1A3c and 1A3d in the Brussels region are revised for the year 2008 following the finalization of the 2008 energy balance of the region. |
| Denmark | 89 | 0.8 | 127 | 0.9 | Several changes has been made. Please refer to the Danish NIR report. |
| Finland | -34 | -0.3 | -31 | -0.2 | Updated calculation and allocation of transport biofuels. |
| France | 73 | 0.1 | 74 | 0.1 | 1A3d: Révisions de la méthodologie de répartition des consommations entre trafic domestique et international |
| Germany | -695 | -0.4 | 466 | 0.3 | AD corrected within Energy Balance; EF corrected within TREMOD v5.11; for civil aviaition new specific EFs due change from tier 2 to tier3 |
| Greece | 0 | 0.0 | 36 | 0.2 | Updated AD |
| Ireland | 0 | 0.0 | -4 | 0.0 | Minor revision in the energy balance |
| Italy | 0 | 0.0 | -223 | -0.2 | an update version of the COPERT4 software has been used; update of maritime traffic data |
| Luxembourg | -64 | -2.4 | -78 | -1.2 | CS EF for gasoline and diesel oil were revised. Activity data was revised due to new energy statistics from National Statistics (STATEC), and due to the application of national densities and NCVs, which are now streamlined with STATEC. |
| Netherlands | 0 | 0.0 | -9 | 0.0 | Final improved AD |
| Portugal | 0 | 0.0 | -262 | -1.4 | Recalculated EF using COPERT4 (v8.0 Oct 2010) and updated ambient temperatures. Revised data from energy balance. |
| Spain | -2,223 | -3.9 | -2,135 | -2.1 | New methodology following application of the national MECETA model for aviation. The revision has effect in the fuel consumption as well as in the emission factors. |
| Sweden | 0 | 0.0 | 11 | 0.1 | Increased number of decimals compared to submission 2010 creates the differences. |
| UK | -2,639 | -2.3 | -4,167 | -3.3 | - Road transport - updated distribution of vkm data between road types and between buses and coaches. Update to vkm data for motorcycles.<br>- Revised activity data for freight railways from the ORR for all years. Revised data for passenger rail from 2005 onwards.<br>- Reallocation of flights between UK and OTs/CDs between domestic and international as appropriate. Reallocation of shipping emissions between international and domestic based on port movement data. Coal use in rail reported from 2005. |
| **EU-15** | **-5,489** | **-0.8** | **-6,199** | **-0.7** | |

Table 3.46 provides information on the contribution of Member States to EU-15 recalculations in $N_2O$ from 1A3 Transport for 1990 and 2008.

**Table 3.46** **1A3 Transport: Contribution of MS to EU-15 recalculations in $N_2O$ for 1990 and 2008 (difference between latest submission and previous submission in Gg of $CO_2$ equivalents and percent)**

| | 1990 | | 2008 | | Main explanations |
|---|---|---|---|---|---|
| | Gg CO2 equiv. | Percent | Gg CO2 equiv. | Percent | |
| Austria | 0 | 0.2 | 3 | 1.0 | Revised model parameters |
| Belgium | -7 | -2.6 | -29 | -11.3 | Modelisation with Copert IV instead of Copert III for the road transport in the Brussels region (all timeseries) and in the Walloon region (2007-2009). AD in the sector 1A3c and 1A3d in the Brussels region are revised for the year 2008 following the finalization of the 2008 energy balance of the region. |
| Denmark | -2 | -1.7 | 6 | 4.5 | Several changes has been made. Please refer to the Danish NIR report |
| Finland | 0 | 0.0 | 0 | 0.0 | |
| France | 501 | 100.4 | 1,104 | 159.0 | Révisions des équations COPERT |
| Germany | -7 | -1.0 | 9 | 0.9 | AD corrected within Energy Balance; EF corrected within TREMOD v5.11; for civil aviaition new specific EFs due change from tier 2 to tier3 |
| Greece | 0 | -0.3 | 48 | 19.5 | Updated AD |
| Ireland | -14 | -19.2 | -38 | -22.9 | Minor revision in the energy balance. Revised COPERT4 model (version 8.0). |
| Italy | 2 | 0.3 | 29 | 2.7 | an update version of the COPERT4 software has been used; update of |
| Luxembourg | 0 | 0.0 | 0 | 0.2 | Copert 4v8 was used instead of Copert 4v7: main difference: updated emission factors for heavy duty vehicles. for more details please refer to the Copert website: http://www.emisia.com/copert/ |
| Netherlands | 0 | 0.0 | 5 | 1.1 | Final improved AD |
| Portugal | -19 | -19.3 | -53 | -21.2 | Recalculated EF using COPERT4 (v8.0 Oct 2010) and updated ambient temperatures. Revised data from energy balance. |
| Spain | -25 | -4.4 | -16 | -1.7 | New methodology following application of the national MECETA model for aviation. The revision has effect in the fuel consumption as well as in the emission factors. |
| Sweden | 0 | 0.0 | 0 | 0.0 | |
| UK | -50 | -3.5 | -71 | -4.9 | - Road transport - updated distribution of vkm data between road types and between buses and coaches. Update to vkm data for motorcycles. - Revised activity data for freight railways from the ORR for all years. Revised data for passenger rail from 2005 onwards. - Reallocation of flights between UK and OTs/CDs between domestic and international as appropriate. Reallocation of shipping emissions between international and domestic based on port movement data. Coal use in rail reported from 2005. |
| **EU-15** | **381** | **6.8** | **996** | **13.5** | |

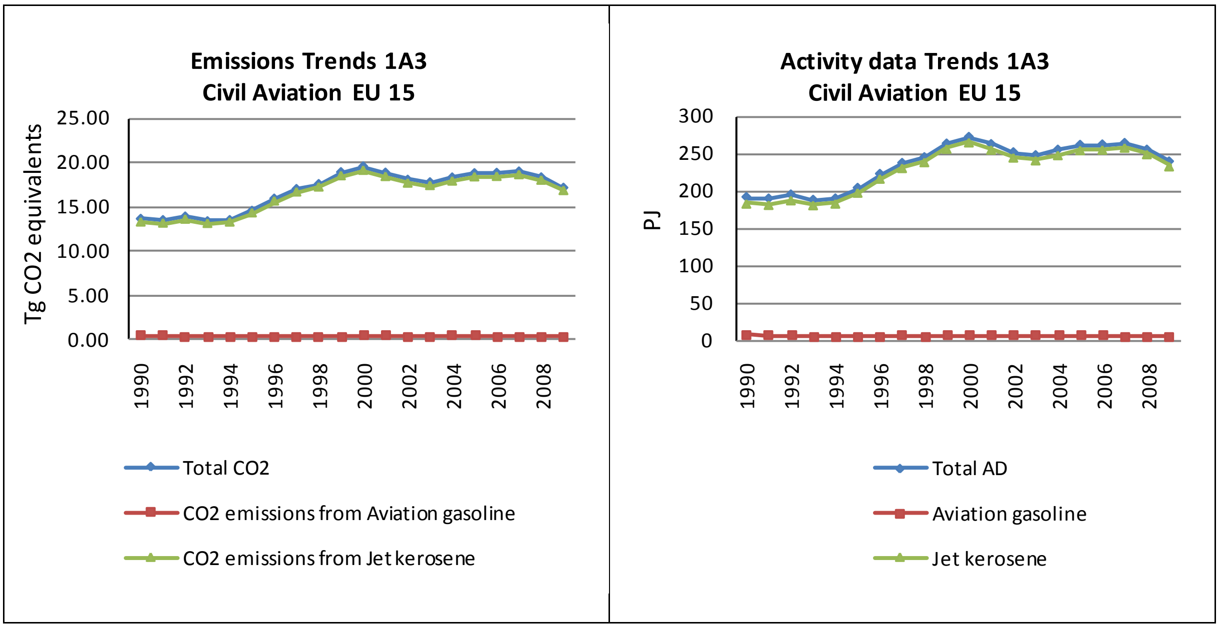
### 3.2.3.1 Civil Aviation (1A3a) (EU-15)

This source category includes emissions from civil domestic passenger and freight traffic that departs and arrives in the same country (commercial, private, agriculture, etc.), including take-offs and landings for these flight stages.

$CO_2$ emissions from 1A3a Civil Aviation account for 2.1% of total transport-related GHG emissions in 2009. Between 1990 and 2009, $CO_2$ emissions from civil aviation increased by 25 % in the EU-15 (Table 3.47, Figure 3.52).

$CO_2$ emissions from Jet Kerosine account for 97.8 % of total $CO_2$ emissions from 1A3a Civil Aviation. Between 2008 and 2009, $CO_2$ emissions from civil aviation decreased by 6 % in the EU-15 (Table 3.47, Figure 3.52).

**Figure 3.52** **1A3a Civil Aviation: $CO_2$ Emissions in $CO_2$ equivalents (Tg) and Activity data in TJ**




The Member States France, Germany, Italy and Spain alone contributed 72.2 % to the emissions from this source. Most Member States increased emissions from civil aviation between 1990 and 2009 (Table 3.47).

**Table 3.47** **1A3a Civil Aviation: Member States' contributions to $CO_2$ emissions**

| Member State | $CO_2$ emissions in Gg | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | |
|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) |
| Austria | 32 | 71 | 67 | 0.4% | -3 | -5% | 35 | 111% |
| Belgium | 12 | 11 | 9 | 0.1% | -2 | -21% | -3 | -26% |
| Denmark | 243 | 162 | 156 | 0.9% | -6 | -4% | -87 | -36% |
| Finland | 385 | 297 | 275 | 1.6% | -22 | -7% | -110 | -28% |
| France | 4,241 | 4,592 | 4,456 | 25.9% | -136 | -3% | 215 | 5% |
| Germany | 2,309 | 2,244 | 2,110 | 12.3% | -134 | -6% | -199 | -9% |
| Greece | 717 | 1,296 | 1,452 | 8.5% | 156 | 12% | 735 | 103% |
| Ireland | 59 | 122 | 102 | 0.6% | -20 | -17% | 43 | 73% |
| Italy | 1,613 | 2,301 | 2,197 | 12.8% | -104 | -5% | 584 | 36% |
| Luxembourg | 0.2 | 1 | 1 | 0.003% | 0.01 | 2% | 0.3 | 152% |
| Netherlands | 41 | 41 | 41 | 0.2% | 0 | 0% | 0 | 0% |
| Portugal | 236 | 360 | 337 | 2.0% | -23 | -6% | 101 | 43% |
| Spain | 1,906 | 4,168 | 3,637 | 21.2% | -531 | -13% | 1,730 | 91% |
| Sweden | 673 | 634 | 532 | 3.1% | -102 | -16% | -141 | -21% |
| United Kingdom | 1,256 | 2,035 | 1,808 | 10.5% | -227 | -11% | 552 | 44% |
| **EU-15** | **13,725** | **18,334** | **17,180** | **100.0%** | **-1,155** | **-6%** | **3,455** | **25%** |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

## 1A3a Civil Aviation – Jet Kerosene ($CO_2$)

In 2009 $CO_2$ emissions resulting from jet kerosene within the category 1A3a were responsible for 97.8 % of $CO_2$ emissions in 1A3a. Within the EU-15 the emissions increased between 1990 and 2009 by 27 % (Table 3.48). By far the largest absolute increase occurred in Spain. Between 2008 and 2009, the emissions decreased by 7 %.

**Table 3.48 1A3a Civil Aviation, jet kerosene: Member States' contributions to $CO_2$ emissions and information on method applied and emission factor**

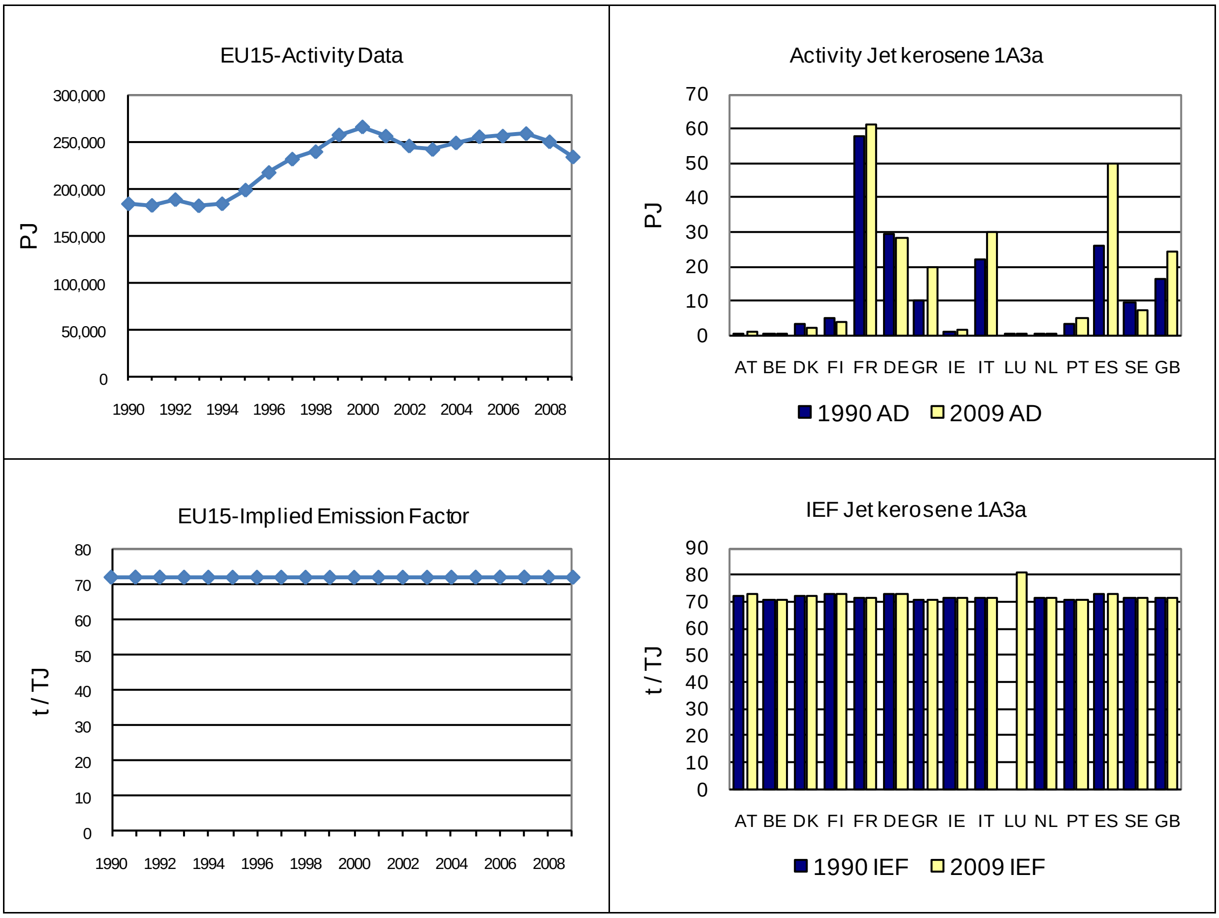
| Member State | $CO_2$ emissions in Gg | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| Austria | 24 | 62 | 57 | 0.3% | -4 | -7% | 33 | 137% | CR,T3 | CS |
| Belgium | 5 | 3 | 0 | 0.00% | -3 | -92% | -5 | -95% | T1 | D |
| Denmark | 234 | 155 | 150 | 0.9% | -5 | -3% | -84 | -36% | OTH | OTH |
| Finland | 377 | 294 | 272 | 1.6% | -22 | -7% | -105 | -28% | M | CS |
| France | 4,135 | 4,526 | 4,374 | 26.0% | -152 | -3% | 239 | 6% | T3,M | CS |
| Germany | 2,140 | 2,200 | 2,069 | 12.3% | -131 | -6% | -71 | -3% | T2 | CS |
| Greece | 705 | 1,251 | 1,401 | 8.3% | 151 | 12% | 697 | 99% | T2 | CR |
| Ireland | 59 | 122 | 102 | 0.6% | -20 | -17% | 43 | 73% | T2 | CS |
| Italy | 1,579 | 2,274 | 2,145 | 12.8% | -129 | -6% | 565 | 36% | T1,T2 | CS |
| Luxembourg | NO | NO | NO | - | - | - | - | - | NA | NA |
| Netherlands | 16 | 16 | 16 | 0.1% | 0 | 0% | 0 | 0% | T2 | CS |
| Portugal | 235 | 358 | 335 | 2.0% | -23 | -6% | 100 | 43% | T2 | CS |
| Spain | 1,872 | 4,133 | 3,605 | 21.5% | -528 | -13% | 1,734 | 93% | CS | D |
| Sweden | 668 | 632 | 530 | 3.2% | -102 | -16% | -138 | -21% | CS,M,T1,T2 | CS |
| United Kingdom | 1,186 | 1,950 | 1,745 | 10.4% | -205 | -11% | 559 | 47% | T3 | CS |
| **EU-15** | **13,237** | **17,976** | **16,804** | **100.0%** | **-1,172** | **-7%** | **3,567** | **27%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

France, Germany, Italy, Spain and the UK account for 83 % of $CO_2$ emissions and for 82.5 % of activity data from jet kerosene in 2009 (

Figure 3.53). The IEF for the EU-15 is 71.95 t/TJ jet kerosene in 2009. Table 3.48 shows that the majority of emissions from Civil Aviation jet kerosene were calculated using a higher tier method.

**Figure 3.53** 1A3a Civil Aviation, jet kerosene: Activity data and implied emission factors for $CO_2$




### 3.2.3.2 Road Transportation (1A3b) (EU-15)

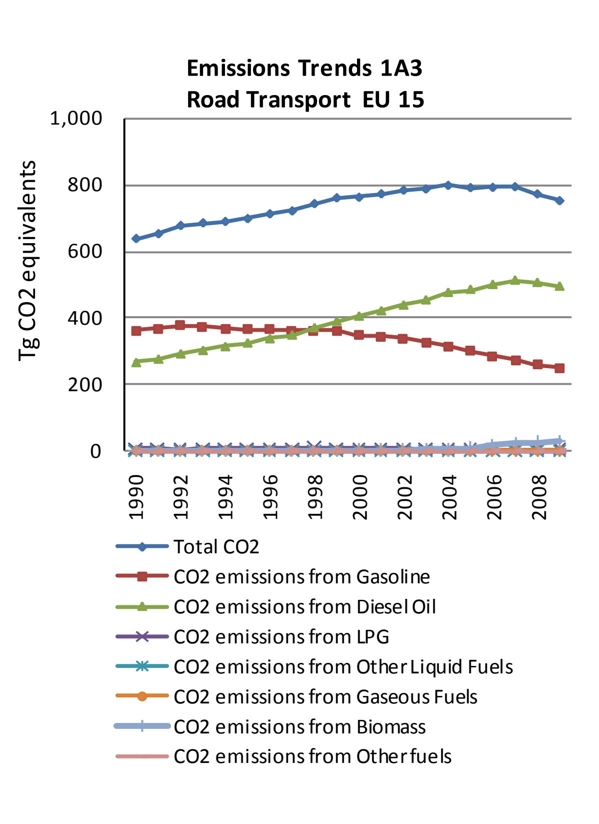
**$CO_2$ emissions from 1A3b Road Transportation**

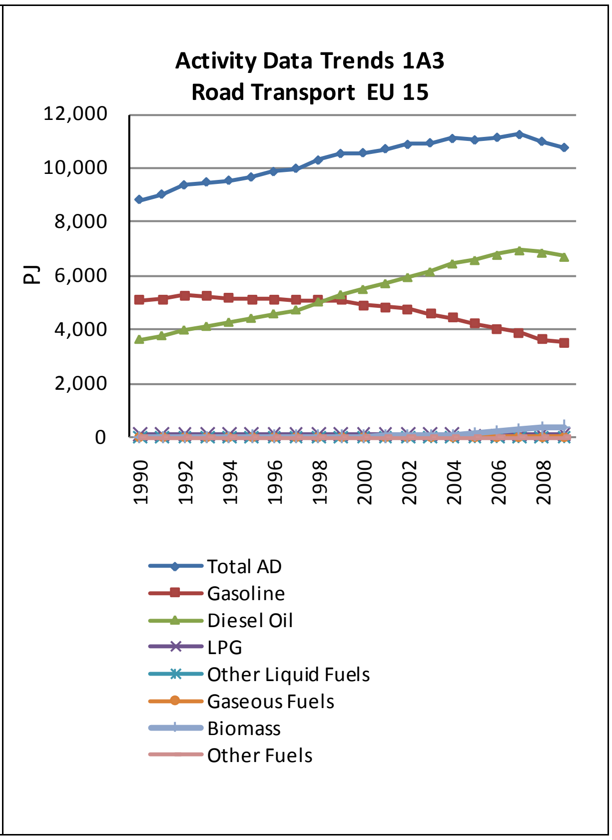
The mobile source category Road Transportation includes all types of light-duty vehicles such as passenger cars and light commercial trucks, and heavy-duty vehicles such as tractors, trailers and buses, and two and three-wheelers (including mopeds, scooters, and motorcycles). These vehicles operate on many types of gaseous and liquid fuels.

$CO_2$ emissions from 1A3b Road Transportation is the second largest key source of all categories in the EU-15 accounting for 20.2 % of total GHG emissions in 2009. Between 1990 and 2009, $CO_2$ emissions from road transportation increased by 18 % in the EU-15 (Table 3.49). The emissions from this key source are due to fossil fuel consumption in road transport, which increased by 17.4 % between 1990 and 2009.

Figure 3.54 gives an overview of the $CO_2$ trend caused by different fuels. The trend is mainly dominated by emissions resulting from the combustion of gasoline and diesel oil. The decline of gasoline and the strong increase of diesel shows the gradual switch from gasoline to diesel passenger cars in several EU-15 Member States.

**Figure 3.54** **1A3b Road Transport: $CO_2$ Emission Trend and Activity Data**




The Member States Germany, France, Italy, Spain and the United Kingdom contributed most to the $CO_2$ emissions from this source (76.1 %). All Member States, except for Germany (-4%), increased emissions from road transportation between 1990 and 2009. The Member States with the highest increases in absolute terms were Spain, Italy, France and Greece. The countries with the lowest increase in relative terms were Finland, France, Sweden and the United Kingdom (Table 3.49).

**Table 3.49** **1A3b Road Transport: Member States' contributions to $CO_2$ emissions**

| Member State | $CO_2$ emissions in Gg | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | |
|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) |
| Austria | 13,286 | 21,430 | 20,713 | 2.8% | -717 | -3% | 7,427 | 56% |
| Belgium | 19,270 | 26,597 | 25,777 | 3.4% | -820 | -3% | 6,507 | 34% |
| Denmark | 9,282 | 12,938 | 12,126 | 1.6% | -812 | -6% | 2,843 | 31% |
| Finland | 10,806 | 11,782 | 11,238 | 1.5% | -544 | -5% | 432 | 4% |
| France | 110,799 | 121,554 | 120,367 | 16.0% | -1,188 | -1% | 9,568 | 9% |
| Germany | 150,358 | 144,845 | 144,616 | 19.2% | -229 | 0% | -5,743 | -4% |
| Greece | 11,742 | 19,067 | 20,965 | 2.8% | 1,898 | 10% | 9,223 | 79% |
| Ireland | 4,701 | 13,646 | 12,602 | 1.7% | -1,044 | -8% | 7,901 | 168% |
| Italy | 93,387 | 113,919 | 109,906 | 14.6% | -4,014 | -4% | 16,518 | 18% |
| Luxembourg | 2,574 | 6,495 | 5,993 | 0.8% | -502 | -8% | 3,419 | 133% |
| Netherlands | 25,472 | 34,732 | 33,357 | 4.4% | -1,375 | -4% | 7,884 | 31% |
| Portugal | 9,246 | 18,084 | 18,019 | 2.4% | -65 | 0% | 8,773 | 95% |
| Spain | 50,442 | 92,311 | 86,114 | 11.4% | -6,197 | -7% | 35,672 | 71% |
| Sweden | 17,309 | 19,208 | 18,899 | 2.5% | -309 | -2% | 1,590 | 9% |
| United Kingdom | 109,141 | 116,731 | 112,138 | 14.9% | -4,592 | -4% | 2,997 | 3% |
| **EU-15** | **637,817** | **773,338** | **752,828** | **100.0%** | **-20,510** | **-2.7%** | **115,011** | **18%** |

## 1A3b Road Transportation – Diesel Oil ($CO_2$)

$CO_2$ emissions from Diesel oil account for 62.4 % of $CO_2$ emissions from 1A3b Road Transport in 2009 (Figure 3.54). All Member States increased emissions from Diesel oil between 1990 and 2009 (Table 3.50). Member States with the highest increase in percent were Austria, Ireland, Luxembourg, Spain and Portugal. Some of these increases is due to fuel bought in the respective countries but consumed abroad (fuel tourism).

**Table 3.50 1A3b Road Transport, diesel oil: Member States' contributions to $CO_2$ emissions and information on method applied and emission factor**

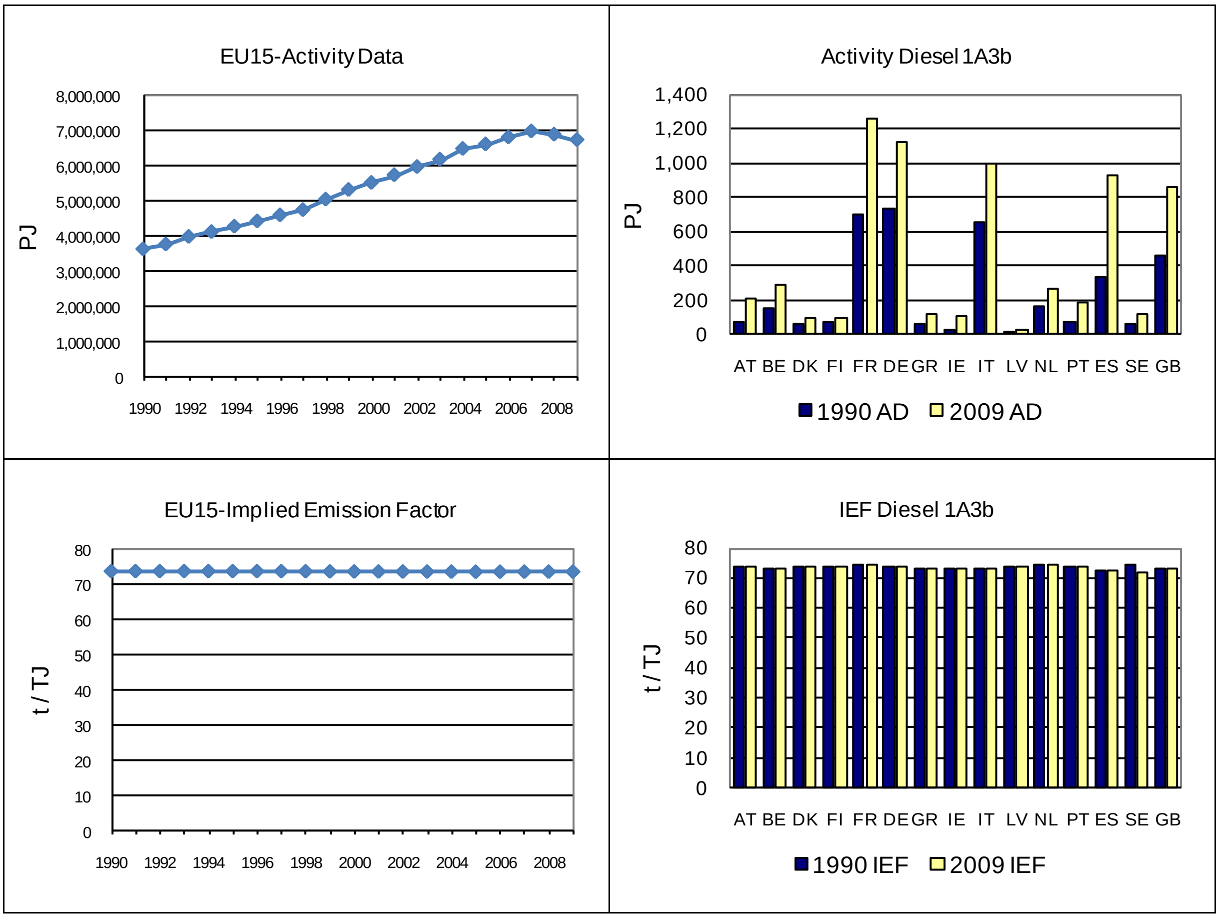
| Member State | $CO_2$ emissions in Gg | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| Austria | 5,341 | 16,029 | 15,324 | 3.1% | -705 | -4% | 9,982 | 187% | CS | CS |
| Belgium | 10,892 | 22,081 | 21,561 | 4.4% | -520 | -2% | 10,668 | 98% | D | CR,CS |
| Denmark | 4,436 | 7,658 | 7,181 | 1.5% | -478 | -6% | 2,745 | 62% | COPERT 4 | CS |
| Finland | 4,923 | 6,959 | 6,586 | 1.3% | -373 | -5% | 1,663 | 34% | M | CS |
| France | 52,071 | 94,468 | 94,346 | 19.1% | -122 | 0% | 42,275 | 81% | T3, COPERT 4 | CS |
| Germany | 54,458 | 81,926 | 83,331 | 16.9% | 1,406 | 2% | 28,873 | 53% | T2 | CS |
| Greece | 4,326 | 6,790 | 8,628 | 1.7% | 1,838 | 27% | 4,302 | 99% | T1 | D |
| Ireland | 1,922 | 8,060 | 7,504 | 1.5% | -556 | -7% | 5,582 | 290% | T1 | CS |
| Italy | 47,776 | 75,940 | 72,845 | 14.7% | -3,095 | -4% | 25,069 | 52% | COPERT 4 | CS |
| Luxembourg | 1,343 | 5,268 | 4,876 | 1.0% | -392 | -7% | 3,533 | 263% | T3 | CS |
| Netherlands | 11,832 | 20,837 | 19,554 | 4.0% | -1,283 | -6% | 7,722 | 65% | T2 | CS |
| Portugal | 5,055 | 13,466 | 13,470 | 2.7% | 4 | 0% | 8,415 | 166% | T2 | CS |
| Spain | 24,436 | 72,613 | 67,593 | 13.7% | -5,020 | -7% | 43,158 | 177% | COPERT 4, CR, CS, T3 | CR |
| Sweden | 4,407 | 8,588 | 8,444 | 1.7% | -143 | -2% | 4,038 | 92% | CS,M,T1,T2 | CS |
| United Kingdom | 33,643 | 65,029 | 63,292 | 12.8% | -1,737 | -3% | 29,649 | 88% | T3 | CS |
| **EU-15** | **266,862** | **505,711** | **494,535** | **100.0%** | **-11,176** | **-2.2%** | **227,673** | **85%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

France, Germany, Italy, Spain and the UK account for 77.2 % of $CO_2$ emissions and for 77.1 % of activity data from diesel oil in 2009 (Figure 3.55). The IEF for the EU-15 is 73.62 t/TJ diesel in 2009. The $CO_2$ IEF for diesel oil decreased by 0.2 per cent between 1990 (73.77 t/TJ) and 2009 (73.62 t/TJ). The main reason for the decline of the IEF is the changing in fuel specifications of some countries and their contribution to the weighted average. The contribution to diesel consumption of Germany and France, the two largest contributing countries with higher IEFs than the average member State, declined between 1990 and 2009 (Germany from 20.3 per cent to 16.8 per cent; France from 19.2 per cent to 18.8 per cent). On the other hand, the contribution to diesel consumption of Spain, which has a low IEF, increased from 9.3 per cent in 1990 to 13.8 per cent in 2009. In addition, a few member States (e.g. Austria, Italy, Great Britain) show declining IEFs for the time-series 1990–2009 because of the increased use of diesel blended with biofuels.

Table 3.50 shows that the majority of $CO_2$ emissions from the combustion of diesel oil in road transportation were calculated using a higher tier method.

**Figure 3.55** 1A3b Road Transport, diesel oil: Activity Data and Implied Emission Factor for $CO_2$



### 1A3b Road Transportation – Gasoline ($CO_2$)

Between 1990 and 2009, $CO_2$ emissions from gasoline decreased by 31 % in the EU-15 (Table 3.51).

**Table 3.51 1A3b Road Transport, gasoline: Member States' contributions to $CO_2$ emissions and information on method applied and emission factor**

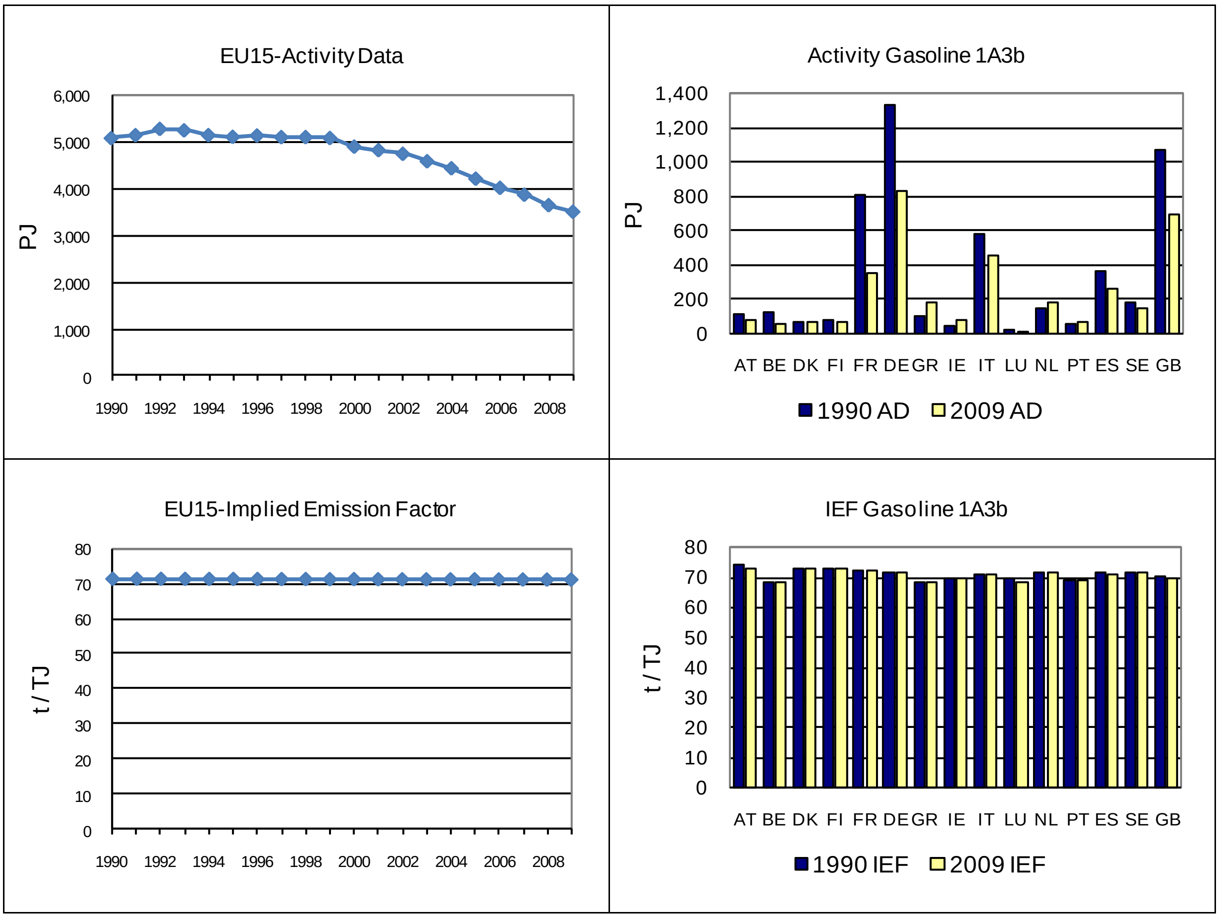
| Member State | $CO_2$ emissions in Gg | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| Austria | 7,945 | 5,401 | 5,389 | 2.2% | -12 | 0% | -2,556 | -32% | CS | CS |
| Belgium | 8,223 | 4,340 | 4,040 | 1.6% | -300 | -7% | -4,183 | -51% | Copert3&4, D | CR,CS |
| Denmark | 4,838 | 5,280 | 4,945 | 2.0% | -335 | -6% | 106 | 2% | COPERT 4 | CS |
| Finland | 5,883 | 4,814 | 4,641 | 1.9% | -173 | -4% | -1,242 | -21% | M | CS |
| France | 58,577 | 26,754 | 25,723 | 10.3% | -1,030 | -4% | -32,854 | -56% | T3, COPERT 4 | CS |
| Germany | 95,794 | 61,498 | 59,609 | 23.9% | -1,890 | -3% | -36,186 | -38% | T2 | CS |
| Greece | 7,294 | 12,158 | 12,191 | 4.9% | 33 | 0% | 4,898 | 67% | T1 | D |
| Ireland | 2,761 | 5,582 | 5,094 | 2.0% | -487 | -9% | 2,334 | 85% | T1 | CS |
| Italy | 41,094 | 33,664 | 32,339 | 13.0% | -1,325 | -4% | -8,755 | -21% | COPERT 4 | CS |
| Luxembourg | 1,221 | 1,219 | 1,113 | 0.4% | -106 | -9% | -108 | -9% | T3 | CS |
| Netherlands | 10,902 | 12,882 | 12,810 | 5.1% | -72 | -1% | 1,907 | 17% | T2 | CS |
| Portugal | 4,190 | 4,514 | 4,429 | 1.8% | -85 | -2% | 239 | 6% | T2 | CS |
| Spain | 25,928 | 19,555 | 18,352 | 7.4% | -1,203 | -6% | -7,576 | -29% | COPERT 4, CR, CS, T3 | CR |
| Sweden | 12,900 | 10,566 | 10,397 | 4.2% | -169 | -2% | -2,502 | -19% | CS,M,T1,T2 | CS |
| United Kingdom | 75,236 | 51,212 | 48,409 | 19.4% | -2,804 | -5% | -26,827 | -36% | T3 | CS |
| **EU-15** | **362,786** | **259,441** | **249,481** | **100.0%** | **-9,960** | **-4%** | **-113,305** | **-31%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

France, Germany, Italy, Spain and the United Kingdom account for 74 % for $CO_2$ emissions and for 73.8 % of activity data from gasoline in 2009 (Figure 3.56). The IEF for the EU-15 is 71.20 t/TJ gasoline in 2009. The $CO_2$ IEF for gasoline decreased by 0.3 percent between 1990 (71.42 t/TJ) and 2009 (71.20 t/TJ). The main reason for the decline of the IEF is the changing specifications of gasoline in Germany and France, the two largest contributing countries with higher IEFs than the average Member State. The contribution to gasoline consumption in Germany and France declined between 1990 and 2009 (Germany from 26.2 per cent to 23.6 per cent; France from 15.9 per cent to 10.1 per cent). On the other hand, the contribution to gasoline consumption of Italy, which has a lower IEF than the average Member State, increased from 11.4 per cent in 1990 to 13 per cent in 2009. Also, the United Kingdom, which has a much lower IEF than the average Member State, can be seen here as an influencing factor as the contribution to gasoline consumption amounts to 19.7 per cent in 2009.

Table 3.51 shows that the majority of $CO_2$ emissions from gasoline combustion in road transportation were calculated using a higher tier method.

**Figure 3.56** **1A3b Road Transport, gasoline: Activity data and implied emission factors for $CO_2$**



## 1A3b Road Transportation –LPG ($CO_2$)

Between 1990 and 2009, $CO_2$ emissions from LPG decreased by 11 % in the EU-15. Three Member States report emissions as 'Not occurring'. Between 2008 and 2009 EU-15 emissions increased by 7 % (Table 3.52) mainly due to emission increases in Germany.

**Table 3.52 1A3b Road Transport, LPG: Member States' contributions to $CO_2$ emissions and information on method applied and emission factor**

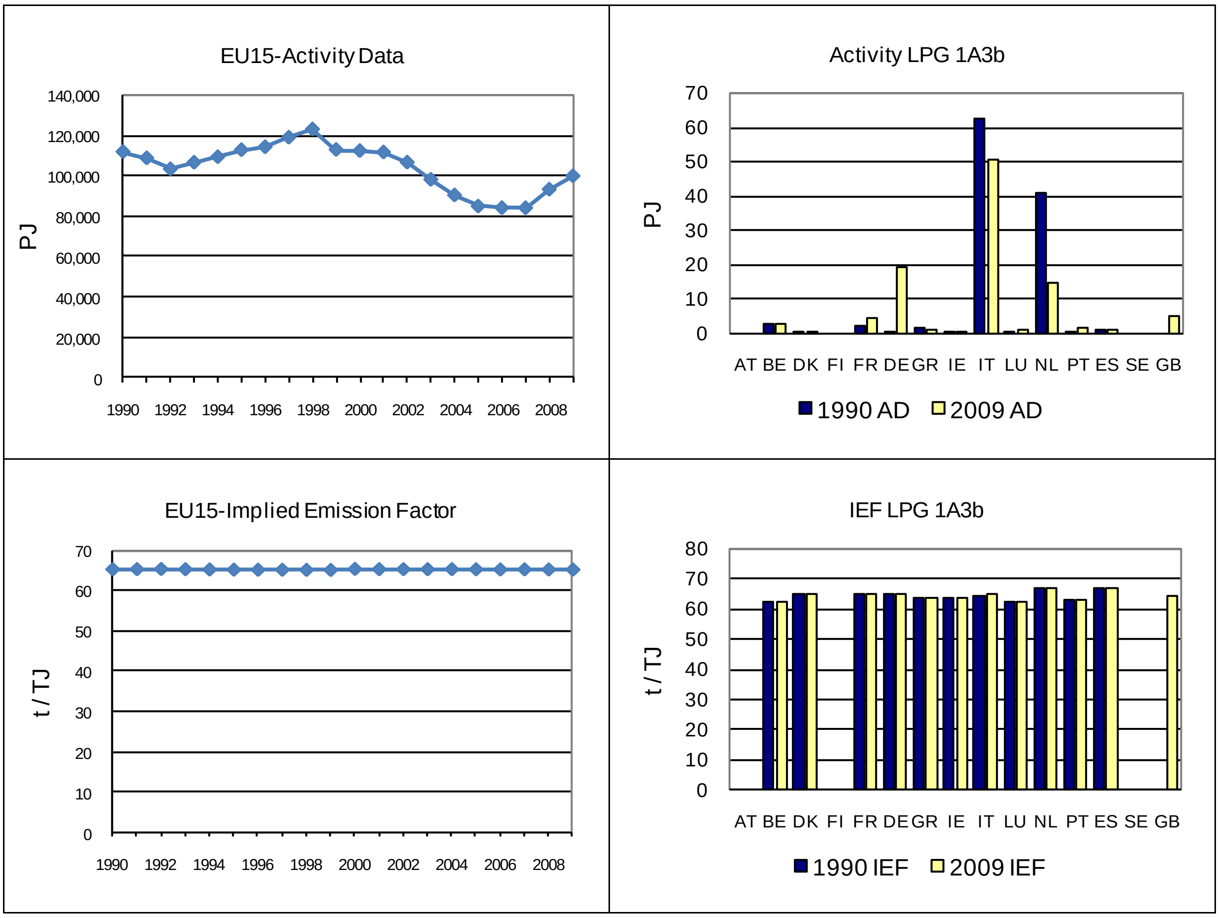
| Member State | $CO_2$ emissions in Gg | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| Austria | NO | NO | NO | - | - | - | - | - | NO | NO |
| Belgium | 154 | 176 | 176 | 2.7% | 0 | 0% | 22 | 14% | Copert3&4, D | CR,CS |
| Denmark | 8 | 0.10 | 0.13 | 0.0% | 0 | 28% | -8 | -98% | COPERT 4 | CS |
| Finland | NO | NO | NO | - | - | - | - | - | NA | NA |
| France | 150 | 333 | 297 | 4.6% | -35 | -11% | 147 | 98% | T3, COPERT 4 | CS |
| Germany | 9 | 1,017 | 1,236 | 19.0% | 219 | 22% | 1,227 | 13683% | T2 | CS |
| Greece | 91 | 36 | 51 | 0.8% | 15 | 42% | -39 | -43% | T1 | D |
| Ireland | 19 | 3 | 3 | 0.0% | 0 | 0% | -15 | -83% | T1 | CS |
| Italy | 4,026 | 3,006 | 3,285 | 50.5% | 278 | 9% | -741 | -18% | COPERT 4 | CS |
| Luxembourg | 11 | 8 | 5 | - | -4 | -46% | -6 | -58% | T3 | CS |
| Netherlands | 2,738 | 1,013 | 993 | 15.3% | -20 | -2% | -1,745 | -64% | T2 | CS |
| Portugal | 0 | 71 | 88 | 1.4% | 17 | 24% | 88 | 142818% | T2 | CS |
| Spain | 78 | 39 | 48 | 0.7% | 9 | 23% | -30 | -38% | COPERT 4, CR, CS, T3 | CR |
| Sweden | NO | NO | NO | - | - | - | - | - | NA | NA |
| United Kingdom | NO | 367 | 316 | 4.9% | -51 | -14% | 316 | - | T3 | CS |
| **EU-15** | **7,283** | **6,071** | **6,498** | **100.0%** | **428** | **7%** | **-785** | **-11%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

France, Germany, Italy, Spain and the United Kingdom account for 79.7 % of $CO_2$ emission and for 80 % of activity data from LPG in 2009 (

Figure 3.57). The IEF for the EU-15 is 65.12 t/TJ LPG in 2009. Table 3.52 shows that the majority of $CO_2$ emissions from LPG consumption in road transportation were calculated using a higher tier method.

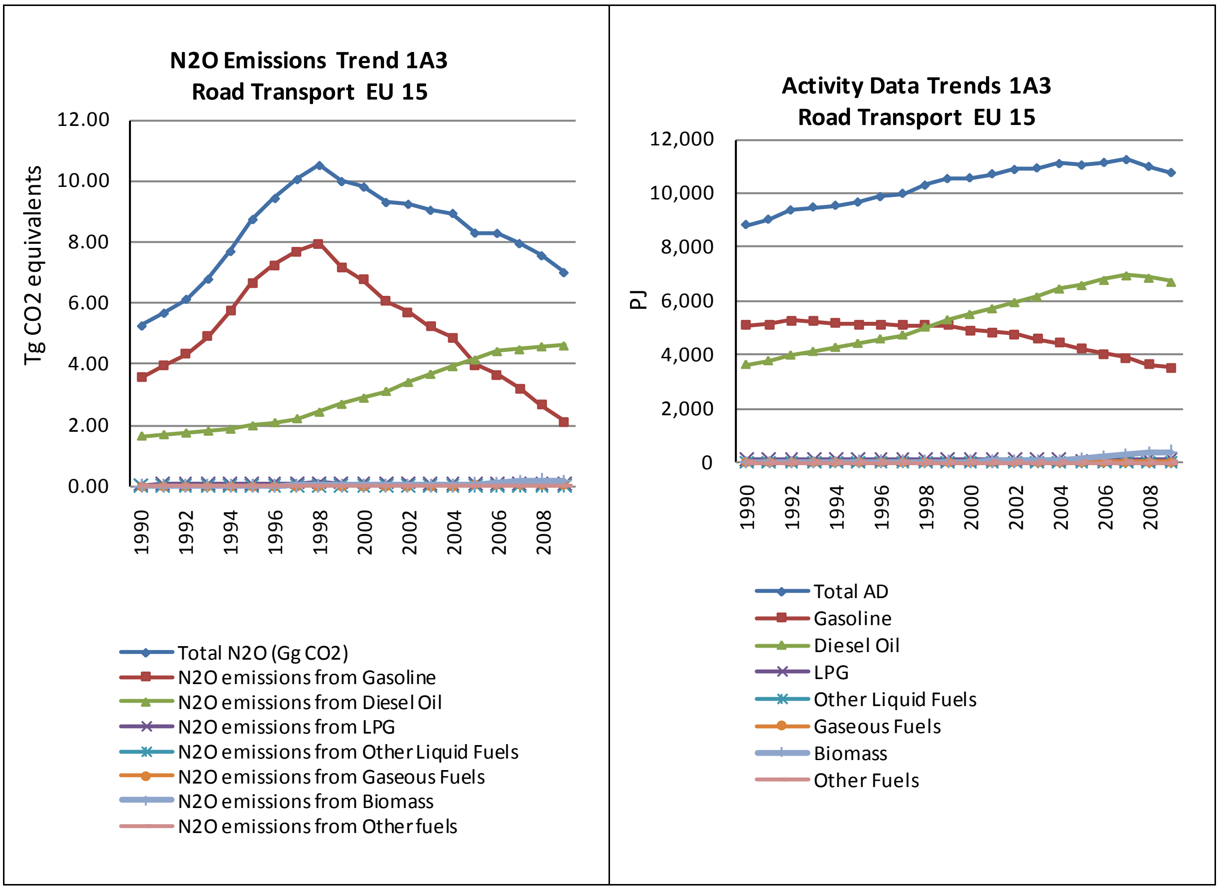
**Figure 3.57** **1A3b Road Transport, LPG: Activity data and implied emission factors for $CO_2$**



### $N_2O$ emissions from 1A3b Road Transportation

$N_2O$ emissions from 1A3b Road Transportation account for 0.19 % of total EU-15 GHG emissions in 2009. Figure 3.58 gives an overview of the $N_2O$ trend caused by different fuels. The trend is mainly dominated by emissions resulting from gasoline and diesel oil.

**Figure 3.58 1A3b Road Transport: $N_2O$ Emissions Trend and Activity Data**




$N_2O$ emissions increased between 1990 and 2009 by 33 % (Table 3.53). $N_2O$ emissions increased by in the 1990s due to the implementation of the catalytic converter in the early Euro vehicles (mainly Euro 1), but decreased thereafter (for post Euro 2 vehicles). The reason for the existing various trends in $N_2O$ emission are different estimates of $N_2O$ emission factors. In principle, two different models/emission factor sources are being used in EU-15 countries to estimate $N_2O$ emissions: (1) HBEFA - Handbook of emissions factors, (2) COPERT. The Emission Factors Handbook (Austria, Germany, the Netherlands and Sweden) estimates that the $N_2O$ emission factors decrease for every technology generation (Euro 1, Euro 2 etc.). At the moment two versions of the COPERT model are being used in EU-15 countries to estimate emissions. The previous version, COPERT III, has a constant $N_2O$ emission factor for cars with catalytic converters, independently of the legislation class. The latest version, COPERT IV (available since 2007), also estimates that the $N_2O$ emission factors decrease for every technology generation.

With the emissions factors of this new COPERT IV model version IEFs are higher in the early nineties (big stock of older technology classes) and lower in recent years (new vehicle fleet). Table 3.54 shows that all Member States use recent $N_2O$ emission factors in 2009. Four MS use different or country specific models or emission factors, as can be seen in Table 3.54.

**Table 3.53 1A3b Road Transport: Member States' contributions to $N_2O$ emissions**

| Member State | $N_2O$ emissions (Gg $CO_2$ equivalents) | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | |
|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg CO2 equivalents) | (%) | (Gg CO2 equivalents) | (%) |
| Austria | 173 | 242 | 223 | 3.2% | -19 | -8% | 50 | 29% |
| Belgium | 223 | 210 | 199 | 2.8% | -12 | -6% | -24 | -11% |
| Denmark | 93 | 129 | 119 | 1.7% | -10 | -8% | 26 | 27% |
| Finland | 160 | 161 | 161 | 2.3% | 0 | 0% | 1 | 1% |
| France | 935 | 1,719 | 1,471 | 21.0% | -248 | -14% | 537 | 57% |
| Germany | 608 | 969 | 939 | 13.4% | -31 | -3% | 331 | 54% |
| Greece | 122 | 251 | 218 | 3.1% | -32 | -13% | 96 | 78% |
| Ireland | 41 | 108 | 106 | 1.5% | -2 | -2% | 65 | 158% |
| Italy | 789 | 1,009 | 980 | 14.0% | -29 | -3% | 191 | 24% |
| Luxembourg | 23 | 72 | 68 | 1.0% | -5 | -7% | 44 | 189% |
| Netherlands | 271 | 436 | 428 | 6.1% | -8 | -2% | 158 | 58% |
| Portugal | 63 | 186 | 187 | 2.7% | 1 | 1% | 124 | 196% |
| Spain | 493 | 887 | 818 | 11.7% | -69 | -8% | 325 | 66% |
| Sweden | 99 | 121 | 123 | 1.7% | 1 | 1% | 23 | 24% |
| United Kingdom | 1,170 | 1,059 | 970 | 13.8% | -90 | -8% | -201 | -17% |
| **EU-15** | **5,264** | **7,561** | **7,008** | **100.0%** | **-552** | **-7%** | **1,745** | **33%** |

**Table 3.54 Methods/models used for road transport by EU-15 MS**

| 1A3b | Method/Emission factors | Remark |
|---|---|---|
| Austria | CS / HBEFA | |
| Belgium | CS / COPERT IV | Emissions of CH4 and N2O are not calculated based on the Belgian energy statistics, but are the sum of the emissions calculated by the 3 regions using a methodology based on the COPERT-methodology. A region-specific methodology (the so-called MIMOSA-model, also based on COPERT IV) is used in the Flemish region. A recalculation is started in Belgium for the non-CO2-emissions of road transport during the 2010 submission by switching the COPERT III-based methodology to COPERT IV. In Wallonia, this switch has only been done for the years 2007 and 2008. In Brussels, the recalculation is still in progress and resultats will be available for next submission. |
| Denmark | CS / COPERT IV | An internal NERI model with a structure similar to the European COPERT III emission model (Ntziachristos, 2000) is used to calculate the Danish annual emissions for road traffic. For most vehicle categories, updated fuel use and emission data from the new COPERT IV version is incorporated in the NERI model. |
| Finland | CS / COPERT IV | According to the recommendations in the review the N2O emission factors have been updated in the LIISA model. Emission factors used in the COPERT IV program have been used as the reference values. |
| France | COPERT IV | |
| Germany | CS / HBEFA | |
| Greece | COPERT IV | |
| Ireland | COPERT IV | |
| Italy | COPERT IV | |
| Luxembourg | COPERT IV | |
| Netherlands | CS-T2 / HBEFA | |
| Portugal | COPERT IV | |
| Spain | COPERT IV | |
| Sweden | ARTEMIS | |
| United Kingdom | COPERT IV | |

### 1A3b Road Transportation – Diesel Oil ($N_2O$)

$N_2O$ emissions from Diesel oil account for 66 % of $N_2O$ emissions from 1A3b "Road Transportation" in 2009. Between 1990 and 2009 $N_2O$ emissions from Diesel oil increased in all Member States; within the EU-15 the emission increased by 181 %. The smallest increase in absolute terms was reported by Greece and Sweden. Between 2008 and 2009, EU-15 emissions rose by 1 % (Table 3.55).

**Table 3.55 1A3b Road Transport, diesel oil: Member States' contributions to $N_2O$ emissions and information on method applied and emission factor**

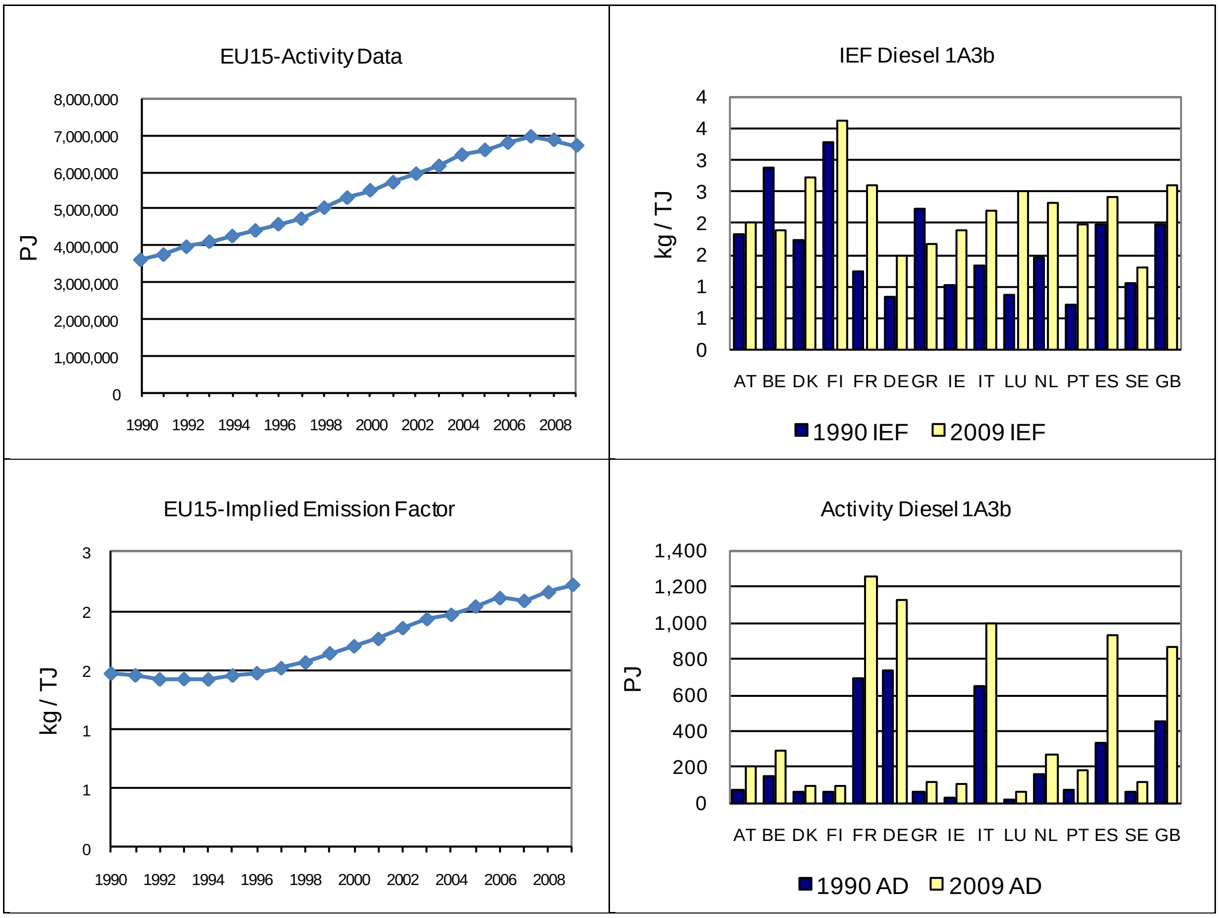
| Member State | $N_2O$ emissions (Gg $CO_2$ equivalents) | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg CO2 equivalents) | (%) | (Gg CO2 equivalents) | (%) | | |
| Austria | 41 | 136 | 130 | 2.8% | -6 | -5% | 89 | 219% | CS | CS |
| Belgium | 133 | 179 | 171 | 3.7% | -8 | -5% | 38 | 29% | Copert3&4 | CR,CS |
| Denmark | 32 | 86 | 82 | 1.8% | -4 | -5% | 50 | 157% | COPERT 4 | CR |
| Finland | 68 | 101 | 101 | 2.2% | 0 | 0% | 33 | 48% | M | CS |
| France | 266 | 987 | 1,020 | 22.1% | 33 | 3% | 755 | 284% | T3, COPERT 4 | CS |
| Germany | 188 | 498 | 521 | 11.3% | 23 | 5% | 334 | 178% | T3 | CS,M |
| Greece | 41 | 63 | 61 | 1.3% | -1 | -2% | 20 | 49% | COPERT 4 | CR |
| Ireland | 8 | 62 | 60 | 1.3% | -2 | -3% | 51 | 622% | T3 | COPERT 4v8. |
| Italy | 271 | 682 | 681 | 14.7% | -1 | 0% | 410 | 151% | COPERT 4 | CS |
| Luxembourg | 5 | 53 | 51 | 1.1% | -1 | -3% | 46 | 935% | T3 | D |
| Netherlands | 72 | 203 | 191 | 4.1% | -12 | -6% | 119 | 166% | T2 | CS |
| Portugal | 15 | 109 | 113 | 2.4% | 4 | 4% | 98 | 659% | T3 | CR |
| Spain | 208 | 694 | 700 | 15.1% | 6 | 1% | 492 | 236% | COPERT 4, CR, CS, T3 | CR |
| Sweden | 19 | 43 | 48 | 1.0% | 5 | 11% | 28 | 145% | CS,M,T1,T2 | CR,CS,D,M |
| United Kingdom | 281 | 702 | 695 | 15.0% | -7 | -1% | 414 | 148% | T3 | CS |
| **EU-15** | **1,647** | **4,598** | **4,626** | **100.0%** | **28** | **1%** | **2,979** | **181%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

France, Germany, Italy, Spain and the United Kingdom account for 78,2 % of $N_2O$ emissions and for 77.1 % of activity data from diesel oil in 2009 (Figure 3.59). The IEF for the EU-15 is 2.22 kg/TJ Diesel in 2009.

Table 3.55 shows that all $N_2O$ emissions from combustion of diesel oil in road transportation were calculated using a higher tier method.

**Figure 3.59** **1A3b Road Transport, diesel oil: Activity Data and Implied Emission Factor for $N_2O$ emission**



### 1A3b Road Transportation – Gasoline ($N_2O$)

$N_2O$ emissions from Gasoline account for 30 % of $N_2O$ emissions from 1A3b Road Transportation in 2009. Between 1990 and 2009, $N_2O$ emissions from gasoline decreased by 41 % in the EU-15. Between 2008 and 2008, all Member States, except for Netherlands which remained constant, showed a decreasing trend. The EU-15 total dropped by 21 % (Table 3.56).

**Table 3.56 1A3b Road Transport, gasoline: Member States' contributions to $N_2O$ emissions and information on method applied and emission factor**

| Member State | $N_2O$ emissions (Gg $CO_2$ equivalents) | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg CO2 equivalents) | (%) | (Gg CO2 equivalents) | (%) | | |
| Austria | 132 | 106 | 93 | 4.4% | -13 | -12% | -39 | -30% | CS | CS |
| Belgium | 89 | 29 | 26 | 1.2% | -3 | -12% | -63 | -71% | 0.0 | 0.0 |
| Denmark | 61 | 43 | 37 | 1.7% | -6 | -14% | -25 | -40% | 0.0 | 0.0 |
| Finland | 92 | 57 | 54 | 2.6% | -3 | -6% | -38 | -41% | M | CS |
| France | 669 | 608 | 346 | 16.5% | -262 | -43% | -323 | -48% | T3, COPERT 4 | CS |
| Germany | 421 | 401 | 350 | 16.7% | -51 | -13% | -70 | -17% | T3 | CS,M |
| Greece | 81 | 186 | 154 | 7.3% | -31 | -17% | 73 | 89% | M | M |
| Ireland | 33 | 45 | 44 | 2.1% | -1 | -2% | 12 | 35% | T3 | COPERT 4v8. |
| Italy | 517 | 279 | 251 | 12.0% | -27 | -10% | -266 | -51% | M | CS |
| Luxembourg | 18 | 18 | 15 | 0.7% | -4 | -20% | -4 | -21% | T3 | D |
| Netherlands | 156 | 206 | 206 | 9.8% | 0 | 0% | 50 | 32% | T2 | CS |
| Portugal | 48 | 73 | 67 | 3.2% | -6 | -8% | 19 | 39% | T3 | CR |
| Spain | 284 | 190 | 114 | 5.4% | -76 | -40% | -170 | -60% | CR,CS,T3 | CR |
| Sweden | 80 | 78 | 74 | 3.5% | -4 | -5% | -6 | -7% | CS,M,T1,T2 | CR,CS,D,M |
| United Kingdom | 890 | 354 | 272 | 12.9% | -82 | -23% | -618 | -69% | T3 | CS |
| **EU-15** | **3,573** | **2,672** | **2,103** | **100.0%** | **-569** | **-21%** | **-1,469** | **-41%** | | |

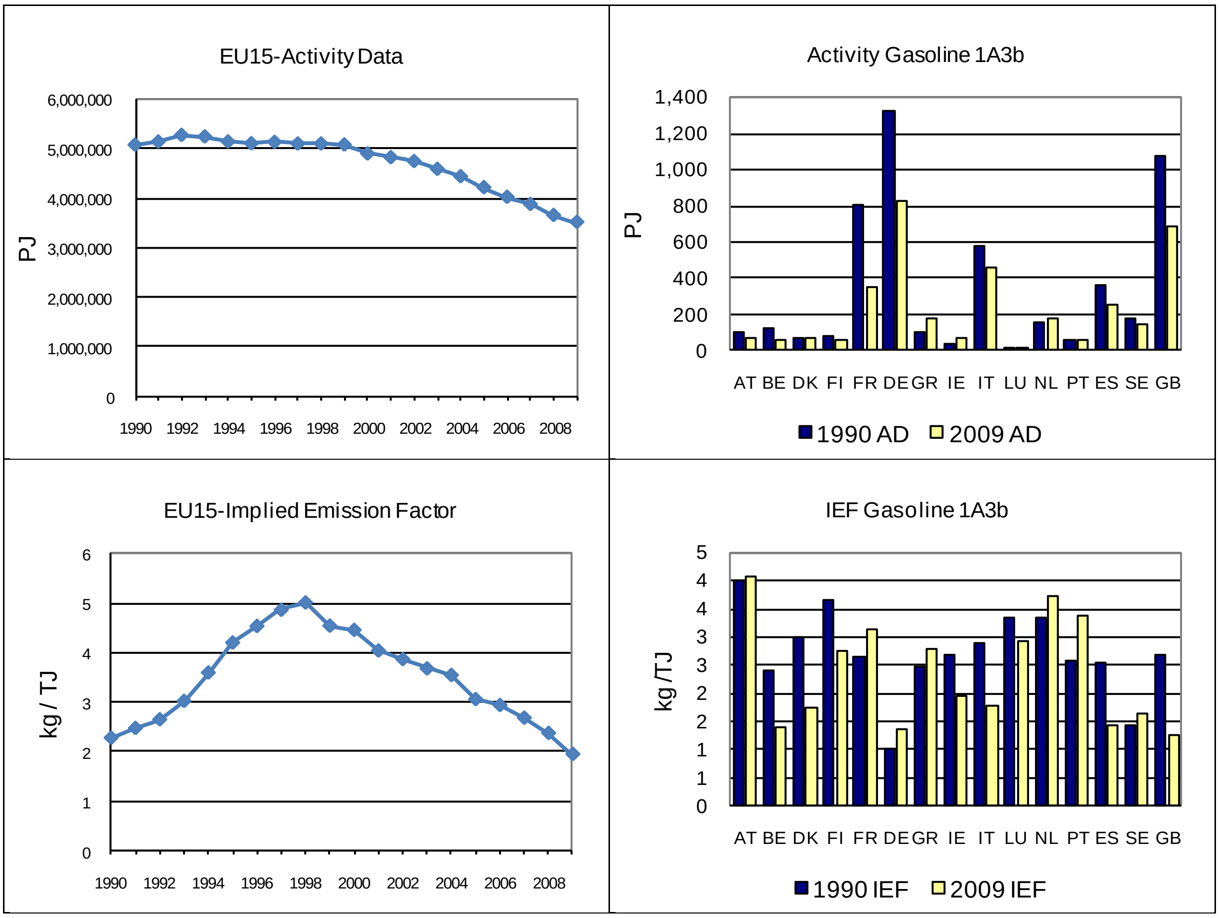
*Abbreviations explained in the Chapter 'Units and abbreviations'.*

France, Germany, Italy, Spain and the United Kingdom accounted for 63.5 % of $N_2O$ emissions and for 73.8 % of activity data from gasoline in 2009 (

Figure 3.60). The IEF for the EU-15 is 1,94 kg/TJ Gasoline in 2009.

Table 3.56 shows that all $N_2O$ emissions from the combustion of gasoline in road transportation were calculated using a higher tier method.

**Figure 3.60 1A3b Road Transport, gasoline: Activity data and implied emission factors for $N_2O$**

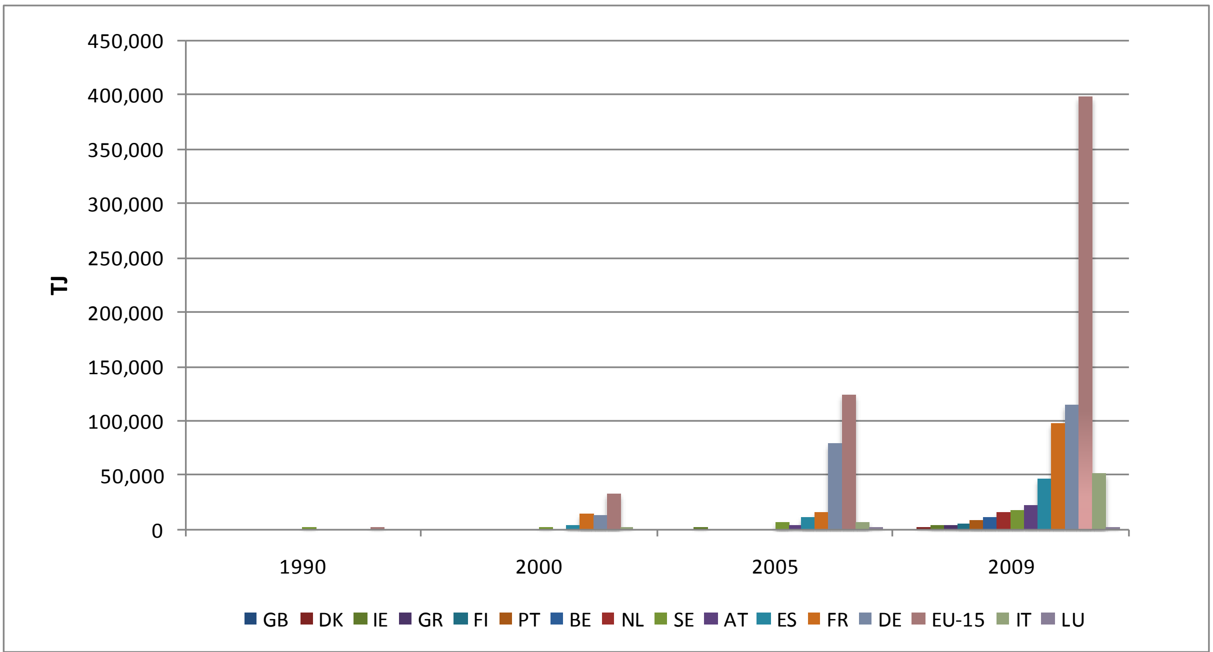


### 1A3b Road Transportation – Activity Data Biofuels

According to the European Directive on the promotion of the use of biofuels or other renewable fuels for transport (2003/30/EG), Member States should ensure that a minimum proportion of biofuels and other renewable fuels is placed on their markets, and, to that effect, shall set national indicative targets, to reduce greenhouse gas emissions. Member States brought into force the laws, regulations and administrative provisions necessary to comply with this Directive by 31 December 2004. A reference value for these targets shall be 2 %, calculated on the basis of energy content, of all petrol and diesel for transport purposes placed on their markets by 31 December 2005. A reference value for these targets shall be 5,75 %, calculated on the basis of energy content, of all petrol and diesel for transport purposes placed on their markets by 31 December 2010. Due to the possibility of different national implementation the MS need to approach partly different targets.

Between 1990 and 2009, activity data of biofuels increased from 24.8 TJ to 398.9 TJ in the EU-15 (Figure 3.61). Germany still reports most of total amount of biofuels (28.5 % of total EU-15 activity in 2009 vs. 36.5 % in 2009) over the last years, followed by France (24.6 %). All Member States except for the UK report biofuels activity data under 1A3b for 2009. Note that some countries might still not report biofuels separately from gasoline or diesel oil (additive) in particular also in other source categories (e.g. 1A2f and 1A4c for other mobile machineries). In this case the use of biofuels are visible in a decreasing trend of the IEFs of gasoline/diesel or liquid fuels.

**Figure 3.61 1A3b Road Transport, biofuels: Trend of Activity data of biofuels**

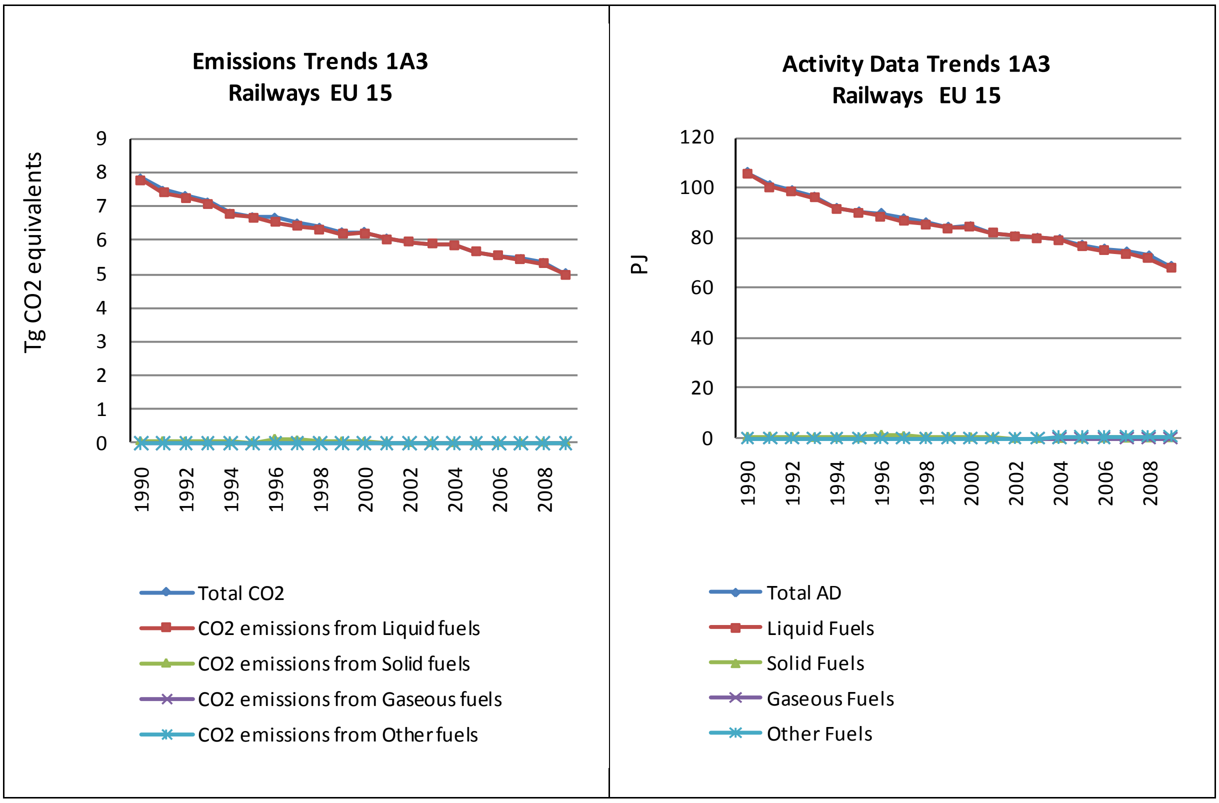


## Railways (1A3c) (EU-15)

Railway locomotives generally are one of these types: diesel, coal, electric, or steam. Diesel locomotives generally use diesel engines in combination with an alternator or generator to produce the electricity required to power their traction motors. Emissions from Railways arise from the combustion of liquid and solid fuels.

$CO_2$ emissions from 1A3c Railways account for 0.6 % of total EU-15 GHG emissions in 2009. Between 1990 and 2009, $CO_2$ emissions from rail transportation decreased by 36 % in the EU-15. The total trend is dominated by $CO_2$ emissions from liquid fuels (Figure 3.62). The emissions from this key category are due to fossil fuel consumption in rail transport, which decreased by 35.7% between 1990 and 2009.

**Figure 3.62 1A3c Railways: $CO_2$ Emission Trend and Activity Data**




The Member States France, Germany and the United Kingdom contributed most to the emissions from this source (71.4 %). All Member States except for the UK decreased emissions from rail transportation between 1990 and 2009. Germany had by far the highest decreases in absolute terms (Table 3.57).

**Table 3.57** **1A3c Railways: Member States' contributions to $CO_2$ emissions**

| Member State | $CO_2$ emissions in Gg | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | |
|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) |
| Austria | 178 | 153 | 148 | 2.9% | -6 | -4% | -30 | -17% |
| Belgium | 224 | 130 | 97 | 1.9% | -34 | -26% | -127 | -57% |
| Denmark | 297 | 237 | 230 | 4.6% | -6 | -3% | -67 | -22% |
| Finland | 191 | 115 | 92 | 1.8% | -23 | -20% | -99 | -52% |
| France | 1,070 | 594 | 540 | 10.8% | -53 | -9% | -530 | -50% |
| Germany | 2,881 | 1,180 | 1,127 | 22.4% | -53 | -4% | -1,754 | -61% |
| Greece | 203 | 116 | 97 | 1.9% | -19 | -16% | -105 | -52% |
| Ireland | 133 | 140 | 123 | 2.4% | -17 | -12% | -10 | -8% |
| Italy | 441 | 219 | 187 | 3.7% | -31 | -14% | -254 | -58% |
| Luxembourg | 25 | 18 | 10 | 0.2% | -7 | -42% | -14 | -58% |
| Netherlands | 91 | 89 | 66 | 1.3% | -23 | -26% | -25 | -28% |
| Portugal | 173 | 79 | 54 | 1.1% | -25 | -32% | -119 | -69% |
| Spain | 414 | 287 | 268 | 5.3% | -19 | -7% | -146 | -35% |
| Sweden | 103 | 68 | 66 | 1.3% | -2 | -2% | -36 | -35% |
| United Kingdom | 1,423 | 1,904 | 1,917 | 38.2% | 13 | 1% | 495 | 35% |
| **EU-15** | **7,846** | **5,328** | **5,023** | **100.0%** | **-305** | **-6%** | **-2,823** | **-36%** |

## 1A3c Railways –Liquid Fuels ($CO_2$)

Between 1990 and 2009, $CO_2$ emissions from liquid fuels decreased by 36 % in the EU-15. Between 2008 and 2009, EU-15 emissions decreased by 6 % (Table 3.58).

**Table 3.58** **1A3c Railways, liquid fuels: Member States' contributions to $CO_2$ emissions and information on method applied and emission factor**

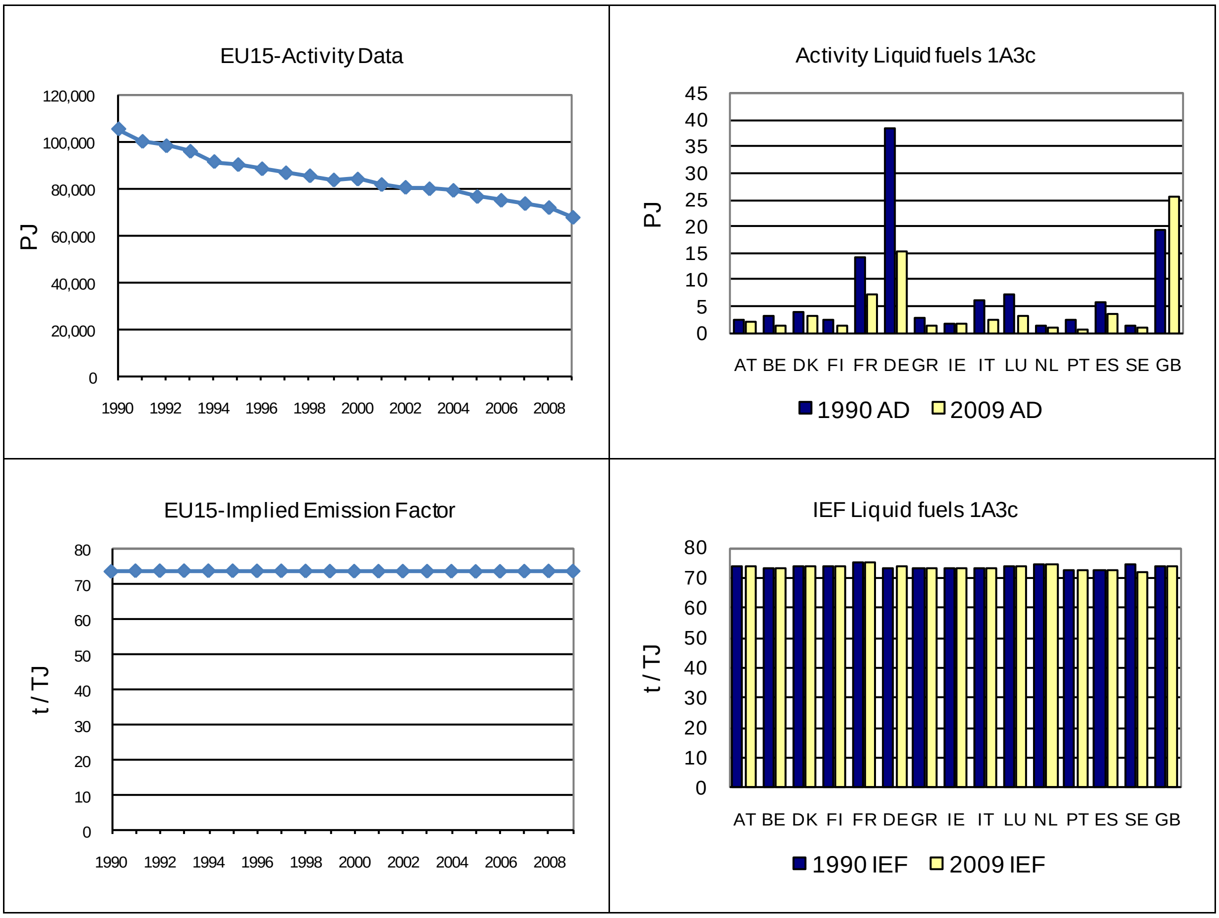
| Member State | $CO_2$ emissions in Gg | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| Austria | 171 | 153 | 147 | 2.9% | -6 | -4% | -24 | -14% | CS | CS |
| Belgium | 224 | 130 | 97 | 1.9% | -34 | -26% | -127 | -57% | CS,M,T1 | CS,D |
| Denmark | 297 | 237 | 230 | 4.6% | -6 | -3% | -67 | -22% | CR | CR |
| Finland | 191 | 115 | 92 | 1.8% | -23 | -20% | -99 | -52% | M | CS |
| France | 1,070 | 594 | 540 | 10.8% | -53 | -9% | -530 | -50% | CR | CS |
| Germany | 2,827 | 1,180 | 1,127 | 22.5% | -53 | -4% | -1,700 | -60% | CS,T1,T2 | CS |
| Greece | 200 | 116 | 97 | 1.9% | -19 | -16% | -103 | -51% | T1 | D |
| Ireland | 133 | 140 | 123 | 2.5% | -17 | -12% | -10 | -8% | T1 | CS |
| Italy | 441 | 219 | 187 | 3.7% | -31 | -14% | -254 | -58% | D | CS |
| Luxembourg | 25 | 18 | 10 | 0.2% | -7 | -42% | -14 | -58% | T2 | CS |
| Netherlands | 91 | 89 | 66 | 1.3% | -23 | -26% | -25 | -28% | CS | CS |
| Portugal | 173 | 79 | 54 | 1.1% | -25 | -32% | -119 | -69% | T1 | OTH |
| Spain | 414 | 287 | 268 | 5.4% | -19 | -7% | -146 | -35% | T2 | CR |
| Sweden | 103 | 68 | 66 | 1.3% | -2 | -2% | -36 | -35% | T1 | CS |
| United Kingdom | 1,423 | 1,886 | 1,893 | 37.9% | 7 | 0% | 471 | 33% | T2 | CS |
| **EU-15** | **7,783** | **5,309** | **4,998** | **100.0%** | **-311** | **-6%** | **-2,785** | **-36%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

France, Germany, Italy, Spain and the United Kingdom account for 80.3 % of $CO_2$ emissions and for 79,4 % of activity data from liquid fuels in 2009 (Figure 3.63). The IEF for the EU-15 is 73.82 t/TJ Liquid fuels in 2009.

Table 3.58 shows that the majority of $CO_2$ emissions from the combustion of liquid fuels in railways were calculated using a higher tier method.

**Figure 3.63 1A3c Railways, liquid fuels: Activity data and implied emission factors for $CO_2$**

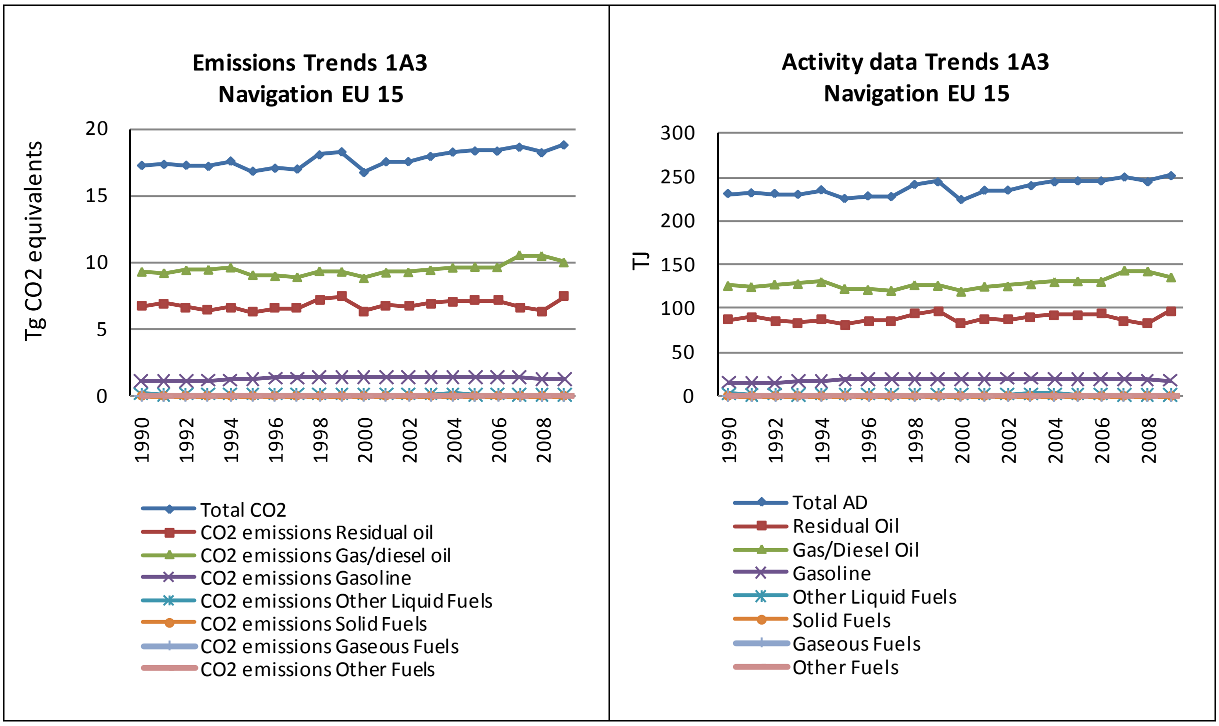


### 3.2.3.3 Navigation (1A3d) (EU-15)

This source category covers all water-borne transport from recreational craft to large ocean-going cargo ships that are driven primarily by large, slow and medium speed diesel engines and occasionally by steam or gas turbines. Emissions arise from gas/diesel oil, residual oil or other.

$CO_2$ emissions from 1A3d Navigation account for 2.3 % of total EU-15 GHG emissions in 2009. Between 1990 and 2009, $CO_2$ emissions from navigation increased by 9 % in the EU-15 (Table 3.58). The emissions from this key source are due to fossil fuel consumption in navigation. The total $CO_2$ emission trend is dominated by emissions from gas/diesel oil and residual oil (Figure 3.64).

**Figure 3.64 1A3d Navigation: $CO_2$ Emission Trend and Activity Data**




Five Member States (Greece, Italy, France, Spain and the United Kingdom) contributed the most to the emissions from this source (80.9%). Most Member States had increasing emissions from navigation between 1990 and 2008. The Member States with the highest increases in absolute terms were Spain, France and Greece (Table 3.59).

**Table 3.59** **1A3d Navigation: Member States' contributions to $CO_2$ emissions**

| Member State | $CO_2$ emissions in Gg | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | |
|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) |
| Austria | 34 | 35 | 35 | 0.2% | 0 | 1% | 1 | 3% |
| Belgium | 396 | 472 | 406 | 2.2% | -66 | -14% | 10 | 3% |
| Denmark | 796 | 593 | 598 | 3.2% | 5 | 1% | -198 | -25% |
| Finland | 441 | 488 | 508 | 2.7% | 20 | 4% | 67 | 15% |
| France | 1,753 | 2,788 | 2,840 | 15.1% | 52 | 2% | 1,087 | 62% |
| Germany | 2,066 | 832 | 723 | 3.8% | -109 | -13% | -1,343 | -65% |
| Greece | 1,825 | 1,885 | 2,808 | 14.9% | 923 | 49% | 983 | 54% |
| Ireland | 84 | 4 | IE,NO | - | -4 | -100% | - | - |
| Italy | 5,420 | 4,914 | 4,762 | 25.3% | -151 | -3% | -658 | -12% |
| Luxembourg | 1 | 1 | 1 | 0.0% | 0 | -15% | 0 | 2% |
| Netherlands | 405 | 632 | 610 | 3.2% | -23 | -4% | 205 | 51% |
| Portugal | 262 | 213 | 226 | 1.2% | 13 | 6% | -36 | -14% |
| Spain | 1,500 | 3,333 | 3,294 | 17.5% | -39 | -1% | 1,794 | 120% |
| Sweden | 542 | 446 | 500 | 2.7% | 54 | 12% | -42 | -8% |
| United Kingdom | 1,751 | 1,598 | 1,517 | 8.1% | -82 | -5% | -234 | -13% |
| **EU-15** | **17,276** | **18,234** | **18,828** | **100.0%** | **594** | **3%** | **1,552** | **9%** |

## 1A3d Navigation – Residual Oil ($CO_2$)

$CO_2$ emissions from residual oil account for 39.5 % of $CO_2$ emissions from 1A3d Navigation in 2009. Between 1990 and 2009, $CO_2$ emissions from residual oil increased by 11 % in the EU-15. The countries with the highest increase in absolute terms were Greece and Spain. Austria, Belgium, Germany, Ireland, Luxembourg and the Netherlands reported emissions as 'Not occuring' (Table 3.60) for 2009.

**Table 3.60** **1A3d Navigation, residual oil: Member States' contributions to $CO_2$ emissions and information on method applied and emission factor**

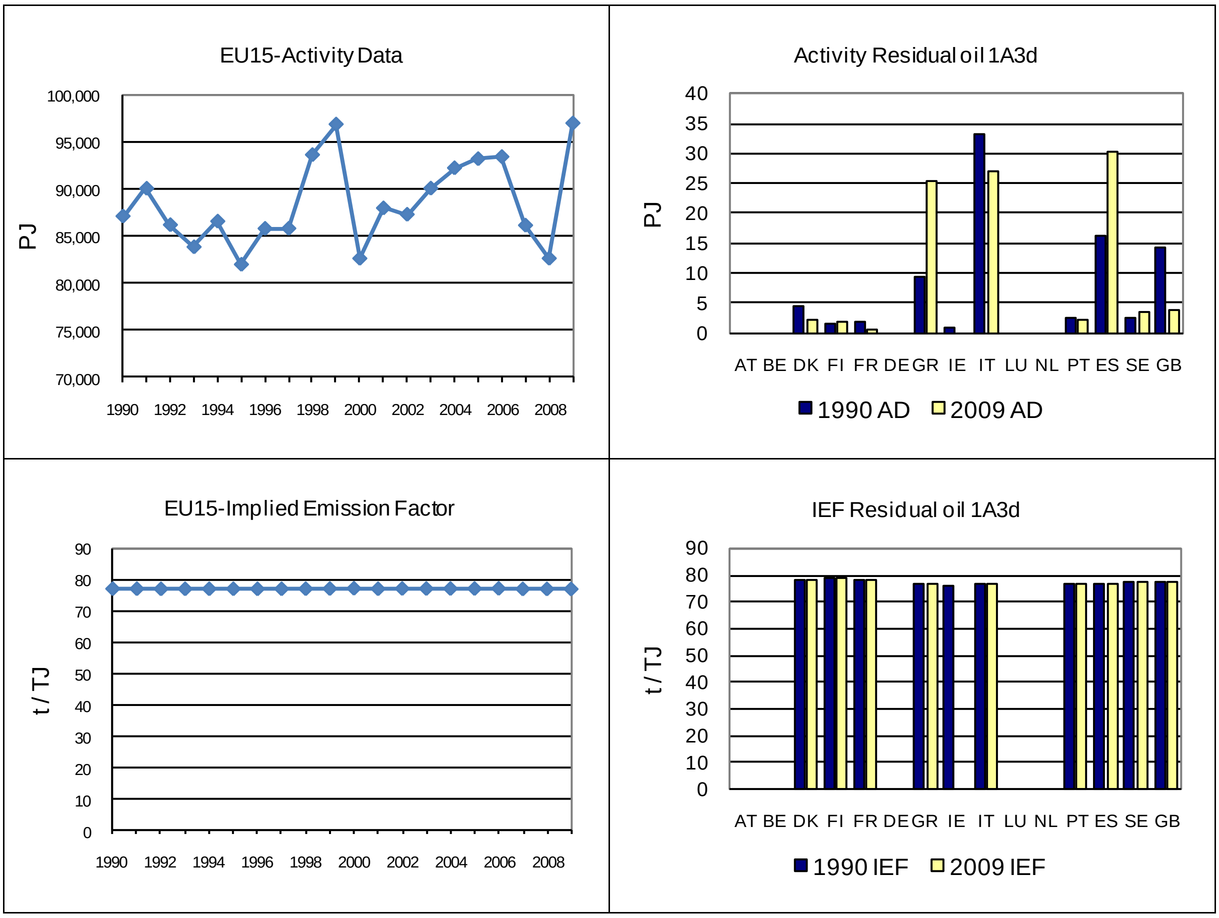
| Member State | $CO_2$ emissions in Gg | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| Austria | NO | NO | NO | - | - | - | - | - | CS | CS |
| Belgium | NO | NO | NO | - | - | - | - | - | CS,M,T1 | CS,D |
| Denmark | 357 | 167 | 179 | 2.4% | 12 | 7% | -178 | -50% | CR | CR |
| Finland | 123 | 150 | 158 | 2.1% | 8 | 5% | 35 | 28% | M | CS |
| France | 158 | 63 | 53 | 0.7% | -11 | -17% | -105 | -67% | CR | CS |
| Germany | NO | NO | NO | - | - | - | - | - | NA | NA |
| Greece | 730 | 899 | 1,939 | 26.0% | 1,040 | 116% | 1,210 | 166% | T1 | D |
| Ireland | 63 | NO | NO | - | 0 | - | -63 | -100% | NO | NO |
| Italy | 2,553 | 2,116 | 2,056 | 27.6% | -60 | -3% | -498 | -19% | T1,T2 | CS |
| Luxembourg | NO | NO | NO | - | - | - | - | - | NA | NA |
| Netherlands | NO | NO | NO | - | - | - | - | - | NA | NA |
| Portugal | 188 | 153 | 162 | 2.2% | 9 | 6% | -26 | -14% | CR | CS |
| Spain | 1,234 | 2,345 | 2,318 | 31.1% | -28 | -1% | 1,084 | 88% | T2 | CR |
| Sweden | 194 | 129 | 277 | 3.7% | 148 | 115% | 83 | 43% | T1 | CS |
| United Kingdom | 1,098 | 324 | 304 | 4.1% | -20 | -6% | -795 | -72% | T2 | CS |
| **EU-15** | **6,698** | **6,347** | **7,445** | **100.0%** | **1,099** | **17%** | **748** | **11%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

Greece, Italy and Spain account for 84.7 % of $CO_2$ emissions and for 84.5 % of activity data from residual oil in 2009 (Figure 3.65). The IEF for the EU-15 is 76.81 t/TJ Residual oil in 2009.

Table 3.60 shows, that the majority of $CO_2$ emissions from the combustion of residual oil in navigation were calculated using a higher tier method.

**Figure 3.65 1A3d Navigation, residual oil: Activity data and implied emission factors for $CO_2$**



## 1A3d Navigation – Gas/Diesel Oil ($CO_2$)

$CO_2$ emissions from Gas/Diesel oil account for 53.1 % of $CO_2$ emissions from 1A3d Navigation in 2009 (Table 3.61). The $CO_2$ emissions from Gas/Diesel oil increased by 7 % between 1990 and 2009.

**Table 3.61 1A3d Navigation, gas/diesel oil: Member States' contributions to $CO_2$ emissions and information on method applied and emission factor**

| Member State | $CO_2$ emissions in Gg | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| Austria | 24 | 26 | 27 | 0.3% | 1 | 2% | 3 | 10% | CS | CS |
| Belgium | 396 | 472 | 406 | 4.1% | -66 | -14% | 10 | 3% | CS,M,T1 | CS,D |
| Denmark | 417 | 399 | 393 | 3.9% | -6 | -1% | -23 | -6% | CR | CR |
| Finland | 186 | 167 | 173 | 1.7% | 6 | 4% | -13 | -7% | M,T3 | CS |
| France | 1,301 | 2,268 | 2,328 | 23.3% | 60 | 3% | 1,027 | 79% | CR | CS |
| Germany | 2,050 | 829 | 721 | 7.2% | -108 | -13% | -1,329 | -65% | T1,T2 | CS |
| Greece | 1,068 | 973 | 863 | 8.6% | -110 | -11% | -204 | -19% | T1 | D |
| Ireland | 21 | 4 | IE | - | -4 | -100% | -21 | -100% | NA | NA |
| Italy | 2,299 | 2,207 | 2,147 | 21.5% | -60 | -3% | -152 | -7% | T1,T2 | CS |
| Luxembourg | 1 | 1 | 1 | 0.0% | 0 | -17% | 0 | 17% | T2 | CS |
| Netherlands | 405 | 632 | 610 | 6.1% | -23 | -4% | 205 | 51% | T2 | CS |
| Portugal | 73 | 60 | 63 | 0.6% | 4 | 6% | -10 | -14% | CR | CS |
| Spain | 266 | 988 | 976 | 9.8% | -12 | -1% | 711 | 267% | T2 | CR |
| Sweden | 271 | 240 | 146 | 1.5% | -94 | -39% | -126 | -46% | T1 | CS |
| United Kingdom | 545 | 1,205 | 1,144 | 11.4% | -61 | -5% | 600 | 110% | T2 | CS |
| **EU-15** | **9,323** | **10,473** | **10,000** | **100.0%** | **-474** | **-5%** | **677** | **7%** | | |

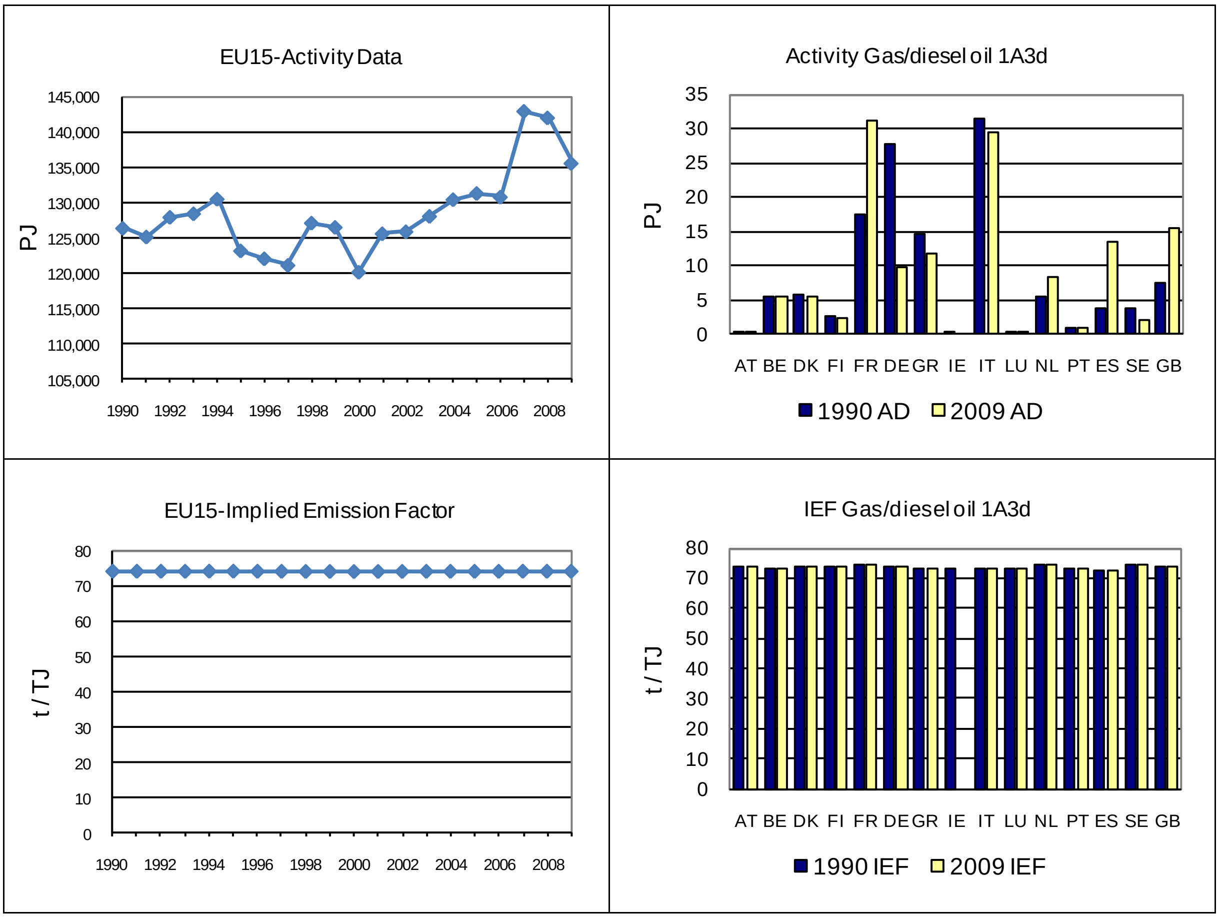
*Abbreviations explained in the Chapter 'Units and abbreviations'.*

France, Germany, Italy, Spain and the United Kingdom account for 73,2 % of the $CO_2$ emissions and for 72,8 % of activity data from gas/diesel oil in 2009 (

Figure 3.66). The IEF for the EU-15 is 73,78 t/TJ residual oil in 2009.

Table 3.61 shows that the majority of $CO_2$ emissions from the combustion of gas/diesel oil in navigation were calculated using a higher tier method.

Figure 3.66 1A3d Navigation, gas/diesel oil: Activity data and implied emission factors for $CO_2$



### 3.2.3.4 Other (1A3e) (EU-15)

$CO_2$ emissions from 1A3e Other account for 0.21 % of total EU-15 GHG emissions in 2009. This source includes mainly pipeline transport and ground activities in airports and harbours. The emissions from this key source are due to fossil fuel consumption in other transportation, which increased by 14.9 % between 1990 and 2009. A fuel shift occurred from oil to gas.

Germany contributed almost 50 % to the EU-15 emissions from this source in 2009 (Table 3.62). Between 1990 and 2009 the EU-15 emissions increased by 11 %. Denmark, Greece, Luxembourg and the Netherlands report emissions as ‘Not occurring’ or ‘Not applicable’. Portugal includes off-road vehicles and machines from manufacturing industries, residential and commercial/institutional with the other combustion equipment of these source categories; emissions from the consumption of jet fuel from military operation in 1 A 5 b (Other Mobile); and emissions from off-road vehicles and machines from agriculture/forestry sector in 1 A 4 c Agriculture/Forestry/Fisheries (see country NIR Portugal, p.134).

**Table 3.62 1A3e Other: Member States’ contributions to $CO_2$ emissions**

| Member State | $CO_2$ emissions in Gg | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | |
|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) |
| Austria | 224 | 574 | 427 | 6.0% | -147 | -26% | 203 | 90% |
| Belgium | 197 | 130 | 200 | 2.8% | 70 | 54% | 4 | 2% |
| Denmark | NO | NO | NO | - | - | - | - | - |
| Finland | 660 | 702 | 595 | 8.3% | -107 | -15% | -65 | -10% |
| France | 213 | 624 | 606 | 8.5% | -18 | -3% | 393 | 184% |
| Germany | 4,302 | 3,692 | 3,608 | 50.3% | -85 | -2% | -695 | -16% |
| Greece | NO | 14 | NO | - | -14 | -100% | - | - |
| Ireland | 62 | 146 | 151 | 2.1% | 5 | 3% | 89 | 143% |
| Italy | 407 | 899 | 821 | 11.4% | -78 | -9% | 414 | 102% |
| Luxembourg | NA | NA | NA | - | - | - | - | - |
| Netherlands | NO | NO | NO | - | - | - | - | - |
| Portugal | IE | IE | IE | - | - | - | - | - |
| Spain | 20 | 162 | 162 | 2.3% | 0 | 0% | 142 | 702% |
| Sweden | 150 | 162 | 162 | 2.3% | 0 | 0% | 13 | 8% |
| United Kingdom | 225 | 467 | 439 | 6.1% | -28 | -6% | 214 | 95% |
| **EU-15** | **6,461** | **7,574** | **7,171** | **100.0%** | **-403** | **-5%** | **710** | **11%** |

*Abbreviations explained in the Chapter ‘Units and abbreviation*

### *3.2.4 Other Sectors (CRF Source Category 1A4) (EU-15)*

Category 1A4 mainly includes emissions from ‘small scale fuel combustion’ used for space heating and hot water production in commercial and institutional buildings, households, agriculture and forestry. It includes also emissions from mobile machinery used within these categories (e.g mowers, harvesters, tractors, chain saws, motor pumps) as well as fuel used for grain drying, horticultural greenhouse heating or $CO_2$ fertilisation and stall heatings. Category 1A4c includes emissions from domestic inland, coastal and deep sea fishing wheras emissions from international fishing are included under category 1A3d. Emissions from transportation of agricultural goods are reported under category 1A3 Transport.

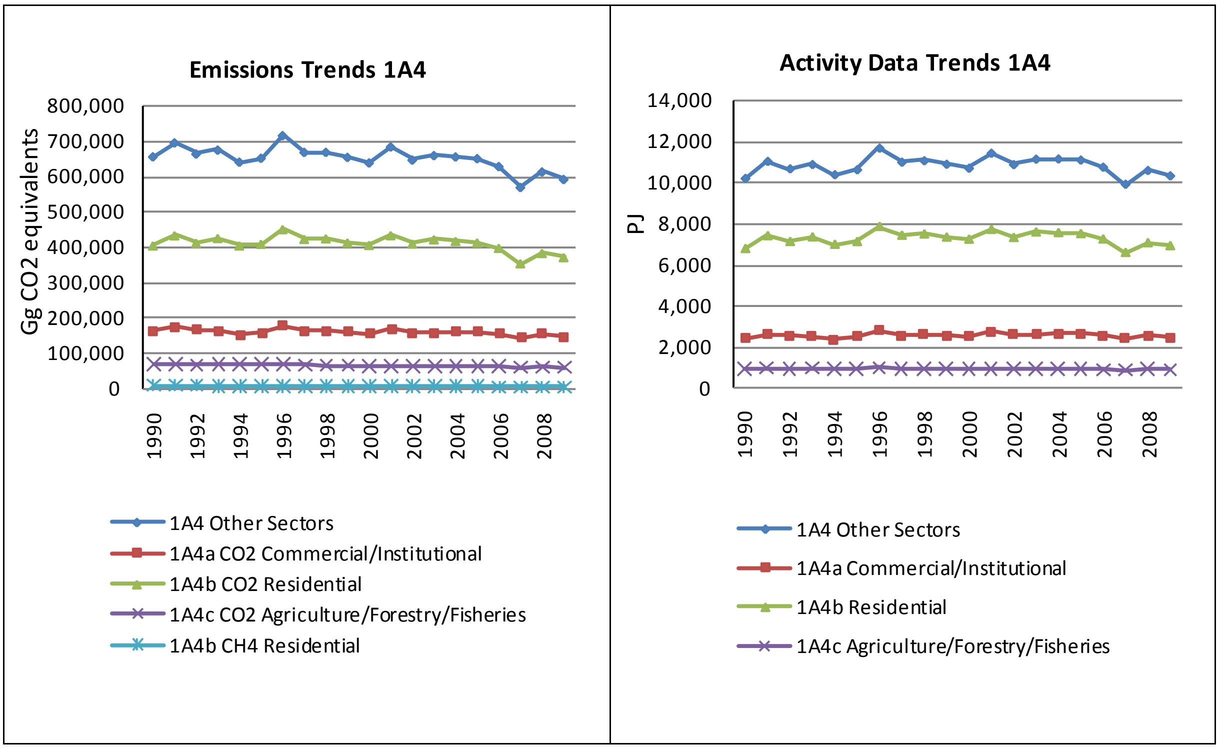
The following enumeration shows the correspondence of 1A4 sub categories and ISIC codes:

- 1 A 4 a Commercial/Institutional: ISIC categories 4103, 42, 6, 719, 72, 8, and 91-96
- 1 A 4 b Residential: All emissions from fuel combustion in households
- 1 A 4 b Agriculture/Forestry/Fishing: ISIC categories 05, 11, 12, 1302

In 2009 category 1A4 contributed to 593,706 Gg $CO_2$ equivalents of which 97.8 % $CO_2$, 1.2 % $CH_4$ and 1.0 % $N_2O$.

Figure 3.67 shows the trend of total GHG emissions within source category 1A4 and the dominating sources: $CO_2$ emissions from 1A4b Residential and from 1A4a Commercial/Residential. The emissions of the large key sources fluctuated between 1990 and 2009, all emissions from 1A4 decreased.

**Figure 3.67 1A4 Other Sectors: Total, $CO_2$ and $CH_4$ emission trends**



In 2009 GHG emissions from source category 1A4 accounted for 16 % of total GHG emissions. This source category includes ten key sources:

- 1 A 4 a Commercial/Institutional: Gaseous Fuels ($CO_2$)
- 1 A 4 a Commercial/Institutional: Liquid Fuels ($CO_2$)
- 1 A 4 a Commercial/Institutional: Solid Fuels ($CO_2$)
- 1 A 4 b Residential: Gaseous Fuels ($CO_2$)
- 1 A 4 b Residential: Liquid Fuels ($CO_2$)
- 1 A 4 b Residential: Solid Fuels ($CO_2$)
- 1 A 4 c Agriculture/Forestry/Fisheries: Gaseous Fuels ($CO_2$)
- 1 A 4 c Agriculture/Forestry/Fisheries: Liquid Fuels ($CO_2$)
- 1 A 4 c Agriculture/Forestry/Fisheries: Solid Fuels ($CO_2$)

Table 3.63 shows total GHG, $CO_2$ and $CH_4$ emissions from 1A4 Other sectors. Between 1990 and 2009 $CO_2$ emissions from 1A4 Other Sectors decreased by 9 %, $CH_4$ decreased by 37 % and $N_2O$ emissions decreased by 8 %.

**Table 3.63 1A4 Other Sectors: Member States' contributions to total GHG, $CO_2$ and $CH_4$ emissions**

| Member State | GHG emissions in 1990 (Gg $CO_2$ equivalents) | GHG emissions in 2009 (Gg $CO_2$ equivalents) | CO2 emissions in 1990 (Gg) | CO2 emissions in 2009 (Gg) | $CH_4$ emissions in 1990 (Gg $CO_2$ equivalents) | CH4 emissions in 2009 (Gg $CO_2$ equivalents) |
|---|---|---|---|---|---|---|
| Austria | 14,432 | 11,283 | 13,811 | 10,858 | 386 | 203 |
| Belgium | 27,949 | 28,956 | 27,565 | 28,630 | 245 | 178 |
| Denmark | 9,128 | 6,414 | 8,943 | 6,135 | 115 | 187 |
| Finland | 7,310 | 5,152 | 7,040 | 4,836 | 183 | 238 |
| France | 100,769 | 100,849 | 95,735 | 98,016 | 3,736 | 1,466 |
| Germany | 208,065 | 147,214 | 204,483 | 146,052 | 2,594 | 653 |
| Greece | 8,592 | 10,929 | 8,126 | 10,610 | 84 | 77 |
| Ireland | 10,540 | 10,696 | 10,053 | 10,428 | 379 | 171 |
| Italy | 78,387 | 88,690 | 76,677 | 86,101 | 309 | 785 |
| Luxembourg | 1,322 | 1,847 | 1,310 | 1,826 | 7 | 8 |
| Netherlands | 38,290 | 39,908 | 37,791 | 38,466 | 454 | 1,399 |
| Portugal | 4,610 | 5,259 | 4,025 | 4,762 | 348 | 314 |
| Spain | 26,454 | 36,659 | 25,320 | 35,601 | 817 | 693 |
| Sweden | 10,809 | 3,823 | 10,290 | 3,311 | 243 | 273 |
| United Kingdom | 111,418 | 96,041 | 108,907 | 94,891 | 1,536 | 535 |
| **EU-15** | **658,076** | **593,721** | **640,077** | **580,522** | **11,438** | **7,181** |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

Table 3.64 provides information on the contribution of Member States to EU-15 recalculations in $CO_2$ from 1A4 Other sectors for 1990 and 2008 and main explanations for the largest recalculations in absolute terms.

**Table 3.64 1A4 Other Sectors: Contribution of MS to EU-15 recalculations in $CO_2$ for 1990 and 2008 (difference between latest submission and previous submission in Gg of $CO_2$ equivalents and percent)**

| | 1990 | | 2008 | | Main explanations |
|---|---|---|---|---|---|
| | Gg CO2 equiv. | Percent | Gg CO2 equiv. | Percent | |
| Austria | 0 | 0.0 | 225 | 2.0 | Revised energy balance |
| Belgium | 369 | 1.4 | -179 | -0.6 | AD in the sector 1A4a in the Brussels region is revised for the year 2008 following the finalization of the 2008 energy balance of the region. Final version of the energy balance in the Walloon region (inventory year 2008 only) |
| Denmark | -14 | -0.2 | -41 | -0.7 | The emission factor time-series for coal and residual oil have been improved based on EU ETS data. In addition emission factors for LPG, kerosene, refinery gas and natural gas applied in off-shore gas turbines have also been updated. Discussed in detail in NIR chapter 3.2.5. |
| Finland | 0 | 0.0 | 281 | 6.3 | Updated data from space heating model. |
| France | 882 | 0.9 | 1,523 | 1.5 | Data consumption has been reviwed and increased in 1A4 due to reallocation of auto-production from district heating plant and energy balance consideration. |
| Germany | 143 | 0.1 | 3,168 | 2.1 | New available data from national statistics. |
| Greece | 0 | 0.0 | 92 | 0.8 | |
| Ireland | 0 | 0.0 | 0 | 0.0 | |
| Italy | 0 | 0.0 | -5 | 0.0 | steam coal and natural gas emission factor update |
| Luxembourg | -48 | -3.6 | 215 | 14.7 | Activity data was revised due to new energy statistics from National Statistics (STATEC), and due to the application of national densities and NCVs, which are now streamlined with STATEC. |
| Netherlands | -426 | -1.1 | -515 | -1.3 | reallocation from 1.A.4 to 1A2 for non-road |
| Portugal | 0 | 0.0 | 6 | 0.1 | Revision of the ten/ton convertion factor for heating gas oil following recommendation given by DGEG's experts. |
| Spain | 33 | 0.1 | 34 | 0.1 | New methodology following EMEP/EEA 2009 Guidebook for mobile agricultural machinery and mobile forestry machinery. Revision of diesel consumption data. |
| Sweden | 0 | 0.0 | -446 | -11.7 | Revised activity data (from energy balances) |
| UK | 55 | 0.1 | -2,699 | -2.6 | - New EF based on carbon content measurements for domestic pet coke. GCV revised for coal for 2006 onwards. Revision to national energy statistics for coke for 2007 onwards.<br>- Northern Ireland domestic peat use data for all years. Revised national energy stats 2005 onward. Updates to CDs caused reallocation of LPG fuel oil and gas oil for all years. New AD for domestic petcoke. Improvements to offroad model 2004 onwards.<br>- Addition of fishing vessels in 1A4c |
| **EU-15** | **993** | **0.2** | **1,660** | **0.3** | |

Table 3.65 provides information on the contribution of Member States to EU-15 recalculations in $CH_4$ from 1A4 Other sectors for 1990 and 2008.

**Table 3.65 1A4 Other Sectors: Contribution of MS to EU-15 recalculations in $CH_4$ for 1990 and 2007 (difference between latest submission and previous submission in Gg of $CO_2$ equivalents and percent)**

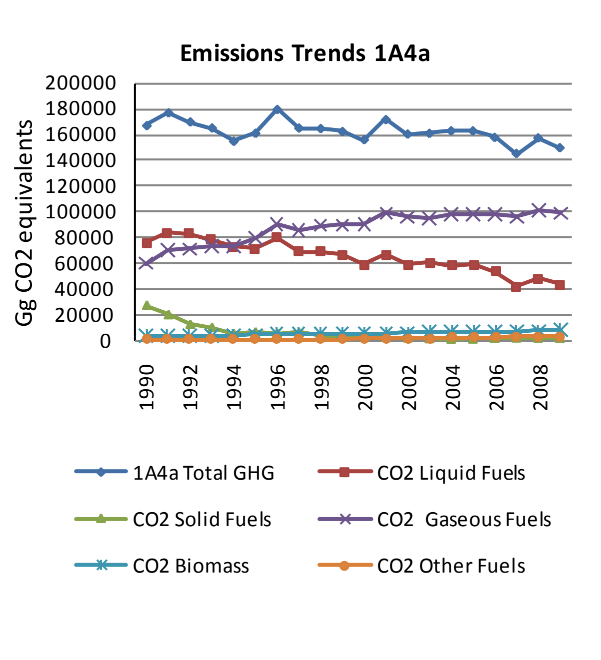
| | 1990 | | 2008 | | Main explanations |
|---|---|---|---|---|---|
| | Gg CO2 equiv. | Percent | Gg CO2 equiv. | Percent | |
| Austria | 0 | 0.0 | -8 | -3.8 | Revised energy balance |
| Belgium | 5 | 2.0 | -6 | -3.1 | AD in the sector 1A4a in the Brussels region is revised for the year 2008 following the finalization of the 2008 energy balance of the region. Final version of the energy balance in the Walloon region (inventory year 2008 only). New emission factors (depending of the type of fuel IPCCrevised 1996guidelines or IPCC2006) are used for the complete time series in the sector 1A4c Agriculture in the Flemish region. |
| Denmark | 24 | 26.7 | -21 | -9.5 | Emission factors that are not nationally referenced have been updated and now all refer to IPCC Guidelines (1996). In addition a time-series have been estimated for the CH4 emission factor for residential wood combustion. |
| Finland | 0 | 0.0 | 1 | 0.3 | Updated data from space heating model. |
| France | 44 | 1.2 | 49 | 3.3 | Ajout des consommations liées à l'autoproduction d'électricité et MAJ des FE CH4 pour améliorer la cohérence entre secteurs |
| Germany | 0 | 0.0 | -14 | -2.1 | New available data from national statistics. |
| Greece | 0 | 0.0 | 0 | 0.0 | |
| Ireland | 0 | 0.0 | 0 | 0.0 | |
| Italy | 0 | 0.0 | 0 | 0.0 | |
| Luxembourg | 0 | -1.5 | 1 | 11.8 | Activity data was revised due to new energy statistics from National Statistics (STATEC), and due to the application of national densities and NCVs, which are now streamlined with STATEC. |
| Netherlands | 5 | 1.1 | -34 | -2.4 | reallocation from 1.A.4 to 1A2 for non-road |
| Portugal | 0 | 0.0 | 0 | 0.0 | |
| Spain | -3 | -0.3 | -6 | -0.9 | Correction of an omission of EF for biomass consumed at cogeneration facilities. New methodology following EMEP/EEA 2009 Guidebook for mobile agricultural machinery and mobile forestry machinery. Revision of diesel consumption data. |
| Sweden | 0 | 0.0 | 11 | 4.5 | Revised activity data (from energy balances) |
| UK | 2 | 0.2 | -16 | -2.8 | - Revised GCV for all years for fuel oil gas oil LPG and vaporising oil.<br>- Northern Ireland domestic peat use data for all years. Revised national energy stats 2005 onward. Updates to CDs caused reallocation of LPG fuel oil and gas oil for all years. New AD for domestic petcoke. Improvements to offroad model 2004 onwards.<br>- Addition of fishing vessels in 1A4c |
| **EU-15** | **78** | **0.7** | **-44** | **-0.6** | |

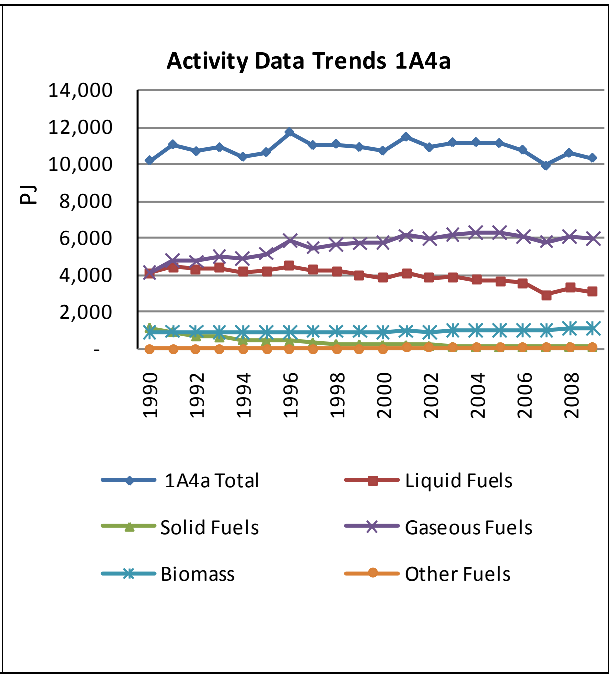
### 3.2.4.1 Commercial/Institutional (1A4a) (EU-15)

In this chapter information about emission trends, Member states' contribution, activity data, and emission factors is provided for category 1A4a by fuels. $CO_2$ emissions from 1A4a Commercial/Institutional was the fifth largest key category of GHG emissions in the EU-15 and accounted for 4.0 % of total GHG emissions in 2009.

Figure 3.68 shows the emission trend within the category 1A4a, which is mainly dominated by $CO_2$ emissions from liquid and gaseous fuels. Total emissions decreased by 10 %, mainly due to decreases in $CO_2$ emissions from solid (-92 %) and liquid (-42 %) fuels.

**Figure 3.68** **1A4a Commercial/Institutional: Total and $CO_2$ emission and activity trends**




Between 1990 and 2009, $CO_2$ emissions from 1A4a decreased by 10 % in the EU-15 (Table 3.66). Main factors influencing $CO_2$ emissions from this source category are (1) outdoor temperature, (2) number and size of offices, (3) building codes, (4) thermal properties of building stock, (5) fuel split for heating and warm water, (6) use of renewable energy sources, e.g. biomass or solar panels, and (7) use of district heating. Fossil fuel consumption in Commercial/Institutional decreased by 1 % between 1990 and 2009, with a fuel switch from coal and oil to gas.

France, Germany, Italy and the United Kingdom contributed the most to the emissions from this source (75 %). The Member States with the highest increases in absolute terms were Spain, Italy and the Netherlands. The Member States with the highest reduction in absolute terms were Germany and the United Kingdom.

**Table 3.66 1A4a Commercial/Institutional: Member States' contributions to $CO_2$ emissions**

| Member State | CO2 emissions in Gg | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | |
|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg CO2 equivalents) | (%) | (Gg CO2 equivalents) | (%) |
| Austria | 2,651 | 3,428 | 2,566 | 1.7% | -862 | -25% | -85 | -3% |
| Belgium | 4,580 | 6,505 | 6,415 | 4.3% | -89 | -1% | 1,835 | 40% |
| Denmark | 1,476 | 1,024 | 980 | 0.7% | -44 | -4% | -496 | -34% |
| Finland | 1,951 | 886 | 952 | 0.6% | 67 | 8% | -999 | -51% |
| France | 28,911 | 29,793 | 28,890 | 19.5% | -903 | -3% | -21 | 0% |
| Germany | 63,950 | 40,854 | 37,579 | 25.3% | -3,275 | -8% | -26,370 | -41% |
| Greece | 527 | 1,494 | 1,230 | 0.8% | -265 | -18% | 702 | 133% |
| Ireland | 2,338 | 2,760 | 2,463 | 1.7% | -297 | -11% | 125 | 5% |
| Italy | 16,187 | 26,822 | 27,409 | 18.5% | 588 | 2% | 11,223 | 69% |
| Luxembourg | 634 | 478 | 492 | 0.3% | 13 | 3% | -142 | -22% |
| Netherlands | 8,379 | 11,140 | 11,390 | 7.7% | 250 | 2% | 3,011 | 36% |
| Portugal | 744 | 1,874 | 1,846 | 1.2% | -28 | -2% | 1,102 | 148% |
| Spain | 3,743 | 8,320 | 7,967 | 5.4% | -353 | -4% | 4,225 | 113% |
| Sweden | 2,533 | 713 | 641 | 0.4% | -72 | -10% | -1,892 | -75% |
| United Kingdom | 26,240 | 19,894 | 17,488 | 11.8% | -2,406 | -12% | -8,752 | -33% |
| **EU-15** | **164,843** | **155,984** | **148,308** | **100.0%** | **-7,676** | **-5%** | **-16,534** | **-10%** |

### 1A4 a Commercial/Institutional – Liquid Fuels ($CO_2$)

In 2009 $CO_2$ emissions from liquid fuels had a share of 28 % within source category 1A4a (compared to 45 % in 1990). Between 1990 and 2009, the emissions decreased by 42 % (Table 3.67). Three Member States had increases in this period, with the highest absolute increase in Spain. The highest absolute decrease was achieved in Germany. Between 2008 and 2009 EU-15 total emissions decreased by 10 %. The strong decrease from 2006 to 2007 for Germany is due to low gasoil sales to end consumers. Many end consumers did not restock their oil tanks in 2007 because of high outdoor temperatures and rising oil prices. Additionally end consumer gasoil stocks were comparatively high in 2007 due to a mild winter 2006. It is assumed that the circumstances were similar for other MS (e.g. Austria).

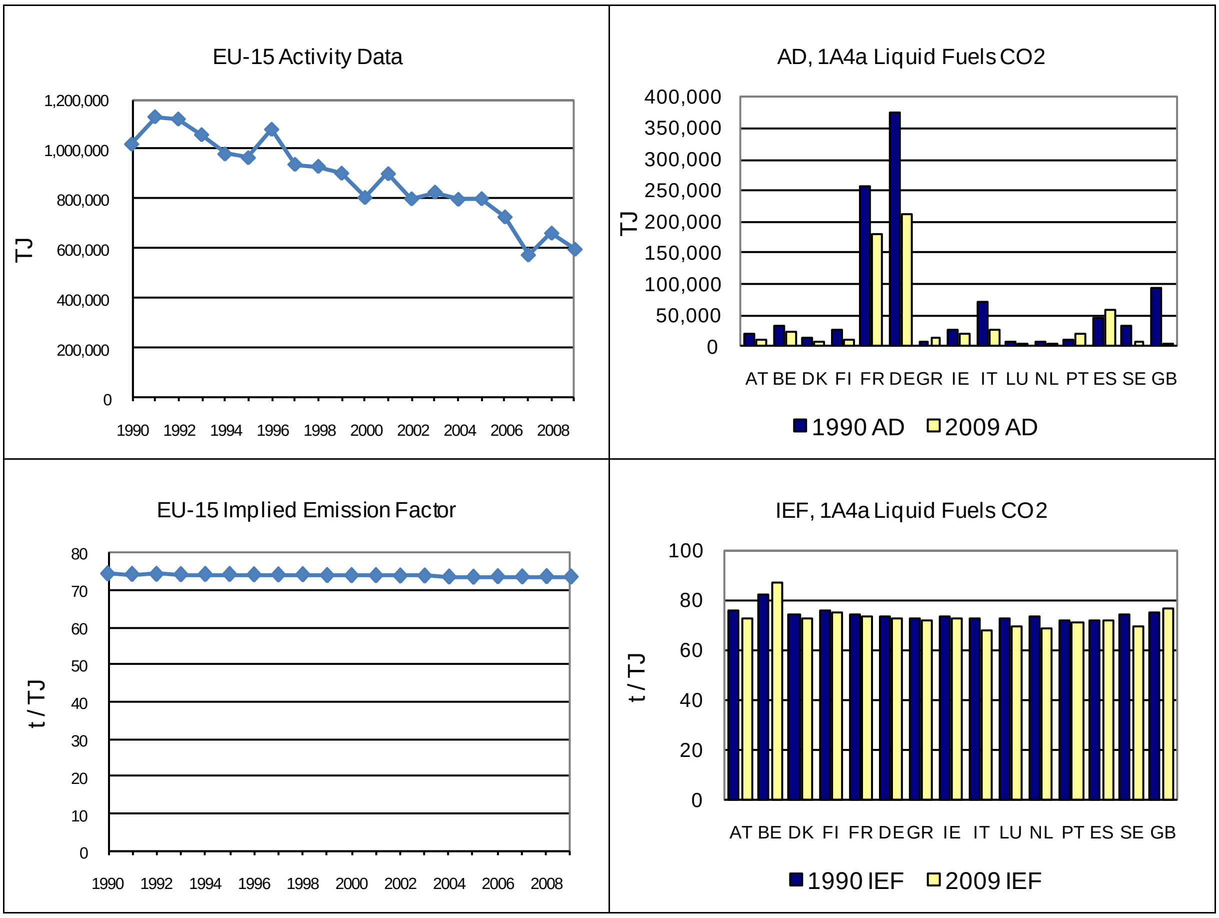
**Table 3.67 1A4a Commercial/Institutional, liquid fuels: Member States' contributions to $CO_2$ emissions and information on method applied and emission factor**

| Member State | CO2 emissions in Gg | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg CO2 equivalents) | (%) | (Gg CO2 equivalents) | (%) | | |
| Austria | 1,448 | 1,537 | 820 | 1.9% | -717 | -47% | -628 | -43% | T2 | CS |
| Belgium | 2,617 | 2,279 | 2,128 | 4.8% | -151 | -7% | -489 | -19% | T1 | D |
| Denmark | 1,081 | 417 | 406 | 0.9% | -11 | -3% | -675 | -62% | CR | CS,CR,D |
| Finland | 1,885 | 784 | 859 | 2.0% | 75 | 9% | -1,026 | -54% | T1 | CS |
| France | 19,103 | 13,766 | 13,241 | 30.2% | -525 | -4% | -5,863 | -31% | CR | CS |
| Germany | 27,633 | 17,963 | 15,584 | 35.5% | -2,379 | -13% | -12,049 | -44% | CS | CS |
| Greece | 505 | 1,197 | 895 | 2.0% | -302 | -25% | 389 | 77% | T2 | D |
| Ireland | 1,977 | 1,685 | 1,415 | 3.2% | -270 | -16% | -562 | -28% | T1 | CS |
| Italy | 5,157 | 1,925 | 1,856 | 4.2% | -68 | -4% | -3,301 | -64% | T2 | CS |
| Luxembourg | 464 | 42 | 14 | 0.0% | -28 | -66% | -450 | -97% | T2 | CS |
| Netherlands | 619 | 62 | 265 | 0.6% | 203 | 328% | -354 | -57% | T2 | CS |
| Portugal | 744 | 1,398 | 1,329 | 3.0% | -69 | -5% | 585 | 79% | T2 | D,CR |
| Spain | 3,193 | 4,552 | 4,309 | 9.8% | -242 | -5% | 1,116 | 35% | T2 | CR |
| Sweden | 2,447 | 476 | 401 | 0.9% | -74 | -16% | -2,046 | -84% | T1 | CS |
| United Kingdom | 7,019 | 645 | 359 | 0.8% | -286 | -44% | -6,659 | -95% | T2 | CS |
| **EU-15** | **75,892** | **48,726** | **43,881** | **100.0%** | **-4,846** | **-10%** | **-32,012** | **-42%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

Figure 3.69 shows activity data and implied emission factors for $CO_2$ for EU-15 and the Member States. The largest emissions are reported by France, Germany and Spain; together they cause 75 % of the $CO_2$ emissions from liquid fuels in 1A4a. Fuel consumption in the EU-15 decreased by 41 % between 1990 and 2009. The implied emission factor of EU-15 was 73.6 t/TJ in 2009. The dip in activity data 2007 is mainly due to Germany. The higher emission factor of Belgium is because the Flemish region allocates emissions from construction mobile machinery in 1A4a but activity data in 1A2f which will be corrected in the next submission.

**Figure 3.69** 1A4a Commercial/Institutional, liquid fuels: Activity Data and Implied Emission Factors for $CO_2$




## 1A4a Commercial/Institutional – Solid Fuels ($CO_2$)

In 2009, $CO_2$ from solid fuels had a share of 1 % within source category 1A4a (compared to 17 % in 1990). Between 1990 and 2009 the emissions decreased by 92 % (Table 3.68). Eight countries report emissions as 'Not occurring' in 2008; all other Member States reduced emissions between 1990 and 2009. Between 2008 and 2009 EU-15 emissions decreased by 9 %.

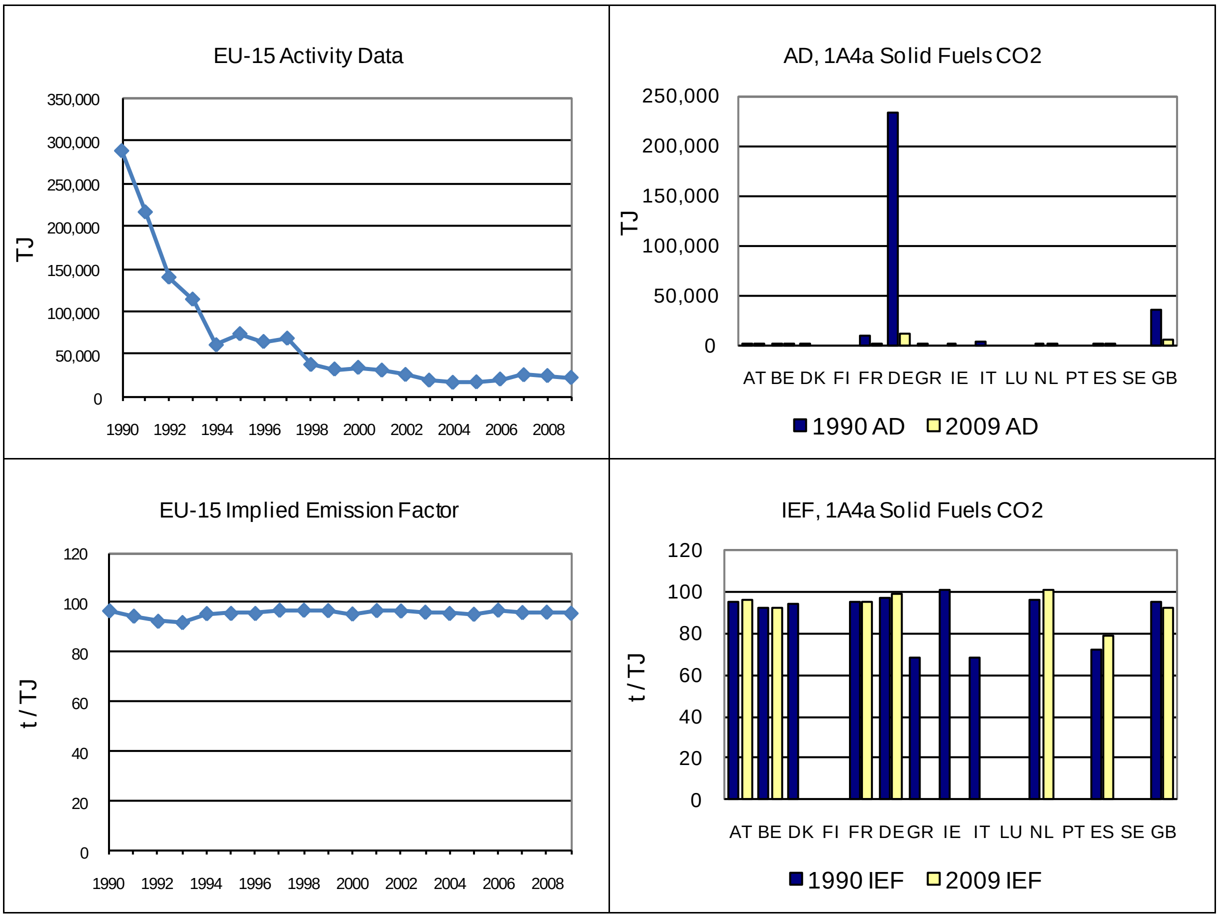
**Table 3.68** 1A4a Commercial/Institutional, solid fuels: Member States' contributions to $CO_2$ emissions and information on method applied and emission factor

| Member State | CO2 emissions in Gg | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg CO2 equivalents) | (%) | (Gg CO2 equivalents) | (%) | | |
| Austria | 90 | 23 | 24 | 1.1% | 0 | 1% | -67 | -74% | T2 | CS |
| Belgium | 9 | 3 | 3 | - | 0 | - | -6 | -71% | T1 | D |
| Denmark | 8 | NO | NO | - | - | - | -8 | -100% | NA | NA |
| Finland | NO | NO | NO | - | - | - | - | - | NA | NA |
| France | 868 | 97 | 157 | 7.5% | 60 | 62% | -712 | -82% | CR | CS |
| Germany | 22,712 | 1,521 | 1,238 | 59.0% | -282 | -19% | -21,473 | -95% | CS | CS |
| Greece | 22 | NO | NO | - | - | - | -22 | -100% | T2 | D |
| Ireland | 138 | 104 | NO | - | -104 | -100% | -138 | -100% | T1 | CS |
| Italy | 218 | NO | NO | - | - | - | -218 | -100% | NA | NA |
| Luxembourg | NO | NO | NO | - | - | - | - | - | NA | NA |
| Netherlands | 128 | 37 | 12 | 0.6% | -25 | -68% | -116 | -91% | T2 | CS |
| Portugal | NO | NO | NO | - | - | - | - | - | T2 | D,CR |
| Spain | 154 | 134 | 131 | 6.2% | -4 | -3% | -24 | -15% | T2 | CR |
| Sweden | NO | NO | NO | - | - | - | - | - | NA | NA |
| United Kingdom | 3,441 | 397 | 536 | 25.5% | 139 | 35% | -2,905 | -84% | T2 | CS |
| **EU-15** | **27,789** | **2,315** | **2,099** | **100.0%** | **-216** | **-9%** | **-25,690** | **-92%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

Figure 3.70 shows activity data and implied emission factors for $CO_2$ for EU-15 and the Member States. The largest emissions are still reported by Germany and the United Kingdom in 2009; together they cause up to 85 % of the $CO_2$ emissions from solid fuels in 1A4a. Fuel consumption in the EU-15 decreased by 92 % between 1990 and 2009. The implied emission factor of EU-15 was 95.6 t/TJ in 2009. The 1990 implied emission factor of Italy is comparatively low because of a high share of gas works gas is included.

**Figure 3.70 1A4a Commercial/Institutional, solid fuels: Activity Data and Implied Emission Factors for $CO_2$**



### 1A4a Commercial/Institutional – Gaseous Fuels ($CO_2$)

In 2009 $CO_2$ from gaseous fuels had a share of 63 % within source category 1A4a (compared to 36 % in 1990). Between 1990 and 2009, the emissions increased by 65 % (Table 3.69). All Member States reported increasing emissions. The highest absolute increases occurred in Germany, France and Italy. Between 2008 and 2009 EU-15 emissions decreased by 2 %.

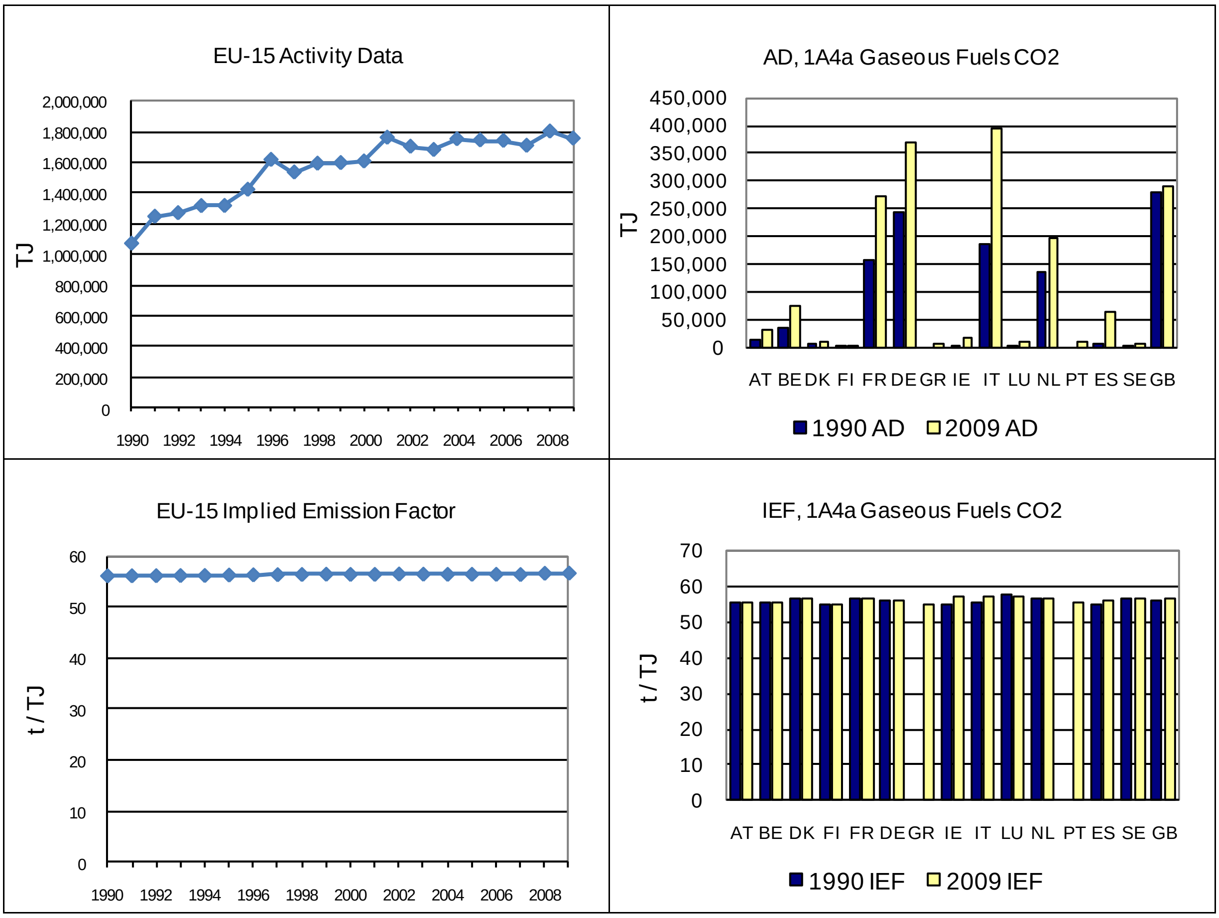
**Table 3.69 1A4a Commercial/Institutional, gaseous fuels: Member States' contributions to $CO_2$ emissions and information on method applied and emission factor**

| Member State | CO2 emissions in Gg | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg CO2 equivalents) | (%) | (Gg CO2 equivalents) | (%) | | |
| Austria | 763 | 1,820 | 1,677 | 1.7% | -143 | -8% | 914 | 120% | T2 | CS |
| Belgium | 1,924 | 4,127 | 4,183 | 4.2% | 56 | 1% | 2,259 | 117% | T1 | D |
| Denmark | 363 | 605 | 573 | 0.6% | -33 | -5% | 210 | 58% | CR | CS |
| Finland | 50 | 92 | 82 | 0.1% | -10 | -11% | 31 | 62% | T1 | CS |
| France | 8,939 | 15,930 | 15,492 | 15.6% | -438 | -3% | 6,554 | 73% | CR | CS |
| Germany | 13,605 | 21,371 | 20,757 | 20.9% | -613 | -3% | 7,152 | 53% | CS | CS |
| Greece | NO | 297 | 335 | 0.3% | 37 | 13% | 335 | - | T2 | CS |
| Ireland | 223 | 972 | 1,048 | 1.1% | 77 | 8% | 825 | 369% | T1 | CS |
| Italy | 10,243 | 21,888 | 22,647 | 22.8% | 759 | 3% | 12,405 | 121% | T2 | CS |
| Luxembourg | 170 | 437 | 478 | 0.5% | 41 | 9% | 308 | 182% | T2 | CS |
| Netherlands | 7,632 | 11,042 | 11,113 | 11.2% | 72 | 1% | 3,481 | 46% | T2 | CS |
| Portugal | NO | 476 | 517 | 0.5% | 41 | 9% | 517 | - | T2 | D,CR |
| Spain | 395 | 3,634 | 3,527 | 3.6% | -107 | -3% | 3,133 | 793% | T2 | CS |
| Sweden | 86 | 237 | 239 | 0.2% | 2 | 1% | 153 | 178% | T1 | CS |
| United Kingdom | 15,721 | 18,813 | 16,555 | 16.7% | -2,258 | -12% | 834 | 5% | T2 | CS |
| **EU-15** | **60,114** | **101,741** | **99,224** | **100.0%** | **-2,517** | **-2%** | **39,111** | **65%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

Figure 3.71 shows activity data and implied emission factors for $CO_2$ for EU-15 and the Member States. The largest emissions are reported by France, Germany, Italy, the Netherlands and the UK; together they cause 87 % of the $CO_2$ emissions from gaseous fuels in 1A4a. Fuel combustion in the EU-15 rose by 64 % between 1990 and 2009. The implied emission factor of EU-15 was 56.6 t/TJ in 2009.

**Figure 3.71** **1A4a Commercial/Institutional, gaseous fuels: Activity Data and Implied Emission Factors for $CO_2$**

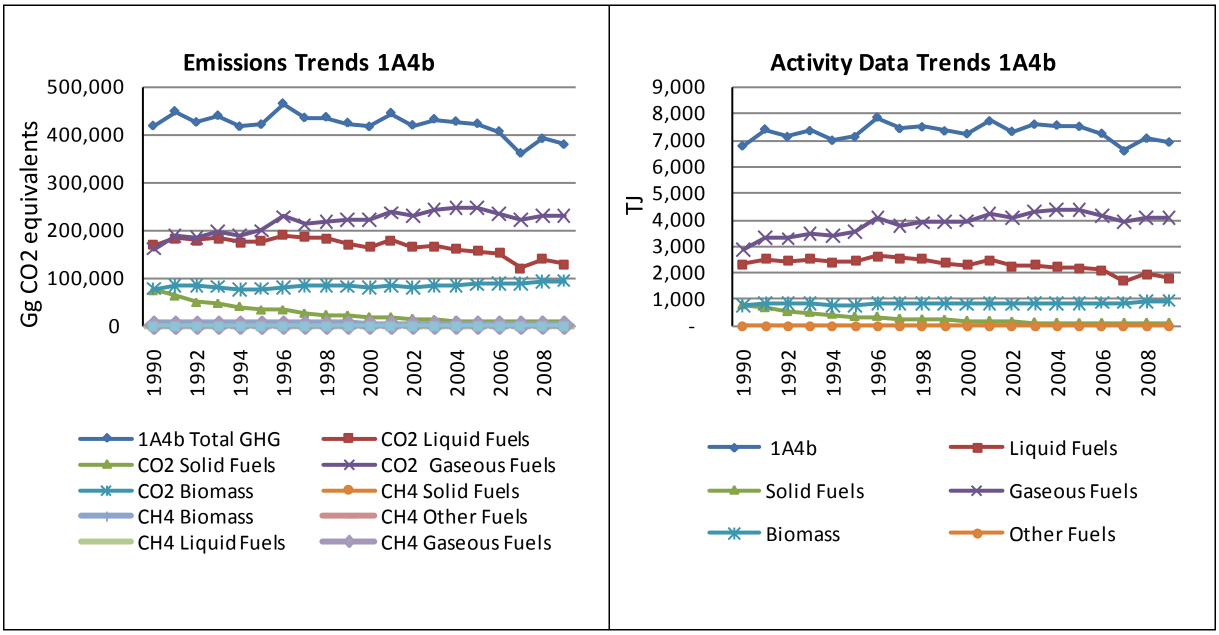


### 3.2.4.2 Residential (1A4b) (EU-15)

In this chapter information about emission trends, Member States' contribution, activity data, and emission factors is provided for category 1A4b by fuels. $CO_2$ emissions from 1A4b Residential are the fourth largest key category of GHG emissions in the EU-15 and account for 10.0 % of total GHG emissions in 2009.

Figure 3.72 shows the emission trend within the category 1A4b, which is mainly dominated by $CO_2$ emissions from liquid and gaseous fuels. Total GHG emissions decreased by 9% since 1990, although $CO_2$ emissions from gaseous fuels increased strongly (+43 %) which was counterbalanced by decreasing emissions from other fossil fuels.

**Figure 3.72 1A4b Residential: Total, $CO_2$ and $CH_4$ emission and activity trends**




### $CO_2$ emissions from 1A4b Residential

Between 1990 and 2009, $CO_2$ emissions from households decreased by 8 % in the EU-15 (Table 3.70). Main factors influencing $CO_2$ emissions from this source category are (1) outdoor temperature, (2) number and size of dwellings, (3) building codes, (4 thermal properties of of building stock, (5) fuel split for heating and warm water, (6) use of renewable energy sources, e.g. biomass or solar panels, and (7) use of district heating. Fossil fuel consumption in households increased by 2 % between 1990 and 2008, with a fuel shift from coal and oil to gas.

Between 1990 and 2009, the largest reduction in absolute terms was reported by Germany reducing emissions by 27 million tonnes. Austria, Denmark, Finland, Italy, the Netherlands, Sweden and the United Kingdom also showed reductions of emissions of one to nearly four million tonnes. In absolute terms Greece, Spain and France had the largest emission increases. One reason for the performance of the Nordic countries and Austria is increased use of district heating. As district heating replaces heating boilers in households, an increase in the share of district heating reduces $CO_2$ emissions from households (but increases emissions from energy industries if fossil fuels are used). In Germany, efficiency improvements and the fuel switch in eastern German households are two reasons for the emission reductions.

**Table 3.70 1A4b Residential: Member States' contributions to $CO_2$ emissions**

| Member State | CO2 emissions in Gg | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | |
|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg CO2 equivalents) | (%) | (Gg CO2 equivalents) | (%) |
| Austria | 9,908 | 7,390 | 7,388 | 2.0% | -2 | 0% | -2,520 | -25% |
| Belgium | 20,248 | 20,654 | 20,083 | 5.4% | -571 | -3% | -165 | -1% |
| Denmark | 4,983 | 2,858 | 2,988 | 0.8% | 129 | 5% | -1,995 | -40% |
| Finland | 3,072 | 2,005 | 2,078 | 0.6% | 73 | 4% | -994 | -32% |
| France | 55,999 | 60,115 | 58,376 | 15.7% | -1,739 | -3% | 2,377 | 4% |
| Germany | 129,474 | 106,761 | 102,421 | 27.5% | -4,340 | -4% | -27,053 | -21% |
| Greece | 4,671 | 8,383 | 7,404 | 2.0% | -979 | -12% | 2,733 | 58% |
| Ireland | 7,054 | 7,393 | 7,316 | 2.0% | -76 | -1% | 262 | 4% |
| Italy | 52,118 | 49,741 | 51,012 | 13.7% | 1,271 | 3% | -1,106 | -2% |
| Luxembourg | 660 | 1,154 | 1,252 | 0.3% | 99 | 9% | 592 | 90% |
| Netherlands | 19,495 | 17,913 | 17,976 | 4.8% | 64 | 0% | -1,518 | -8% |
| Portugal | 1,621 | 1,900 | 1,921 | 0.5% | 21 | 1% | 299 | 18% |
| Spain | 12,979 | 18,683 | 17,363 | 4.7% | -1,320 | -7% | 4,384 | 34% |
| Sweden | 6,220 | 1,045 | 1,027 | 0.3% | -19 | -2% | -5,194 | -83% |
| United Kingdom | 77,505 | 78,057 | 73,362 | 19.7% | -4,695 | -6% | -4,143 | -5% |
| **EU-15** | **406,008** | **384,050** | **371,967** | **100.0%** | **-12,083** | **-3%** | **-34,041** | **-8%** |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

## 1A4b Residential – Liquid Fuels ($CO_2$)

In 2009 $CO_2$ from liquid fuels had a share of 34 % within source category 1A4b (compared to 40 % in 1990). Between 1990 and 2009 the emissions decreased by 23 % (Table 3.71). The highest absolute increases showed Greece, Ireland and the UK. The highest absolute decreases were reported by Germany, France, Italy and Sweden. Between 2008 and 2009 EU-15 emissions decreased by 7 %. The strong decrease from 2006 to 2007 for Germany is due to low gasoil sales to end consumers. Many end consumers did not restock their oiltanks in 2007 because of high outdoor temperatures and rising oil prices. Additionally end consumer gasoil stocks were comparatively high in 2007 due to a mild winter 2006. It is assumed that the circumstances were similar for other MS (e.g. Austria).

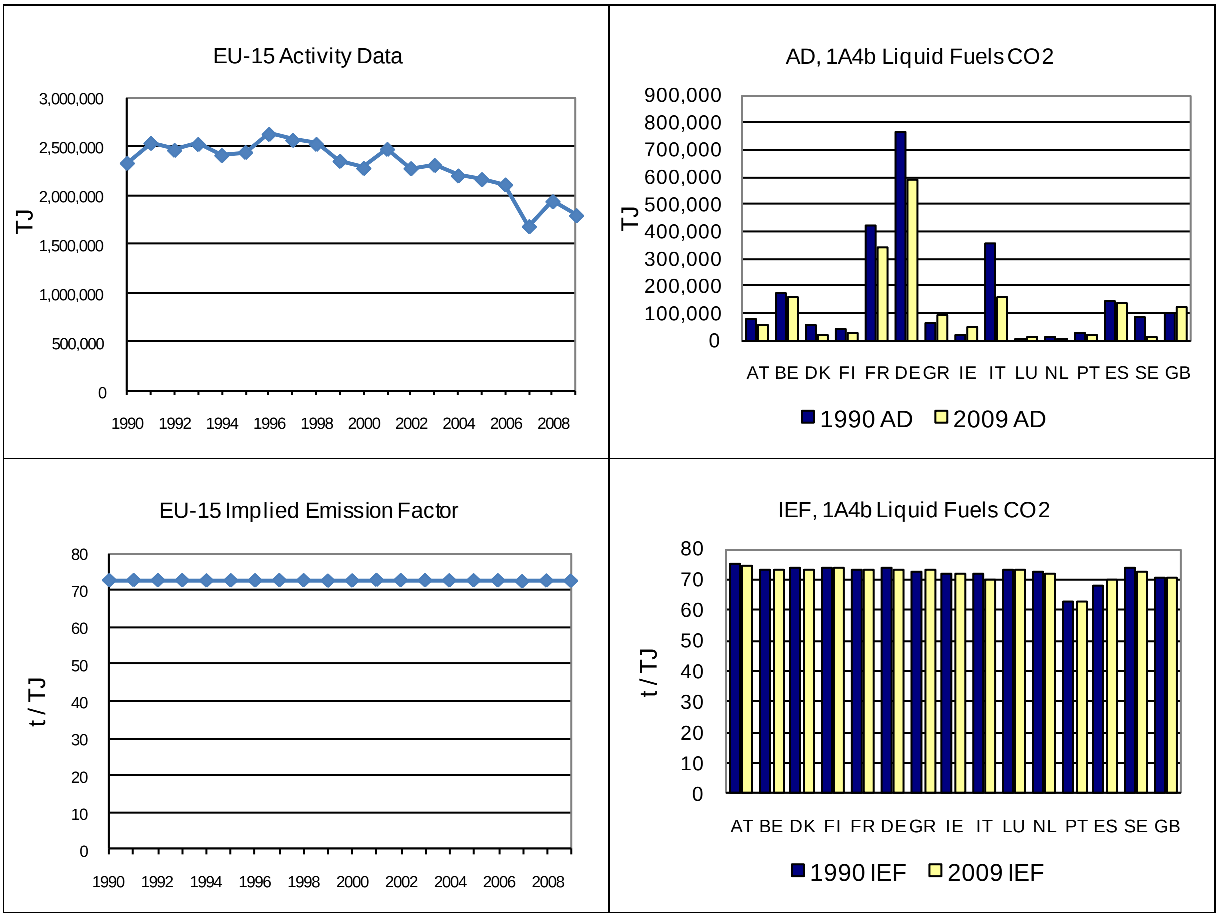
**Table 3.71 1A4b Residential, liquid fuels: Member States' contributions to $CO_2$ emissions and information on method applied and emission factor**

| Member State | CO2 emissions in Gg | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg CO2 equivalents) | (%) | (Gg CO2 equivalents) | (%) | | |
| Austria | 5,605 | 4,374 | 4,328 | 3.3% | -46 | -1% | -1,277 | -23% | T2 | CS |
| Belgium | 12,644 | 12,015 | 11,411 | 8.8% | -604 | -5% | -1,233 | -10% | T1 | D |
| Denmark | 3,923 | 1,277 | 1,393 | 1.1% | 116 | 9% | -2,530 | -64% | CR | CS,CR,D |
| Finland | 2,951 | 1,874 | 1,932 | 1.5% | 57 | 3% | -1,019 | -35% | T1 | CS |
| France | 31,000 | 25,830 | 24,846 | 19.1% | -984 | -4% | -6,154 | -20% | CR | CS |
| Germany | 56,344 | 49,868 | 43,506 | 33.4% | -6,362 | -13% | -12,839 | -23% | CS | CS |
| Greece | 4,585 | 7,881 | 6,797 | 5.2% | -1,083 | -14% | 2,213 | 48% | T2 | D |
| Ireland | 1,177 | 3,689 | 3,635 | 2.8% | -55 | -1% | 2,457 | 209% | T1 | CS |
| Italy | 25,292 | 11,761 | 11,099 | 8.5% | -662 | -6% | -14,193 | -56% | T2 | CS |
| Luxembourg | 464 | 744 | 768 | 0.6% | 23 | 3% | 303 | 65% | T2 | CS |
| Netherlands | 737 | 275 | 276 | 0.2% | 2 | 1% | -461 | -63% | T2 | CS |
| Portugal | 1,621 | 1,412 | 1,361 | 1.0% | -51 | -4% | -260 | -16% | T2 | D,CR |
| Spain | 9,971 | 10,137 | 9,303 | 7.1% | -834 | -8% | -668 | -7% | T2 | CR |
| Sweden | 6,134 | 962 | 943 | 0.7% | -20 | -2% | -5,191 | -85% | T1 | CS |
| United Kingdom | 7,018 | 8,596 | 8,604 | 6.6% | 8 | 0% | 1,586 | 23% | T2 | CS |
| **EU-15** | **169,468** | **140,696** | **130,201** | **100.0%** | **-10,495** | **-7%** | **-39,267** | **-23%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

Figure 3.73 shows activity data and implied emission factors for $CO_2$ for EU-15 and the Member States. The largest emissions are reported by Belgium, France, Germany, Italy, Spain and the UK; together they cause 74 % of the $CO_2$ emissions from liquid fuels in 1A4b. Fuel consumption in the EU-15 decreased by 23 % between 1990 and 2009. The implied emission factor of EU-15 was 72.5 t/TJ in 2009. The implied emission factor of Portugal is lower than for other countries because a high share of city gas and LPG is used by the domestic sector.

**Figure 3.73 1A4b Residential, liquid fuels: Activity Data and Implied Emission Factors for $CO_2$**



### 1A4b Residential –Solid Fuels ($CO_2$)

In 2009 $CO_2$ from solid fuels had a share of 3 % within source category 1A4b (compared to 18 % in 1990). Between 1990 and 2009 the emissions decreased by 85 % (

Table 3.72). All Member States reported decreasing emissions with the highest reductions in absolute terms in Germany, the UK, Ireland and France. Between 2008 and 2009 EU-15 emissions decreased by 1 %. Sweden and Portugal report emissions as 'Not occuring'.

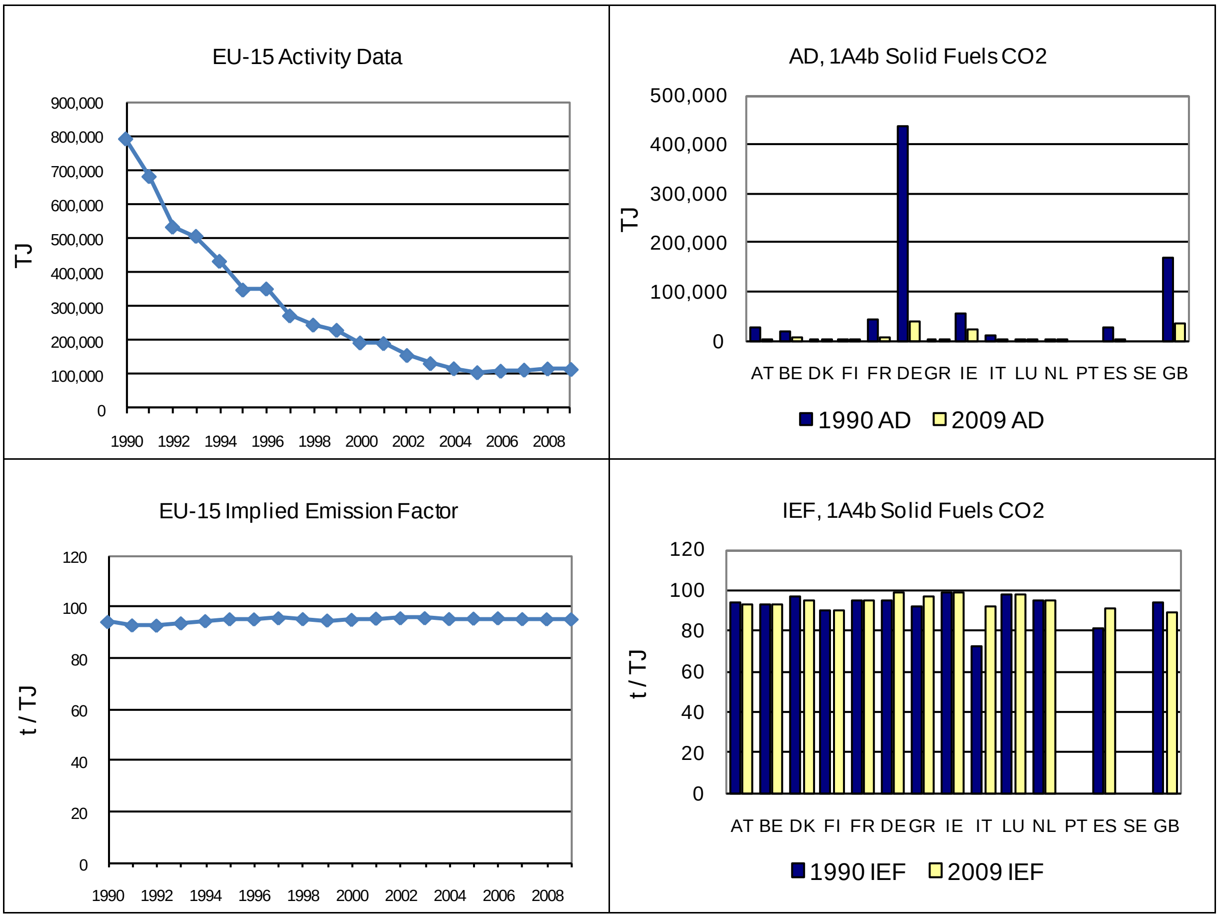
**Table 3.72 1A4b Residential, solid fuels: Member States' contributions to $CO_2$ emissions and information on method applied and emission factor**

| Member State | CO2 emissions in Gg | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg CO2 equivalents) | (%) | (Gg CO2 equivalents) | (%) | | |
| Austria | 2,512 | 314 | 312 | 2.9% | -2 | -1% | -2,200 | -88% | T2 | CS |
| Belgium | 1,759 | 484 | 488 | 4.5% | 4 | 1% | -1,271 | -72% | T1 | D |
| Denmark | 72 | 2 | 2 | 0.0% | 0 | 17% | -70 | -97% | CR | CS,D |
| Finland | 33 | 1 | 1 | 0.0% | 0 | 0% | -33 | -98% | T1 | D |
| France | 4,168 | 291 | 470 | 4.3% | 179 | 62% | -3,698 | -89% | CR | CS |
| Germany | 41,415 | 4,226 | 3,931 | 36.2% | -295 | -7% | -37,484 | -91% | CS | CS |
| Greece | 87 | 24 | 15 | 0.1% | -9 | -38% | -72 | -83% | T2 | D |
| Ireland | 5,607 | 2,111 | 2,190 | 20.2% | 79 | 4% | -3,417 | -61% | T1 | CS |
| Italy | 702 | 20 | 17 | 0.2% | -3 | -15% | -685 | -98% | T2 | CS |
| Luxembourg | 26 | 2 | 2 | 0.0% | 0 | 9% | -24 | -92% | T1 | D |
| Netherlands | 61 | 19 | 19 | 0.2% | 0 | 1% | -42 | -68% | T2 | CS |
| Portugal | NO | NO | NO | - | - | - | - | - | T2 | D,CR |
| Spain | 2,091 | 423 | 416 | 3.8% | -7 | -2% | -1,675 | -80% | T2 | CR |
| Sweden | NO | NO | NO | - | - | - | - | - | NA | NA |
| United Kingdom | 15,979 | 3,103 | 2,994 | 27.6% | -109 | -4% | -12,985 | -81% | T2 | CS |
| **EU-15** | **74,513** | **11,019** | **10,858** | **100.0%** | **-161** | **-1%** | **-63,656** | **-85%** | #NV | #NV |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

Figure 3.74 shows activity data and implied emission factors for $CO_2$ for EU-15 and the Member States. The largest emissions are reported by Germany, Ireland and the United Kingdom; together they cause 84 % of the $CO_2$ emissions from solid fuels in 1A4b. Fuel consumption in the EU-15 decreased by 86 % between 1990 and 2009. The implied emission factor of EU-15 was 95.2 t/TJ in 2009. The 1990 implied emission factor of Italy is comparatively low because of a high share of gas works gas is included.

**Figure 3.74 1A4b Residential, solid fuels: Activity Data and Implied Emission Factors for $CO_2$**



## 1A4b Residential – Gaseous Fuels ($CO_2$)

In 2009, $CO_2$ from gaseous fuels had a share of 61 % within source category 1A4b (compared to 39 % in 1990). Between 1990 and 2009, the emissions increased by 43 % (Table 3.73). All Member States reported increasing emissions except for the Netherlands and Sweden. The highest absolute increase occurred in Germany, France, the UK, Spain and Italy. Between 2008 and 2009, EU-15 emissions decreased by 1 %.

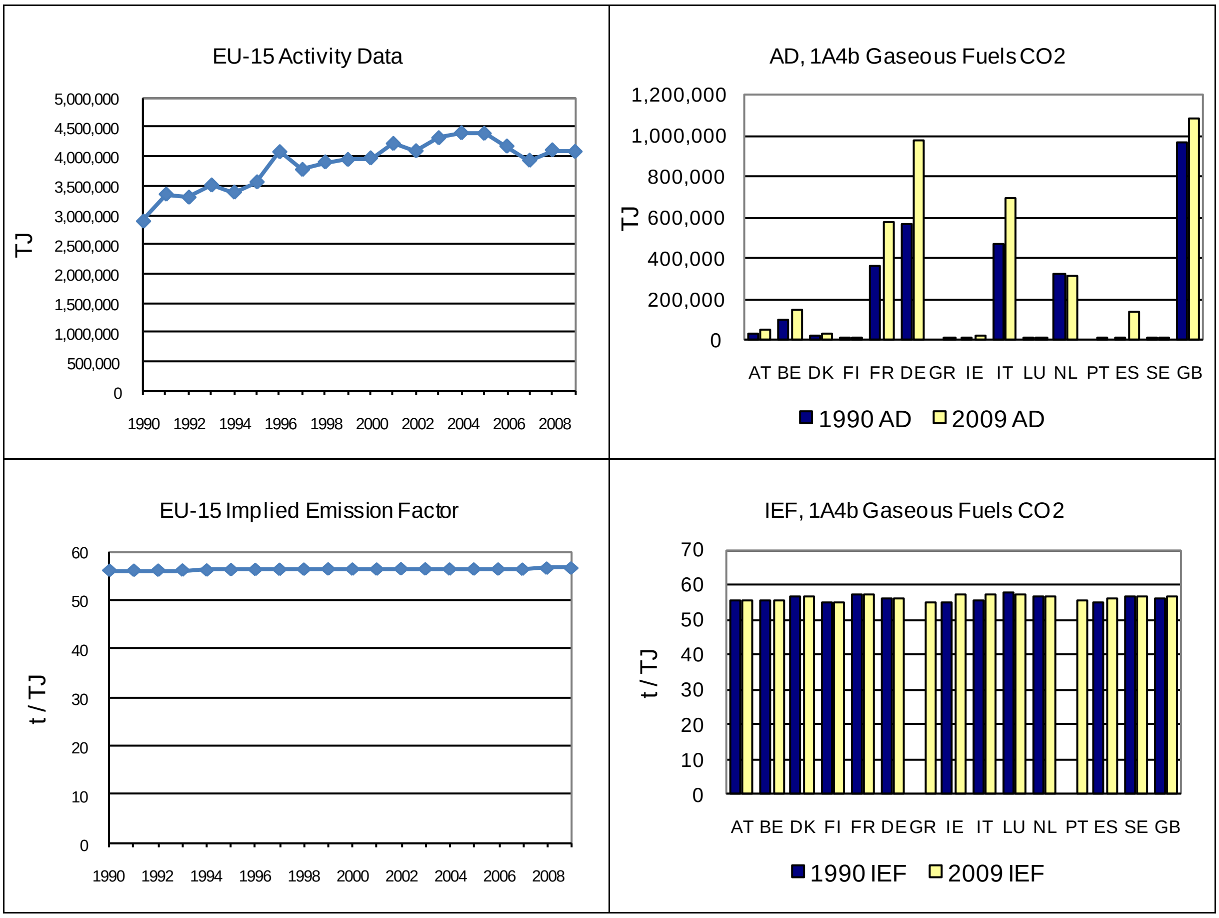
**Table 3.73 1A4b Residential, gaseous fuels: Member States' contributions to $CO_2$ emissions and information on method applied and emission factor**

| Member State | CO2 emissions in Gg | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg CO2 equivalents) | (%) | (Gg CO2 equivalents) | (%) | | |
| Austria | 1,791 | 2,701 | 2,748 | 1.2% | 47 | 2% | 957 | 53% | T2 | CS |
| Belgium | 5,824 | 8,134 | 8,164 | 3.5% | 29 | 0% | 2,340 | 40% | T1 | D |
| Denmark | 988 | 1,579 | 1,592 | 0.7% | 13 | 1% | 604 | 61% | CR | CS |
| Finland | 22 | 84 | 94 | 0.0% | 10 | 12% | 72 | 330% | T1 | CS |
| France | 20,831 | 33,994 | 33,060 | 14.3% | -934 | -3% | 12,229 | 59% | CR | CS |
| Germany | 31,714 | 52,667 | 54,984 | 23.8% | 2,317 | 4% | 23,269 | 73% | CS | CS |
| Greece | NO | 479 | 592 | 0.3% | 113 | 24% | 592 | - | T2 | CS |
| Ireland | 270 | 1,593 | 1,491 | 0.6% | -101 | -6% | 1,222 | 453% | T1 | CS |
| Italy | 26,123 | 37,960 | 39,896 | 17.3% | 1,936 | 5% | 13,773 | 53% | T2 | CS |
| Luxembourg | 170 | 407 | 483 | 0.2% | 75 | 18% | 313 | 185% | T2 | CS |
| Netherlands | 18,696 | 17,619 | 17,681 | 7.7% | 62 | 0% | -1,015 | -5% | T2 | CS |
| Portugal | NO | 487 | 560 | 0.2% | 72 | 15% | 560 | - | T2 | D,CR |
| Spain | 918 | 8,123 | 7,644 | 3.3% | -479 | -6% | 6,726 | 733% | T2 | CS |
| Sweden | 86 | 83 | 84 | 0.0% | 1 | 1% | -2 | -3% | T1 | CS |
| United Kingdom | 54,507 | 66,358 | 61,764 | 26.8% | -4,594 | -7% | 7,257 | 13% | T2 | CS |
| **EU-15** | **161,940** | **232,268** | **230,837** | **100.0%** | **-1,432** | **-1%** | **68,896** | **43%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

Figure 3.75 shows activity data and implied emission factors for $CO_2$ for EU-15 and the Member States. The largest emissions are reported by France, Germany, Italy and the United Kingdom; together they cause 82 % of the $CO_2$ emissions from gaseous fuels in 1A4b. Fuel consumption in the EU-15 rose 41 % between 1990 and 2009. The implied emission factor of EU-15 was 56.6 t/TJ in 2009.

**Figure 3.75 1A4b Residential, gaseous fuels: Activity Data and Implied Emission Factors for $CO_2$**



### $CH_4$ emissions from 1A4b Residential

$CH_4$ emissions from 1A4b Residential accounted for 0.2 % of total GHG emissions in 2009. Between 1990 and 2009, $CH_4$ emissions from households decreased by 43 % in the EU-15 (Table 3.74). In 2009 France was reponsible for 30 % of EU-15 $CH_4$ emissions even though emissions were reduced by 62 % between 1990 and 2009. All Member States except for Denmark, Finland, Luxembourg and Italy reported a decrease in emissions. Between 2008 and 2009 EU-15 emissions increased by 1%.

**Table 3.74 1A4b Residential: Member States' contributions to $CH_4$ emissions**

| Member State | $CH_4$ emissions (Gg $CO_2$ equivalents) | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | |
|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg CO2 equivalents) | (%) | (Gg CO2 equivalents) | (%) |
| Austria | 377 | 188 | 185 | 3.4% | -3 | -1% | -192 | -51% |
| Belgium | 209 | 140 | 138 | 2.5% | -2 | -1% | -71 | -34% |
| Denmark | 86 | 157 | 143 | 2.6% | -15 | -9% | 56 | 65% |
| Finland | 164 | 204 | 221 | 4.1% | 17 | 8% | 57 | 35% |
| France | 3,649 | 1,478 | 1,385 | 25.5% | -93 | -6% | -2,264 | -62% |
| Germany | 1,200 | 567 | 572 | 10.5% | 5 | 1% | -628 | -52% |
| Greece | 80 | 70 | 69 | 1.3% | -1 | -1% | -11 | -14% |
| Ireland | 372 | 153 | 160 | 2.9% | 6 | 4% | -212 | -57% |
| Italy | 260 | 567 | 615 | 11.3% | 47 | 8% | 355 | 136% |
| Luxembourg | 6 | 7 | 7 | 0.1% | 0 | 2% | 1 | 25% |
| Netherlands | 360 | 342 | 344 | 6.3% | 2 | 1% | -16 | -4% |
| Portugal | 344 | 311 | 311 | 5.7% | 0 | 0% | -34 | -10% |
| Spain | 775 | 613 | 612 | 11.3% | -1 | 0% | -164 | -21% |
| Sweden | 234 | 211 | 223 | 4.1% | 11 | 5% | -11 | -5% |
| United Kingdom | 1,444 | 474 | 451 | 8.3% | -23 | -5% | -993 | -69% |
| **EU-15** | **9,561** | **5,483** | **5,436** | **100.0%** | **-47** | **-1%** | **-4,125** | **-43%** |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

### 1A4b Residential – Biomass ($CH_4$)

In 2009 $CH_4$ from biomass had a share of 1.1 % within source category 1A4b (compared to 1.4 % in 1990). Between 1990 and 2009 the emissions decreased by 30 % (Table 3.75). France reported the highest absolute decrease, while Denmark's (62 %), Germany's (86 %), Italy's (206 %) and the UK's (115 %) $CH_4$ emissions increased significantly. Between 2008 and 2009, EU-15 emissions did not change.

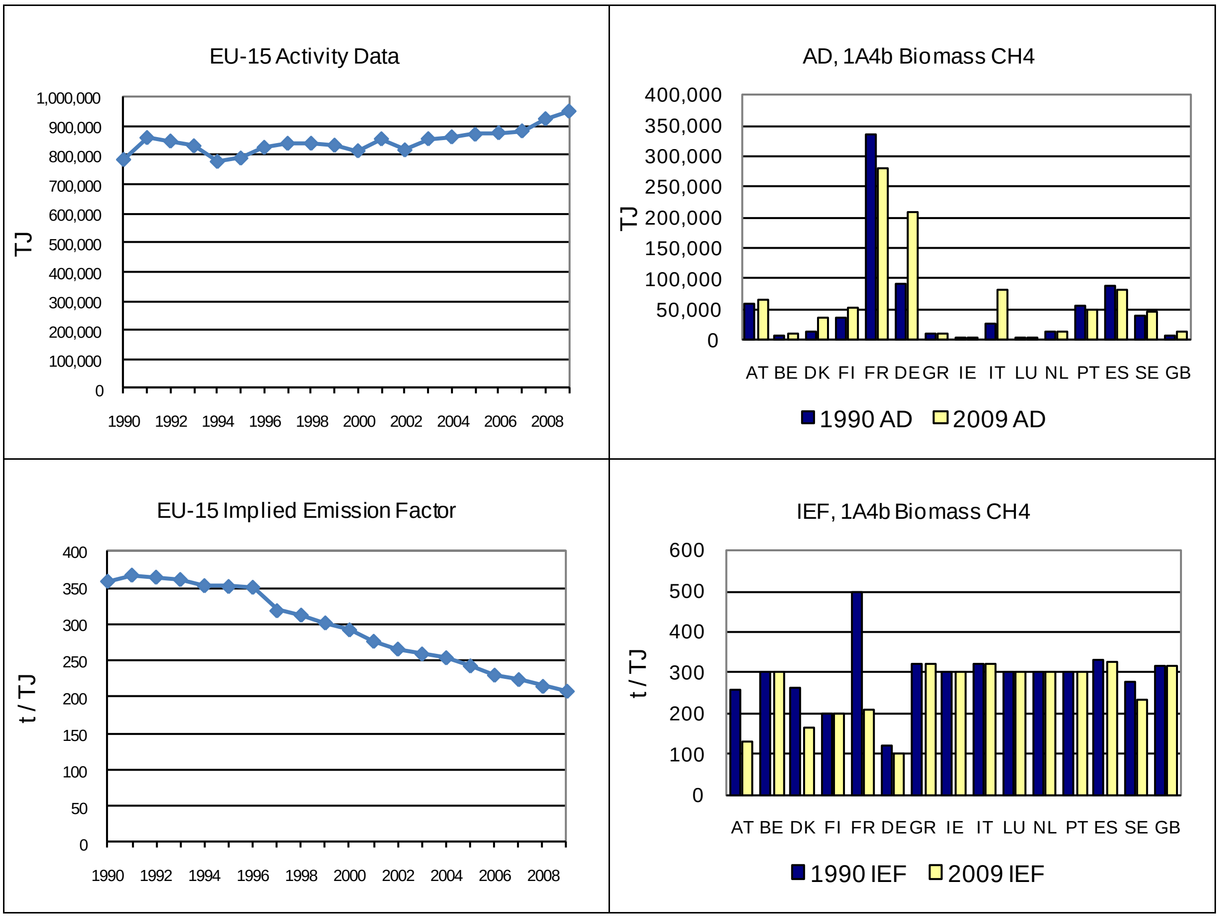
**Table 3.75 1A4b Residential, biomass: Member States' contributions to $CH_4$ emissions and information on method applied and emission factor**

| Member State | $CH_4$ emissions (Gg $CO_2$ equivalents) | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | |
|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg CO2 equivalents) | (%) | (Gg CO2 equivalents) | (%) |
| Austria | 313 | 179 | 177 | 4.2% | -3 | -1% | -136 | -44% |
| Belgium | 42 | 58 | 57 | 1.4% | -1 | -1% | 15 | 35% |
| Denmark | 78 | 141 | 126 | 3.0% | -14 | -10% | 49 | 62% |
| Finland | 152 | 198 | 215 | 5.2% | 17 | 9% | 62 | 41% |
| France | 3,511 | 1,337 | 1,249 | 30.0% | -89 | -7% | -2,262 | -64% |
| Germany | 235 | 428 | 437 | 10.5% | 10 | 2% | 202 | 86% |
| Greece | 77 | 64 | 63 | 1.5% | 0 | 0% | -13 | -17% |
| Ireland | 12 | 6 | 7 | 0.2% | 1 | 22% | -4 | -37% |
| Italy | 183 | 515 | 562 | 13.5% | 47 | 9% | 378 | 206% |
| Luxembourg | 4 | 4 | 4 | 0.1% | 0 | -1% | 0 | 0% |
| Netherlands | 78 | 76 | 77 | 1.9% | 1 | 1% | -1 | -2% |
| Portugal | 343 | 310 | 309 | 7.4% | 0 | 0% | -34 | -10% |
| Spain | 621 | 562 | 562 | 13.5% | 0 | 0% | -59 | -9% |
| Sweden | 229 | 209 | 220 | 5.3% | 11 | 5% | -9 | -4% |
| United Kingdom | 46 | 95 | 99 | 2.4% | 4 | 5% | 53 | 115% |
| **EU-15** | **5,924** | **4,180** | **4,165** | **100.0%** | **-15** | **0%** | **-1,759** | **-30%** |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

Figure 3.76 shows activity data and implied emission factors for $CH_4$ for EU-15 and the Member States. The largest emissions are reported by France, Germany, Italy and Spain; together they cause 67 % of the $CH_4$ emissions from biomass fuels in 1A4b. Fuel consumption in the EU-15 rose by 21 % between 1990 and 2009. The implied emission factor of EU-15 was 208.6 kg/TJ in 2009. The decrease of the IEF is because of improved combustion in new (automated) heating devices and less use of small stoves having higher $CH_4$ emissions.

**Figure 3.76 1A4b Residential, biomass: Activity Data and Implied Emission Factors for $CH_4$**

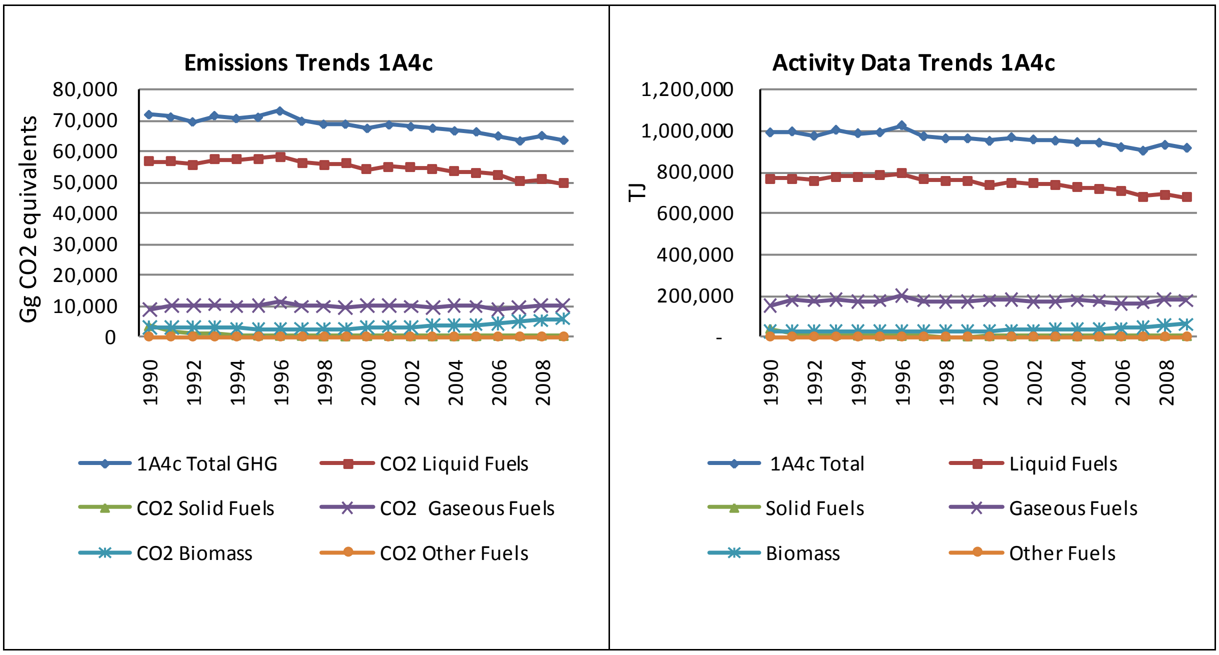


### 3.2.4.3 Agriculture/Forestry/Fisheries (1A4c) (EU-15)

In this chapter information about emission trends, Member States' contribution, activity data, and emission factors is provided for category 1A4c by fuels. $CO_2$ emissions from 1A4c Agriculture/Forestry/Fisheries accounted for 1.6 % of total EU-15 GHG emissions in 2009. Between 1990 and 2009, $CO_2$ emissions from 1A4c Agriculture/Forestry/Fisheries decreased by 12 % in the EU-15 (Table 3.76).

Figure 3.77 shows the emission trend within source category 1A4c, which is mainly dominated by $CO_2$ emissions from liquid fuels. Total GHG emissions decreased by 12 %, mainly due to decreases in $CO_2$ emissions from liquid fuels (-12 %).

**Figure 3.77 1A4c Agriculture/Forestry/Fisheries: Total and $CO_2$ emission trends**




Only five Member States, France, Germany, Italy, the Netherlands and Spain together contributed 73 % to the emissions from this source. Spain was the Member State with the highest increase in absolute terms between 1990 and 2009, while the highest decreases were achieved in Germany and the UK.

**Table 3.76 1A4c Agriculture/Forestry/Fisheries: Member States' contributions to $CO_2$ emissions**

| Member State | CO2 emissions in Gg | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | |
|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg CO2 equivalents) | (%) | (Gg CO2 equivalents) | (%) |
| Austria | 1,252 | 950 | 904 | 1.5% | -46 | -5% | -348 | -28% |
| Belgium | 2,738 | 1,979 | 2,132 | 3.5% | 153 | 8% | -606 | -22% |
| Denmark | 2,485 | 2,251 | 2,167 | 3.6% | -84 | -4% | -318 | -13% |
| Finland | 2,017 | 1,858 | 1,806 | 3.0% | -52 | -3% | -211 | -10% |
| France | 10,825 | 11,111 | 10,750 | 17.8% | -361 | -3% | -76 | -1% |
| Germany | 11,060 | 6,400 | 6,052 | 10.0% | -348 | -5% | -5,008 | -45% |
| Greece | 2,927 | 2,506 | 1,976 | 3.3% | -530 | -21% | -951 | -32% |
| Ireland | 660 | 771 | 649 | 1.1% | -122 | -16% | -11 | -2% |
| Italy | 8,372 | 7,593 | 7,679 | 12.7% | 86 | 1% | -693 | -8% |
| Luxembourg | 16 | 53 | 81 | 0.1% | 28 | 53% | 66 | 420% |
| Netherlands | 9,917 | 9,252 | 9,099 | 15.1% | -152 | -2% | -818 | -8% |
| Portugal | 1,660 | 1,073 | 995 | 1.7% | -78 | -7% | -665 | -40% |
| Spain | 8,598 | 10,209 | 10,271 | 17.0% | 62 | 1% | 1,673 | 19% |
| Sweden | 1,536 | 1,604 | 1,643 | 2.7% | 40 | 2% | 107 | 7% |
| United Kingdom | 5,162 | 4,087 | 4,041 | 6.7% | -46 | -1% | -1,122 | -22% |
| **EU-15** | **69,227** | **61,696** | **60,247** | **100.0%** | **-1,449** | **-2%** | **-8,980** | **-13%** |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

### 3.2.4.4 1A4c Agriculture/Forestry/Fisheries – Liquid Fuels ($CO_2$)

In 2009 $CO_2$ from liquid fuels had a share of 78 % within source category 1A4c (compared to 79 % in 1990). Between 1990 and 2009 the emissions decreased by 12 % (Table 3.77). Only Luxembourg and Spain reported increasing emissions with the highest increases in absolute terms in Spain. Between 2008 and 2009 EU-15 emissions decreased by 3 %.

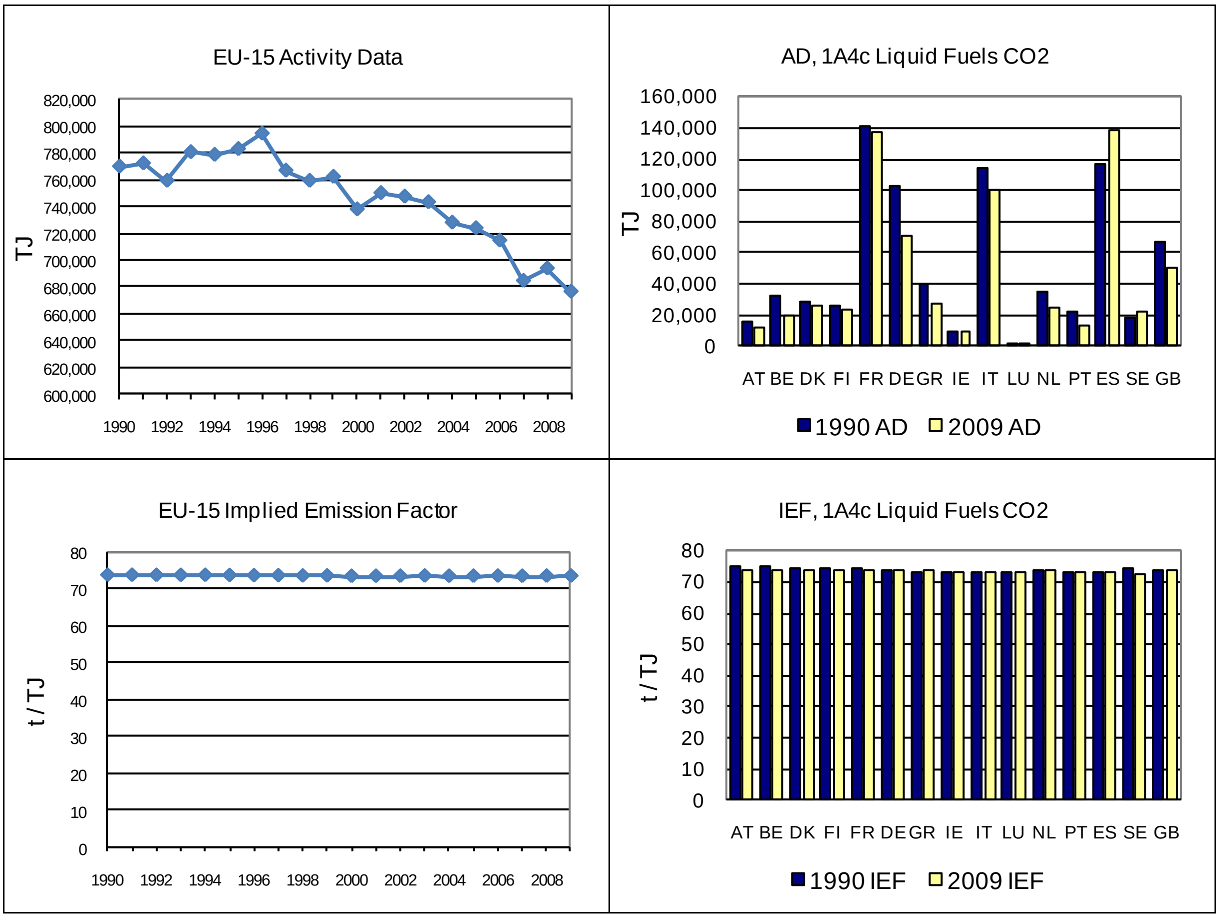
**Table 3.77 1A4c Agriculture/Forestry/Fisheries, liquid fuels: Member States' contributions to $CO_2$ emissions and information on method applied and emission factor**

| Member State | CO2 emissions in Gg | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg CO2 equivalents) | (%) | (Gg CO2 equivalents) | (%) | | |
| Austria | 1,181 | 913 | 867 | 1.7% | -46 | -5% | -314 | -27% | T2 | CS |
| Belgium | 2,463 | 1,463 | 1,465 | 2.9% | 1 | 0% | -998 | -41% | T1 | D |
| Denmark | 2,120 | 1,921 | 1,895 | 3.8% | -26 | -1% | -225 | -11% | CR | CS,CR,D |
| Finland | 1,932 | 1,774 | 1,719 | 3.5% | -55 | -3% | -213 | -11% | M,T1 | CS |
| France | 10,442 | 10,536 | 10,199 | 20.5% | -337 | -3% | -243 | -2% | CR | CS |
| Germany | 7,627 | 5,542 | 5,256 | 10.6% | -286 | -5% | -2,370 | -31% | CS | CS |
| Greece | 2,917 | 2,506 | 1,976 | 4.0% | -530 | -21% | -940 | -32% | T2 | D |
| Ireland | 660 | 771 | 649 | 1.3% | -122 | -16% | -11 | -2% | T1 | CS |
| Italy | 8,321 | 7,267 | 7,341 | 14.8% | 73 | 1% | -980 | -12% | T2 | CS |
| Luxembourg | 16 | 53 | 81 | 0.2% | 28 | 53% | 66 | 419% | 0.0 | 0.0 |
| Netherlands | 2,587 | 1,862 | 1,805 | 3.6% | -57 | -3% | -782 | -30% | T2 | CS,D |
| Portugal | 1,660 | 1,052 | 976 | 2.0% | -76 | -7% | -685 | -41% | T2 | D,CR |
| Spain | 8,555 | 10,053 | 10,133 | 20.4% | 81 | 1% | 1,579 | 18% | T2,T3 | CR |
| Sweden | 1,346 | 1,577 | 1,616 | 3.3% | 39 | 2% | 270 | 20% | T1 | CS |
| United Kingdom | 4,932 | 3,665 | 3,701 | 7.5% | 37 | 1% | -1,231 | -25% | T2 | CS |
| **EU-15** | **56,758** | **50,955** | **49,680** | **100.0%** | **-1,276** | **-3%** | **-7,078** | **-12%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

Figure 3.78 shows activity data and implied emission factors for $CO_2$ for EU-15 and the Member States. The largest emissions are reported by France, Germany, Italy and Spain; together they cause 66 % of the $CO_2$ emissions from liquid fuels in 1A4c. Fuel consumption in the EU-15 decreased by 12 % between 1990 and 2009. The implied emission factor of EU-15 was 73.5 t/TJ in 2009.

**Figure 3.78** 1A4c Agriculture/Forestry/Fisheries, liquid fuels: Activity Data and Implied Emission Factors for $CO_2$



### 1A4c Agriculture/Forestry/Fisheries – Solid Fuels ($CO_2$)

In 2009 $CO_2$ from solid fuels had a share of 1 % within source category 1A4c (compared to 5 % in 1990). Between 1990 and 2009 the emissions decreased by 88 % (Table 3.78). Ten member states reported $CO_2$ emissions from this source category as 'Not occurring' or "Not applicable" in 2009. All other Member States reported decreasing emissions between 1990 and 2009. Between 2008 and 2009 EU-15 emissions decreased by 21 %. The strong decrease in 1990 to 1992 emissions is due to the reporting of Germany.

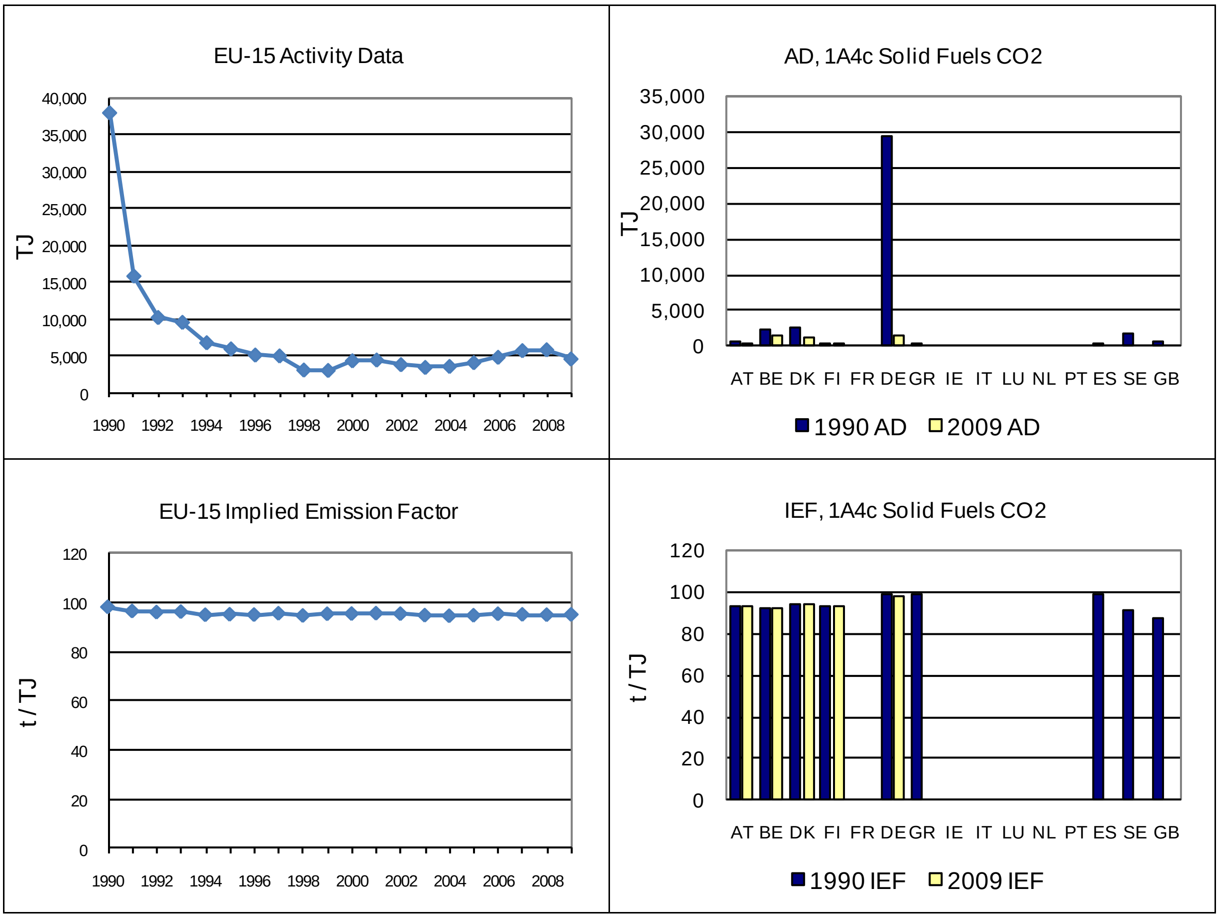
**Table 3.78 1A4c Agriculture/Forestry/Fisheries, solid fuels: Member States' contributions to $CO_2$ emissions and information on method applied and emission factor**

| Member State | CO2 emissions in Gg | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg CO2 equivalents) | (%) | (Gg CO2 equivalents) | (%) | | |
| Austria | 51 | 7 | 7 | 1.5% | 0 | 0% | -45 | -87% | T2 | CS |
| Belgium | 208 | 143 | 143 | 32.9% | 0 | 0% | -65 | -31% | T1 | D |
| Denmark | 238 | 176 | 124 | 28.6% | -51 | -29% | -114 | -48% | CR | CS,D |
| Finland | 13 | 10 | 12 | 2.7% | 2 | 18% | -2 | -12% | T3 | CS |
| France | NO | NO | NO | - | - | - | - | - | CR | CS |
| Germany | 2,948 | 193 | 149 | 34.3% | -44 | -23% | -2,799 | -95% | CS | CS |
| Greece | 11 | NO | NO | - | 0 | - | -11 | -100% | T2 | D |
| Ireland | NO | NO | NO | - | - | - | - | - | NO | NO |
| Italy | NO | NO | NO | - | - | - | - | - | NA | NA |
| Luxembourg | NO | NO | NO | - | - | - | - | - | NA | NA |
| Netherlands | NO | NO | NO | - | - | - | - | - | NA | NA |
| Portugal | NO | NO | NO | - | - | - | - | - | T2 | D,CR |
| Spain | 37 | NA | NA | - | - | - | -37 | -100% | NA | NA |
| Sweden | 157 | NO | NO | - | - | - | -157 | -100% | NA | NA |
| United Kingdom | 48 | 23 | NO | - | -23 | -100% | -48 | -100% | NA | NA |
| **EU-15** | **3,712** | **551** | **435** | **100.0%** | **-117** | **-21%** | **-3,277** | **-88%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

Figure 3.79 shows activity data and implied emission factors for $CO_2$ for EU-15 and the Member States. Fuel consumption in the EU-15 decreased by 88 % between 1990 and 2009. The implied emission factor of EU-15 was 95.1 t/TJ in 2009.

Figure 3.79 1A4c Agriculture/Forestry/Fisheries, solid fuels: Activity Data and Implied Emission Factors for $CO_2$




## 1A4c Agriculture/Forestry/Fisheries –Gaseous Fuels ($CO_2$)

In 2009, $CO_2$ from gaseous fuels had a share of 16 % within source category 1A4c (compared to 12 % in 1990). Between 1990 and 2009 the emissions increased by 16 % (Table 3.79). All Member States reported increasing or almost unchanged emissions except for Finland and Sweden. The highest relative increase occurred in Spain (+2135 %). Between 2008 and 2009 EU-15 emissions decreased by 1 %. This source is dominated by the Netherlands were natural gas is used for greenhouse horticulture.

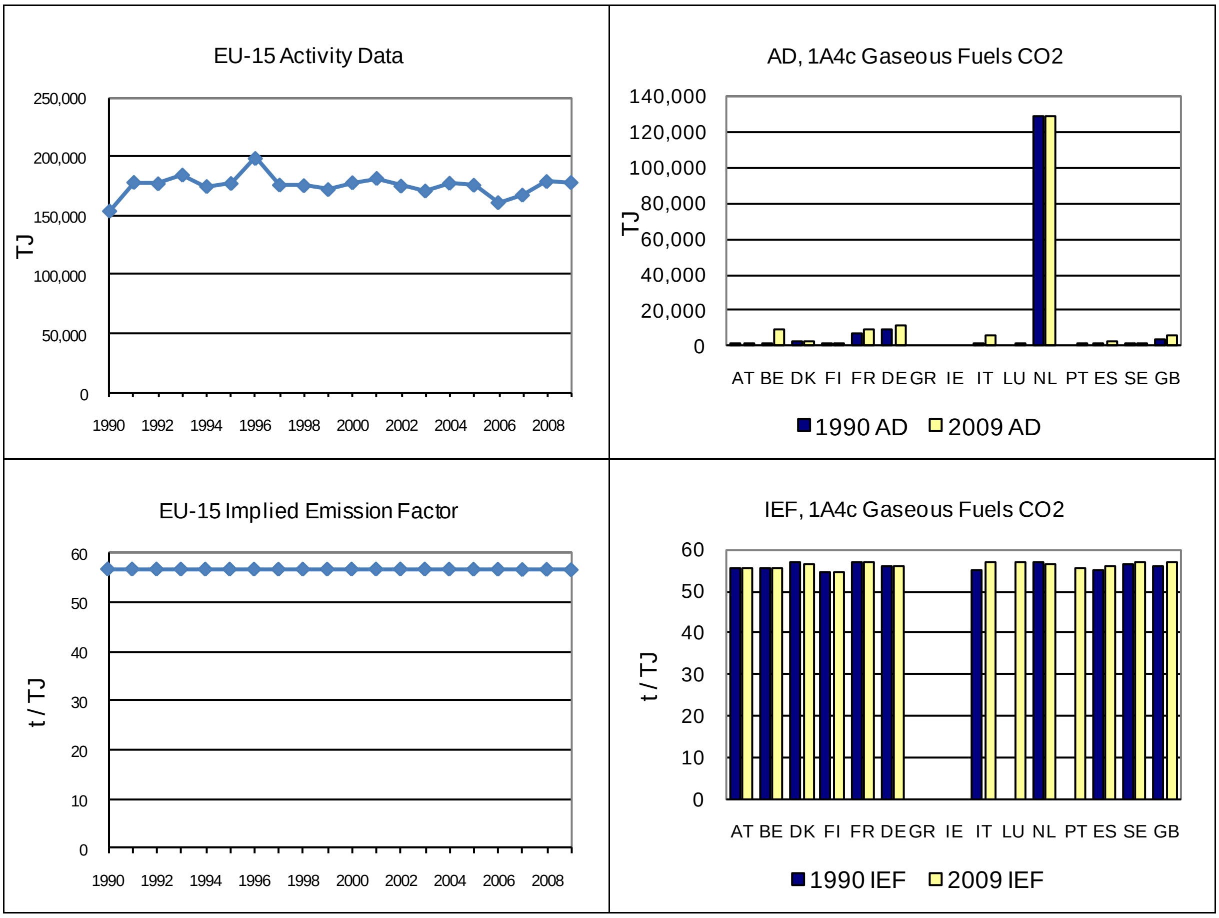
**Table 3.79 1A4c Agriculture/Forestry/Fisheries, gaseous fuels: Member States' contributions to $CO_2$ emissions and information on method applied and emission factor**

| Member State | CO2 emissions in Gg | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg CO2 equivalents) | (%) | (Gg CO2 equivalents) | (%) | | |
| Austria | 20 | 31 | 31 | 0.3% | 1 | 2% | 11 | 54% | T2 | CS |
| Belgium | 67 | 372 | 524 | 5.2% | 152 | 41% | 457 | 682% | T1 | D |
| Denmark | 126 | 154 | 148 | 1.5% | -6 | -4% | 21 | 17% | CR | CS |
| Finland | 32 | 20 | 16 | 0.2% | -4 | -19% | -16 | -50% | T1 | CS |
| France | 383 | 575 | 551 | 5.5% | -24 | -4% | 168 | 44% | CR | CS |
| Germany | 485 | 666 | 646 | 6.4% | -19 | -3% | 162 | 33% | CS | CS |
| Greece | NO | NO | NO | - | - | - | - | - | NO | NO |
| Ireland | NO | NO | NO | - | - | - | - | - | NO | NO |
| Italy | 52 | 326 | 339 | 3.4% | 13 | 4% | 287 | 556% | T2 | CS |
| Luxembourg | NO | 0 | 0 | - | - | - | - | - | T2 | CS |
| Netherlands | 7,330 | 7,389 | 7,294 | 72.4% | -95 | -1% | -36 | 0% | T2 | CS |
| Portugal | NO | 21 | 20 | 0.2% | -2 | -8% | 20 | - | T2 | D,CR |
| Spain | 6 | 156 | 138 | 1.4% | -18 | -12% | 131 | 2135% | T2 | CS |
| Sweden | 33 | 27 | 27 | 0.3% | 0 | 1% | -6 | -18% | T1 | CS |
| United Kingdom | 182 | 399 | 339 | 3.4% | -59 | -15% | 157 | 87% | T2 | CS |
| **EU-15** | **8,716** | **10,135** | **10,073** | **100.0%** | **-62** | **-1%** | **1,356** | **16%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

Figure 3.80 shows activity data and implied emission factors for $CO_2$ for EU-15 and the Member States. The largest emissions are reported by the Netherlands, accounting for 72 % of the $CO_2$ emissions from gaseous fuels in 1A4c. Fuel consumption in the EU-15 decreased by 16 % between 1990 and 2009. The implied emission factor of EU-15 was 56.6 t/TJ in 2009.

**Figure 3.80 1A4c Agriculture/Forestry/Fisheries, gaseous fuels: Activity Data and Implied Emission Factors for $CO_2$**



### 3.2.5 Other (CRF Source Category 1A5) (EU-15)

Source category 1A5 Other includes emissions from stationary and mobile military fuel use including air craft. Under category '1A5a solid fuels' Sweden reports transformation losses of energy in 'iron ore based iron and steel industry' as activity data without any emissions (for reason of consistency with the Reference Approach). In 2009 category 1A5 contributed to 6727 Gg $CO_2$ equivalents of which 94.6% $CO_2$, 0.1% $CH_4$ and 5.3% $N_2O$.

Table 3.80 provides an overview of Member States' source allocation to Source Category 1A5 Other.

**Table 3.80 1A5 Other: Member States' allocation of sources**

| Member State | Source allocation to 1A5 Other | Source |
|---|---|---|
| **Austria** | Mobile: Military use | CRF Table 1.s.2 |
| **Belgium** | Mobile: Military use | CRF Table 1.s.2 |
| **Denmark** | Mobile: Military use | CRF Table 1.s.2 |
| **Finland** | Stationary: Other non-specified, Non-specified emissions of Fuels from non-energy use, Indirect $N_2O$ emissions from NOx<br>Mobile: other non-specified | CRF Table 1.s.2 |
| **France** | Emissions are 'Not occuring' | CRF Table 1.s.2 |
| **Germany** | Military: stationary and mobile | CRF Table 1.s.2 |
| **Greece** | Emissions are 'Not occuring' | CRF Table 1.s.2 |
| **Ireland** | Emissions are 'Not occuring' | CRF Table 1.s.2 |
| **Italy** | Mobile: other non-specified | CRF Table 1.s.2 |
| **Luxembourg** | Emissions are 'Included elsewhere' or 'Not occuring' | CRF Table 1.s.2 |
| **Netherlands** | Mobile: military use | CRF Table 1.s.2 |
| **Portugal** | Stationary: emissions are reported for 1990-1994 and 'Not occuring' from 1995 on.<br>Mobile: other non-specified | CRF Table 1.s.2 |
| **Spain** | Emissions are 'Not occuring' | CRF Table 1.s.2 |
| **Sweden** | Stationary: other non-specified<br>Mobile: Military use and Other non-specified | CRF Table 1.s.2 |
| **United Kingdom** | Mobile: military use | CRF Table 1.s.2 |

Figure 3.81 shows the total trend within source category 1A5 and the dominating emission sources: $CO_2$ emissions from 1A5b Mobile and from 1A5a Stationary. Total GHG emissions of source category 1A5 decreased by 70 % between 1990 and 2009. Germany has the most influence to the overall trend, it reports minus 89% $CO_2$ emissions since 1990 and contributes to 56% in 1990. The German NIR states that only military sources (incl. aircraft) are included in its inventory. Since 2001 the United Kingdom has a main share and contributes 38 % to $CO_2$ emissions in 2009. UK reports military air-craft and naval vessels within this category.

**Figure 3.81** 1A5 Other: Total and $CO_2$ emission and activity trends

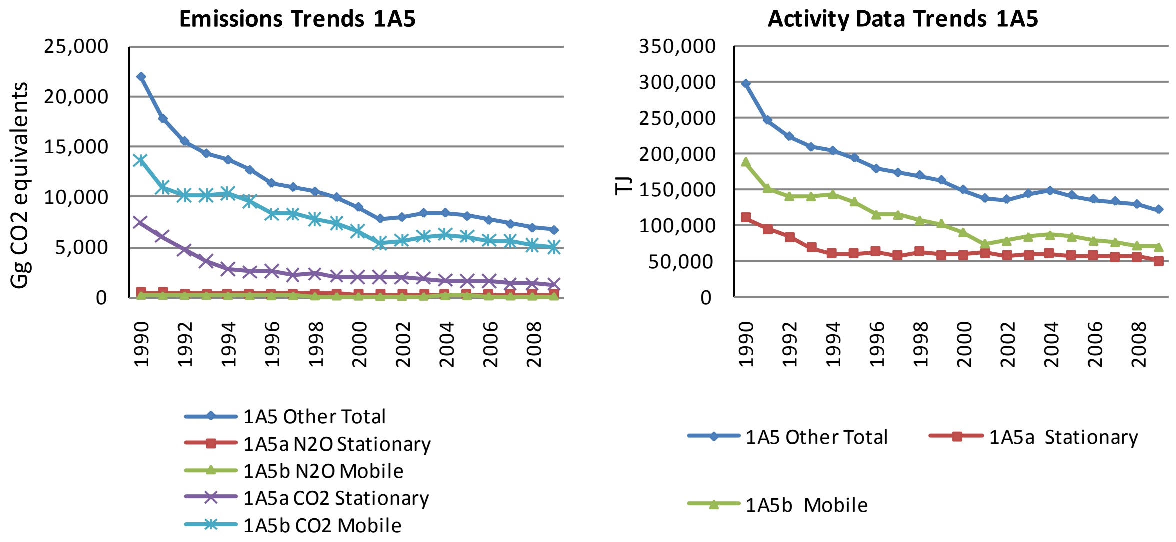



Table 3.81 shows total GHG and $CO_2$ emissions by Member State from 1A5. $CO_2$ emissions from 1A5 Other accounted for 0.2 % of total GHG emissions in 2009. Between 1990 and 2009, $CO_2$ emissions from this source decreased by 83 % in the EU-15. Between 1990 and 2009, the largest reduction in absolute terms was reported by Germany, which was partly due to reduced military operations after German reunification.

**Table 3.81** 1A5 Other: Member States' contributions to $CO_2$ emissions

| Member State | GHG emissions in 1990 (Gg $CO_2$ equivalents) | GHG emissions in 2009 (Gg $CO_2$ equivalents) | $CO_2$ emissions in 1990 (Gg) | CO2 emissions in 2009 (Gg) |
|---|---|---|---|---|
| Austria | 36 | 47 | 35 | 46 |
| Belgium | 163 | 56 | 161 | 56 |
| Denmark | 120 | 162 | 119 | 160 |
| Finland | 1,640 | 1,128 | 1,188 | 891 |
| France | NO | NO | NO | NO |
| Germany | 12,117 | 1,353 | 11,811 | 1,339 |
| Greece | NO | NO | IE,NO | IE,NO |
| Ireland | NO | NO | NO | NO |
| Italy | 1,120 | 920 | 1,046 | 844 |
| Luxembourg | 29 | 0 | 26 | NO |
| Netherlands | 577 | 272 | 566 | 267 |
| Portugal | 104 | 86 | 103 | 85 |
| Spain | 0 | 0 | IE,NA | IE,NA |
| Sweden | 828 | 252 | 801 | 246 |
| United Kingdom | 5,337 | 2,450 | 5,285 | 2,427 |
| **EU-15** | **22,071** | **6,727** | **21,143** | **6,361** |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

Table 3.82 provides information on the contribution of Member States to EU-15 recalculations in $CO_2$ from 1A5 Other for 1990 and 2008 and main explanations for the largest recalculations in absolute terms.

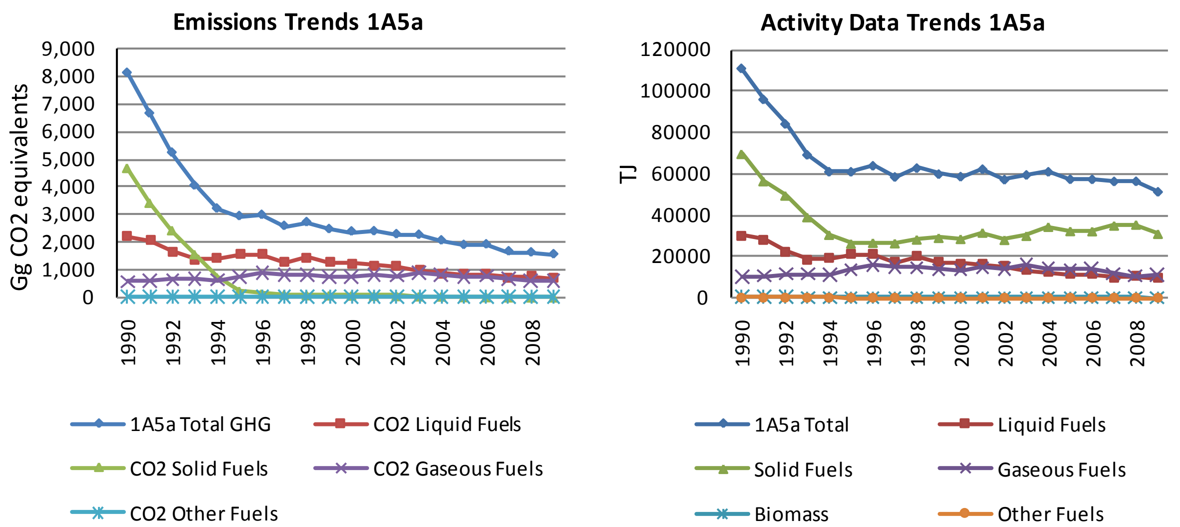
**Table 3.82** **1A5 Other: Contribution of MS to EU-15 recalculations in $CO_2$ for 1990 and 2008 (difference between latest submission and previous submission in Gg of $CO_2$ equivalents and percent)**

| | 1990 | | 2008 | | Main explanations |
|---|---|---|---|---|---|
| | Gg CO2 equiv. | Percent | Gg CO2 equiv. | Percent | |
| Austria | 0 | 0.0 | 0 | 0.0 | |
| Belgium | 0 | 0.0 | 0 | 0.0 | |
| Denmark | 0 | -0.4 | 0 | -0.3 | |
| Finland | 0 | 0.0 | -2 | -0.6 | Updates in other categories are reflected here. |
| France | 0 | 0.0 | 0 | 0.0 | |
| Germany | 0 | 0.0 | 0 | 0.2 | Correction of a net calorific value and EF. |
| Greece | 0 | 0.0 | 0 | 0.0 | |
| Ireland | - | - | 0 | 0.0 | |
| Italy | 0 | 0.0 | 0 | 0.0 | |
| Luxembourg | -3 | -50.6 | -2 | -100.0 | Activity data was revised due to new energy statistics from National Statistics (STATEC), and due to the application of national densities and NCVs, which are now streamlined with STATEC. |
| Netherlands | 0 | 0.0 | 0 | 0.0 | |
| Portugal | 0 | 0.0 | 0 | 0.0 | |
| Spain | 0 | 0.0 | 0 | 0.0 | |
| Sweden | 0 | 0.0 | 0 | 0.4 | Added number of decimals compared to submission 2010 creates the differences. |
| UK | 0 | 0.0 | -2 | -5.9 | Revised fuel consumption data for military aviation and naval shipping supplied by the defence fuels group. |
| **EU-15** | **-3** | **-0.4** | **-5** | **-1.3** | |

### 3.2.5.1 Stationary (1A5a) (EU-15)

In this chapter information about emission trends, Member States' contribution, activity data, and emission factors is provided for category 1A5a by fuels. $CO_2$ emissions from 1A5a Stationary accounted for 0.03 % of total EU-15 GHG emissions in 2009. Figure 3.82 shows the emission trend within the categories 1A5a, which is mainly dominated by $CO_2$ emissions from solid and liquid fuels. The reduction in the early 1990s was driven by $CO_2$ from solid fuels. Total emissions decreased by 81 %, mainly due to decreases in emissions from solid fuels (-99.8 %) and liquid fuels (-69.6 %).

**Figure 3.82** **1A5a Stationary: Total and $CO_2$ emission and activity trends**



Only 3 Member States (Finland, Germany and Sweden) reported emissions from this key source in 2009 (Table 3.83). Between 1990 and 2009 Finland had a decrease of 37 % and Germany of 91 %. Portugal reports emissions from 1990 to 1994 only. Luxembourg reports emissions 1990 to 2003 only. This led to an EU-15 decrease of 81 %. Between 2008 and 2009 $CO_2$ emissions decreased by 3 %.

**Table 3.83 1A5a Stationary: Member States' contributions to $CO_2$ emissions**

| Member State | CO2 emissions in Gg | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | |
|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg CO2 equivalents) | (%) | (Gg CO2 equivalents) | (%) |
| Austria | NA | NA | NA | - | - | - | - | - |
| Belgium | NA | NA | NA | - | - | - | - | - |
| Denmark | NA,NO | NA,NO | NA,NO | - | - | - | - | - |
| Finland | 1,130 | 744 | 715 | 55.1% | -29 | -4% | -415 | -37% |
| France | NO | NO | NO | - | - | - | - | - |
| Germany | 6,329 | 589 | 574 | 44.2% | -15 | -3% | -5,756 | -91% |
| Greece | NO | NO | NO | - | - | - | - | - |
| Ireland | NO | NO | NO | - | - | - | - | - |
| Italy | NA | NA | NA | - | - | - | - | - |
| Luxembourg | 3 | NO | NO | - | 0 | - | -3 | -100% |
| Netherlands | NA | NA | NA | - | - | - | - | - |
| Portugal | 8 | NO | NO | - | - | - | -8 | -100% |
| Spain | IE,NA | IE,NA | IE,NA | - | - | - | - | - |
| Sweden | NO | 11 | 10 | 0.7% | -2 | -14% | 10 | - |
| United Kingdom | NA | NA | NA | - | - | - | - | - |
| **EU-15** | **7,471** | **1,344** | **1,299** | **100.0%** | **-46** | **-3%** | **-6,172** | **-83%** |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

## 1A5a Stationary – Solid Fuels ($CO_2$)

In 2009 $CO_2$ from solid fuels had a share of 1 % within source category 1A5a (compared to 57 % in 1990). Between 1990 and 2008, the emissions decreased by nearly 100 % (Table 3.84). In 2009 only Germany reported emissions for this key source.

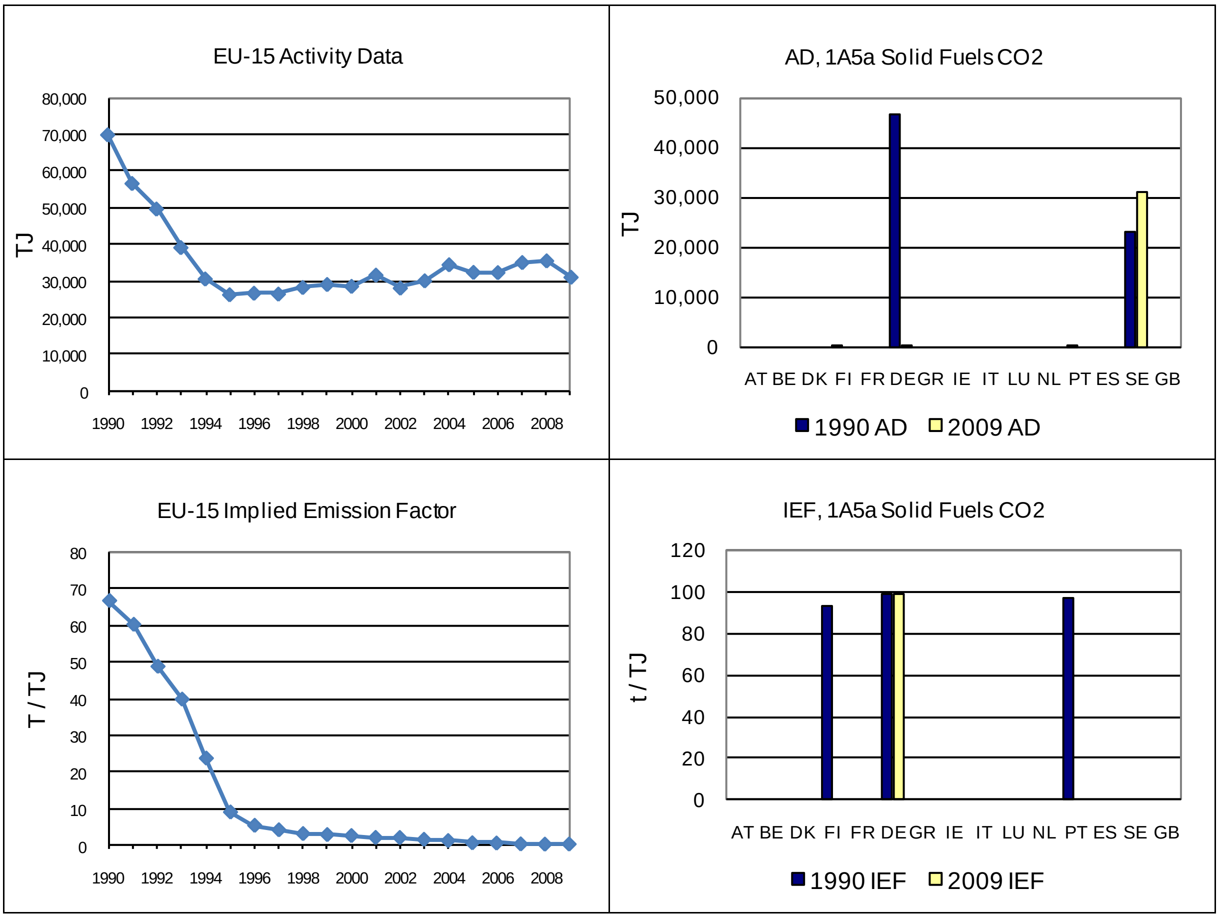
**Table 3.84 1A5a Stationary, solid fuels: Member States' contributions to $CO_2$ emissions and information on method applied and emission factor**

| Member State | $CH_4$ emissions (Gg $CO_2$ equivalents) | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg CO2 equivalents) | (%) | (Gg CO2 equivalents) | (%) | | |
| Austria | NA | NA | NA | - | - | - | - | - | NO | NO |
| Belgium | NA | NA | NA | - | - | - | - | - | NA | NA |
| Denmark | NO | NO | NO | - | - | - | - | - | NA | NA |
| Finland | 1 | NO | NO | - | - | - | -1 | -100% | NA | NA |
| France | NO | NO | NO | - | - | - | - | - | NA | NA |
| Germany | 4,657 | 10 | 10 | 100.0% | 0 | -3% | -4,648 | -100% | CS | CS |
| Greece | NO | NO | NO | - | - | - | - | - | NO | NO |
| Ireland | NO | NO | NO | - | - | - | - | - | NO | NO |
| Italy | NA | NA | NA | - | - | - | - | - | NA | NA |
| Luxembourg | NO | NO | NO | - | - | - | - | - | NA | NA |
| Netherlands | NA | NA | NA | - | - | - | - | - | NA | NA |
| Portugal | 8 | NO | NO | - | - | - | -8 | -100% | T1 | D,CR |
| Spain | NA | NA | NA | - | - | - | - | - | NA | NA |
| Sweden | NO | NO | NO | - | - | - | - | - | NA | NA |
| United Kingdom | NA | NA | NA | - | - | - | - | - | NA | NA |
| **EU-15** | **4,667** | **10** | **10** | **100.0%** | **0** | **-3%** | **-4,657** | **-100%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

Figure 3.83 shows activity data and implied emission factors for $CO_2$ for EU-15 and the Member States. Germany accounts for 100 % of EU-15 $CO_2$ emissions from this source category since 1995. Fuel combustion in the EU-15 decreased by 55 % between 1990 and 2009. The implied emission factor is 0.31 t/TJ in 2009. Sweden reports transformation losses of energy in iron ore based iron and steel industry as activity data without any emissions.

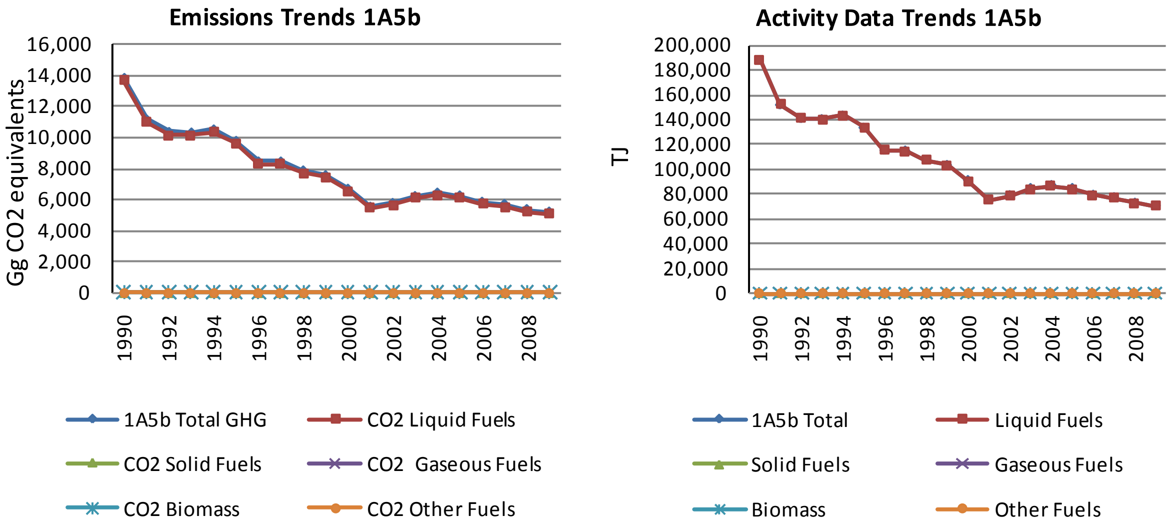
**Figure 3.83 1A5a Stationary, solid fuels: Activity Data and Implied Emission Factors for $CO_2$**



### 3.2.5.2 Mobile (1A5b) (EU-15)

In this chapter information about emission trends, Member States' contribution, activity data, and emission factors is provided for category 1A5a by fuels. $CO_2$ emissions from 1A5b Mobile accounted for 0.14 % of total EU-15 GHG emissions in 2009. Figure 3.84 shows the emission trend within the category 1A5b, which is dominated by $CO_2$ emissions from liquid fuels. Total $CO_2$ emissions decreased by 63 %.

**Figure 3.84 1A5b-Mobile: Total and $CO_2$ emission trends**




Four Member States reported emissions as 'Not occurring' and/or "Included elsewhere". The UK had the highest emissions in 2009 and – together with Germany - decreased the most in absolute terms between 1990 and 2009. Finland reported an increase of more than 200 %. Between 2008 and 2009 the UK had the highest absolute decrease. The EU-15 emissions decreased by 3 % between 2008 and 2009 (Table 3.85).

**Table 3.85 1A5b Mobile: Member States' contributions to $CO_2$ emissions**

| Member State | CO2 emissions in Gg | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | |
|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg CO2 equivalents) | (%) | (Gg CO2 equivalents) | (%) |
| Austria | 35 | 45 | 46 | 0.9% | 1 | 1% | 11 | 31% |
| Belgium | 161 | 61 | 56 | 1.1% | -5 | -9% | -106 | -66% |
| Denmark | 119 | 108 | 160 | 3.2% | 52 | 49% | 41 | 34% |
| Finland | 58 | 178 | 176 | 3.5% | -2 | -1% | 118 | 203% |
| France | NO | NO | NO | - | - | - | - | - |
| Germany | 5,482 | 721 | 766 | 15.1% | 44 | 6% | -4,716 | -86% |
| Greece | IE,NO | IE,NO | IE,NO | - | - | - | - | - |
| Ireland | NO | NO | NO | - | - | - | - | - |
| Italy | 1,046 | 738 | 844 | 16.7% | 107 | 14% | -202 | -19% |
| Luxembourg | 23 | NO | NO | - | - | - | -23 | -100% |
| Netherlands | 566 | 392 | 267 | 5.3% | -125 | -32% | -299 | -53% |
| Portugal | 95 | 85 | 85 | 1.7% | 0 | 0% | -10 | -10% |
| Spain | IE,NA | IE,NA | IE,NA | - | - | - | - | - |
| Sweden | 801 | 150 | 237 | 4.7% | 87 | 58% | -565 | -70% |
| United Kingdom | 5,285 | 2,758 | 2,427 | 47.9% | -331 | -12% | -2,858 | -54% |
| **EU-15** | **13,672** | **5,236** | **5,062** | **100.0%** | **-173** | **-3%** | **-8,609** | **-63%** |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

## 1A5b Mobile – Liquid Fuels ($CO_2$)

In 2009, $CO_2$ from liquid fuels had a share of 97 % within source category 1A5b (compared to 98 % in 1990). Between 1990 and 2009 the emissions decreased by 63 % (Table 3.86). France, Greece, Ireland, Luxembourg and Spain report emissions as 'Not occurring', or 'Included Elsewhere'. The highest decrease was achieved in Germany (-86 %), while Finland had increases by more than 200 %.

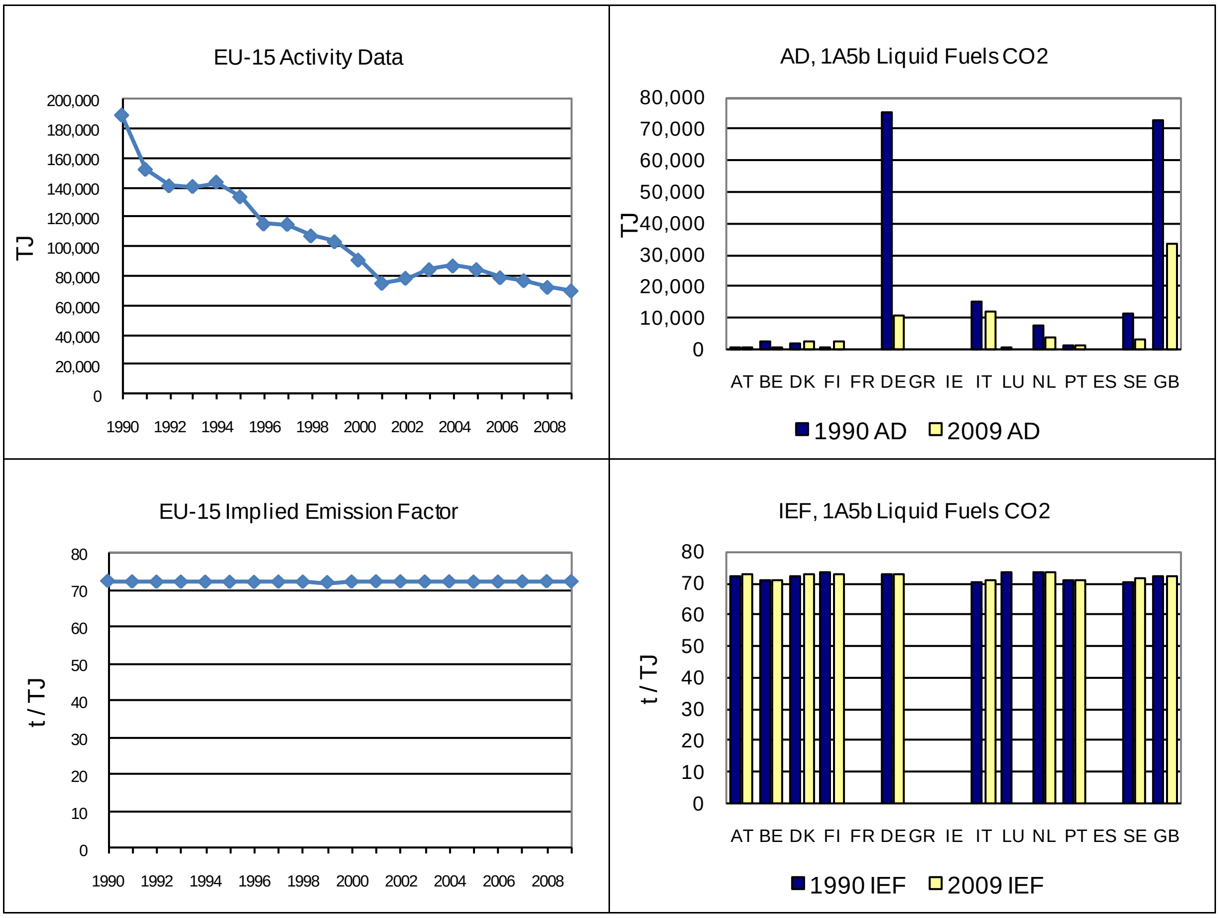
**Table 3.86 1A5b Mobile, liquid fuels: Member States' contributions to $CO_2$ emissions and information on method applied and emission factor**

| Member State | $CH_4$ emissions (Gg $CO_2$ equivalents) | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg CO2 equivalents) | (%) | (Gg CO2 equivalents) | (%) | | |
| Austria | 35 | 45 | 46 | 0.9% | 1 | 1% | 11 | 31% | M | CS |
| Belgium | 161 | 61 | 56 | 1.1% | -5 | -9% | -106 | -66% | T1 | D |
| Denmark | 119 | 108 | 160 | 3.2% | 52 | 49% | 41 | 34% | CR | CS |
| Finland | 58 | 178 | 176 | 3.5% | -2 | -1% | 118 | 203% | T1 | CS |
| France | NO | NO | NO | - | - | - | - | - | NA | NA |
| Germany | 5,482 | 721 | 766 | 15.1% | 44 | 6% | -4,716 | -86% | CS,T1 | CS |
| Greece | IE | IE | IE | - | - | - | - | - | NO | NO |
| Ireland | NO | NO | NO | - | - | - | - | - | NO | NO |
| Italy | 1,046 | 738 | 844 | 16.7% | 107 | 14% | -202 | -19% | T2 | CS |
| Luxembourg | 23 | NO | NO | - | - | - | -23 | -100% | NA | NA |
| Netherlands | 566 | 392 | 267 | 5.3% | -125 | -32% | -299 | -53% | T2 | D |
| Portugal | 95 | 85 | 85 | 1.7% | 0 | 0% | -10 | -10% | T1 | D,CR |
| Spain | IE | IE | IE | - | - | - | - | - | NA | NA |
| Sweden | 801 | 150 | 237 | 4.7% | 87 | 58% | -565 | -70% | T1 | CS |
| United Kingdom | 5,285 | 2,758 | 2,427 | 47.9% | -331 | -12% | -2,858 | -54% | T2,T3 | CS |
| **EU-15** | **13,672** | **5,236** | **5,062** | **100.0%** | **-173** | **-3%** | **-8,609** | **-63%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

Figure 3.85 shows activity data and implied emission factors for $CO_2$ for EU-15 and the Member States. The largest emissions are reported by Germany, Italy and the United Kingdom; together they cause 89 % of the $CO_2$ emissions from liquid fuels in 1A5b. Fuel consumption in the EU-15 decreased by 63 % between 1990 and 2009. The implied emission factor of EU-15 was 72.3 t/TJ in 2009.

**Figure 3.85** **1A5b Mobile, liquid fuels Activity Data and Implied Emission Factors for $CO_2$**

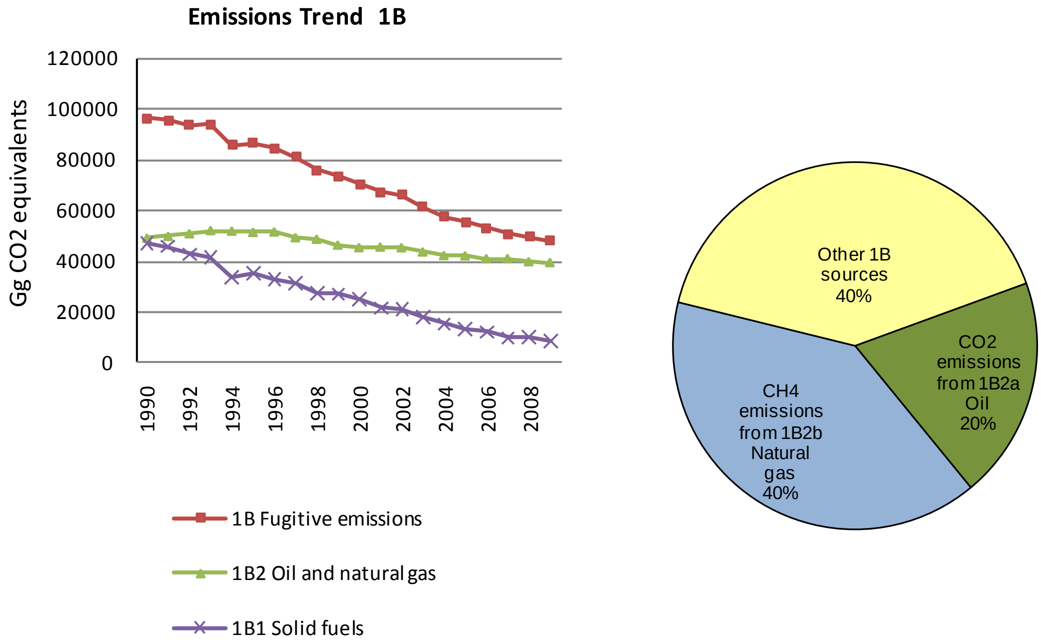



### *3.2.6 Fugitive emissions from fuels (CRF Source Category 1.B) (EU-15)*

This chapter describes gaseous or volatile emissions which occur during extraction, handling and consumption of fossil fuels. In the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories fugitive emissions are defined as intentional or unintentional releases of gases from anthropogenic activities that in particular may arise from the production, processing, transmission, storage and use of fuels. Emissions from combustion are only included where it does not support a productive activity (e.g., flaring of natural gases at oil and gas production facilities). Evaporative emissions from vehicles are included under Road Transport as Subsection 1A3b v (Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories).

In 2009, in terms of $CO_2$ equivalents, almost two thirds of emissions from source category 1B were fugitive $CH_4$ emissions while more than a third were fugitive $CO_2$ emissions. Together, they represented 1.3% of total GHG emissions in the EU-15. Fugitive GHG emissions have been steadily declining (Figure 3.86). Between 1990 and 2009, the total fugitive GHG emissions decreased by 50 %. This was mainly due to the decrease in underground mining activities: underground mining activity decreased by 84 % since 1990 and decreases in $CH_4$ emissions from category 1B1a i underground mines are responsible for three fourths of the total decrease of fugitive emissions. Between 1990 and 2009, GHG emissions from 1B1 Solid Fuels decreased by 82 %, while emissions from 1B2 Oil and Natural Gas decreased only by 20 %. As a result, while emissions from the two sources (1B1 Solid Fuels and 1B2 Oil and Natural Gas) represented each roughly 50 % of total fugitive emissions in 1990, fugitive emissions from 1B1 Solid Fuels represented only 18 % of total fugitive emissions in 2009.

**Figure 3.86** **1B Fugitive Emission from Fuel: GHG Emissions trend and proportion of fugitive emissions within source category**




Fugitive emissions includes three key sources:

- 1B1a Coal Mining ($CH_4$)
- 1B2a Oil ($CO_2$)
- 1B2b Natural Gas ($CH_4$)

The two largest key sources, i.e. $CH_4$ emissions from 1B2b Natural Gas and $CO_2$ emissions from 1B2a Oil account together for 59.4 % of total fugitive GHG emissions (Figure 3.86).

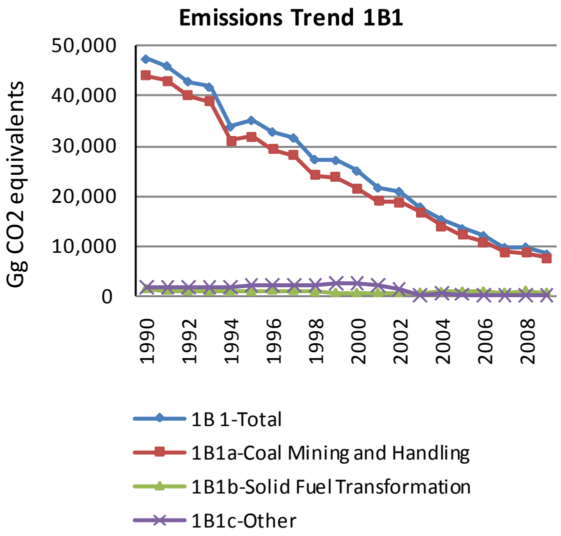
### 3.2.6.1 Fugitive emissions from Solid Fuels (1B1) (EU-15)

In the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories fugitive emissions from solid fuels are defined as the total release of methane during coal mining and post-mining activities. Combustion emissions from colliery methane recovered and used are excluded here and reported under Fuel Combustion Emissions.

In 2009 fugitive emissions from solid fuels accounted for 0.2 % of the total GHG emissions in the EU-15 and 18 % of total fugitive emissions in the EU-15:

- 90 % of these emissions were $CH_4$ emissions from coal mining. The emissions arise by the natural production of methane when coal is formed. Methane is partly stored within the coal seam and escapes when mined. Most $CH_4$ emissions resulted from underground mines; surface mines were a smaller source.
- 8 % of these emissions were $CO_2$ emissions due to solid fuel transformation.
- Since 1990 fugitive $CH_4$ emissions from 1B1 Solid fuels have been steadily decreasing, caused by the reduction of coal mining (Figure 3.87)

**Figure 3.87 1B1 Fugitive Emissions from Solid Fuels: Trend**




In 2009 three countries, Germany, the United Kingdom and Greece represented 85 % of total fugitive GHG emissions from solid fuels (Table 3.87).

**Table 3.87 1B1 Fugitive Emissions from Solid Fuels: Member States Contribution**

| Member State | GHG emissions in 1990 (Gg $CO_2$ equivalents) | GHG emissions in 2009 (Gg $CO_2$ equivalents) | $CH_4$ emissions in 1990 (Gg $CO_2$ equivalents) | CH4 emissions in 2009 (Gg $CO_2$ equivalents) | $CO_2$ emissions in 1990 (Gg) | CO2 emissions in 2009 (Gg) |
|---|---|---|---|---|---|---|
| Austria | 11 | IE,NA,NO | 11 | IE,NA,NO | IE,NA,NO | IE,NA,NO |
| Belgium | 330 | 4 | 330 | 4 | NO | NO |
| Denmark | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO |
| Finland | NO | NO | NO | NO | NO | NO |
| France | 4,065 | 52 | 4,065 | 52 | NA,NO | NA,NO |
| Germany | 20,240 | 2,846 | 20,240 | 2,846 | IE,NO | IE,NO |
| Greece | 1,095 | 1,370 | 1,095 | 1,370 | NO | IE,NO |
| Ireland | NE, NO | NO | NE,NO | NO | NE,NO | NO |
| Italy | 122 | 45 | 122 | 45 | NA | NA |
| Luxembourg | NO | NO | NO | NO | NO | NO |
| Netherlands | 433 | 530 | 30 | 18 | 403 | 513 |
| Portugal | 75 | IE, NO | 66 | IE,NO | 9 | IE,NO |
| Spain | 1,835 | 625 | 1,818 | 624 | 18 | 1 |
| Sweden | 5 | 15 | 0.0 | 0.0 | 5 | 15 |
| United Kingdom | 19,148 | 3,018 | 18,290 | 2,868 | 856 | 150 |
| **EU-15** | **47,359** | **8,504** | **46,067** | **7,825** | **1,291** | **679** |

*For For methodological issues and remarks on completeness see Table 3.88.*
*Abbreviations explained in the Chapter 'Units and abbreviations'*

Between 1990 and 2009 fugitive $CH_4$ emissions from solid fuels decreased by 83 % (Table 3.87). Large reductions (in absolute terms) were observed in Germany and in the United Kingdom, while emissions actually increased by about a quarter in Greece. Table 3.88 provides information on the methodologies used by EU-15 Member States.

**Table 3.88 1B1 Fugitive Emissions from Solid Fuels: Methodological Issues according to NIRs (submitted in 2010) and Member State information of EU-15 Member States**

| Member State | Methodology |
|---|---|
| *Austria* | **General:** This category covers methane emissions from one brown coal surface mine. $CH_4$ emissions from this category decreased by more than 50% from 1990 to 1999 due to lower mining activities. Before coal mining was stopped in 2007 emissions decreased sharply between 2003 and 2004.<br>**Activity data:** are taken from the national energy balance and statistical year books (e.g. yearbook of the Association of Mining and Steel).<br>**Emission factor:** CORINAIR default emission factor 214g $CH_4$/Mg coal |
| *Belgium* | **General:** During the in-country review in June 2007, the expert review team of UNFCCC detected some missing underground mining activities in the Belgian greenhouse gas emission inventory. In the beginning of the nineties until 1992 there still was some mining activity in the Flemish region. Until 1999 energetic mining activities remained existent. These activities consisted of an auto-producer of electricity that was active until 1996 (the waste of the coal was used to produce electricity) and of energy needed for the sorting machines which were active until 1999. The latter energetic activities are allocated to the category 1A1c.<br>**Activity data:** federal statistics, delivered by corresponding industry<br>**Emission factor:** IPCC 2006 guidelines, CITEPA, EMEP/CORINAIR Handbook (400 g $CH_4$/ton cokes) |
| *Denmark* | **General:** Coal mining does not occur |
| *Finland* | **General:** Emissions from the peat production were reported in LULUCF sector (category Wetlands, CRF 5.D 2) as suggested in GPG LULUCF (IPCC 2003) (see chapter 7.5). There were no coal mines in Finland. |
| *France* | **General:** closure of surface mines 2002, closure of underground mines 2004, methane emissions after closure are accounted under 1B1c<br>**Activity data:** plant specific for 1B1b, bottom up approach according to site specific data, Tier 2/3 depending on sub-sector, for closed mines: a tier 2 is used<br>**Emission factor:** specific EF for sites, Tier 2/3 depending on site, EMEP/CORINAIR 350 g $CH_4$/Mg coke |
| *Germany* | **General**: hard coal mining Tier 3, brown coal Tier 2<br>Coal mining (1B1a): mainly emissions from current mining (coalseam methane, CSM)<br>Emissions from hard coal dressing are included in 1B1b. For hard coal emissions from closed coal mines (coalmine methane, CMM) are included in 1B1c. Because of the chosen method of calculation, for brown coal all emissions are included in 1B1a (ii).<br>**Activity data:** Statistik der Kohlenwirtschaft, national statistics<br>**Emission factor:** country specific, study FHG ISI (1993), German lignite-industry association, Deutsche Montan Technologie GmbH |
| *Greece* | **General:** only brown coal surface mines<br>**Activity data:** national energy balance<br>**Emission factor:** IPCC Good Practice Guidance (Default) |
| *Ireland* | **General:** coal mining does not occur |
| *Italy* | **General**: $CH_4$ emissions from coal mining referred to only two mines with very low production in the last ten years, one of which was underground and produced coal and the other, on the surface, produced lignite. The surface mine stopped the activity in 2001. $CH_4$ emissions from solid fuel transformation referred to the coke production in the iron and steel industry, which was also decreasing in the last years. $CO_2$ and $N_2O$ emissions from 1B1 are not occurring.<br>**Activity Data:** National Energy Balance<br>**Emission Factor**: IPCC Guidelines (1997), Corinair Guidebook |
| *Luxembourg* | **General:** This source category does not exist in Luxembourg. |
| *Netherlands* | **General:** The Netherlands currently has only one on-site coke production facility at the iron and steel plant of Tata Steel. A second independent coke producer in Sluiskil discontinued its activities in 1999. The fugitive emissions of $CO_2$ and $CH_4$ from both coke production sites are included here. There are no fugitive emissions from coal mining and handling activities (1B1a) in the Netherlands; these activities ceased with the closing of the last coal mine in the early 1970s.<br>**Activity data:** individual company data, national energy statistics (CBS)<br>**Emission factor:** country specific, IPCC default values |
| *Portugal* | **General:** Since 1990 in Portugal there was extraction of coal at only two coal mines, but both were latter closed down in 1992 and 1994 and did not resume activity since.<br>**Activity data:** General-Directorate for Energy and Geology (DGEG). |

| Member State | Methodology |
|---|---|
| | **Emission factor:** emission factors from IPCC96 (IPCC,1997) |
| ***Spain*** | **Activity Data**: national studies, AITEMIN (Asociación de Investigación Tecnológica de Equipos Mineros)<br>**Emission Factor**: country specific |
| ***Sweden*** | **General:** There are no coalmines in Sweden and hence no fugitive emissions from coalmines occur. SO2 emissions from quenching and extinction at coke ovens are reported in CFR 1B1b. Flaring of coke oven gas from the coke oven is reported in CRF 1B1c since submission 2004. Since submission 2010, flaring of blast furnace gas in the blast furnace and steel converter gas in the steel converter are reported under CRF 2C1. |
| ***United Kingdom*** | **General:** Methane emissions from closed coal mines are accounted for within Sector 1B1a of the UK inventory. Carbon emissions from coke ovens are based on a carbon balance approach.<br>**Activity data:** saleable coal production statistics (national study)<br>**Emission factor:** UK Coal Mining Ltd data, national studies, US EPA |

**$CH_4$ from Coal Mining (1B1a)**

Fugitive emissions from coal mining correspond to the total emissions from:

- underground mining (emissions from underground mines, brought to the surface by ventilation systems),
- surface mining (emissions primarily from the exposed coal surfaces and coal rubble, but also emissions associated with the release of pressure on the coal),
- post-mining (emissions from coal after extraction from the ground, which occur during preparation, transportation, storage, or final crushing prior to combustion).

$CH_4$ emissions from 1B1a coal-mining accounted for 0.2 % of total GHG emissions in 2009 and for 16 % of all fugitive emissions in the EU-15. $CH_4$ emissions from this source decreased by 83 % in the EU-15 between 1990 and 2009 and by 12 % between 2008 and 2009 (Table 3.89). In 2009 Germany and the United Kingdom accounted together for 74 % of EU-15 $CH_4$ emissions from 1B1a. They both used higher tier methods for the estimation of emissions from 1B1a and both had substantially reduced their emissions between 1990 and 2009 due to the decline of coal mining (

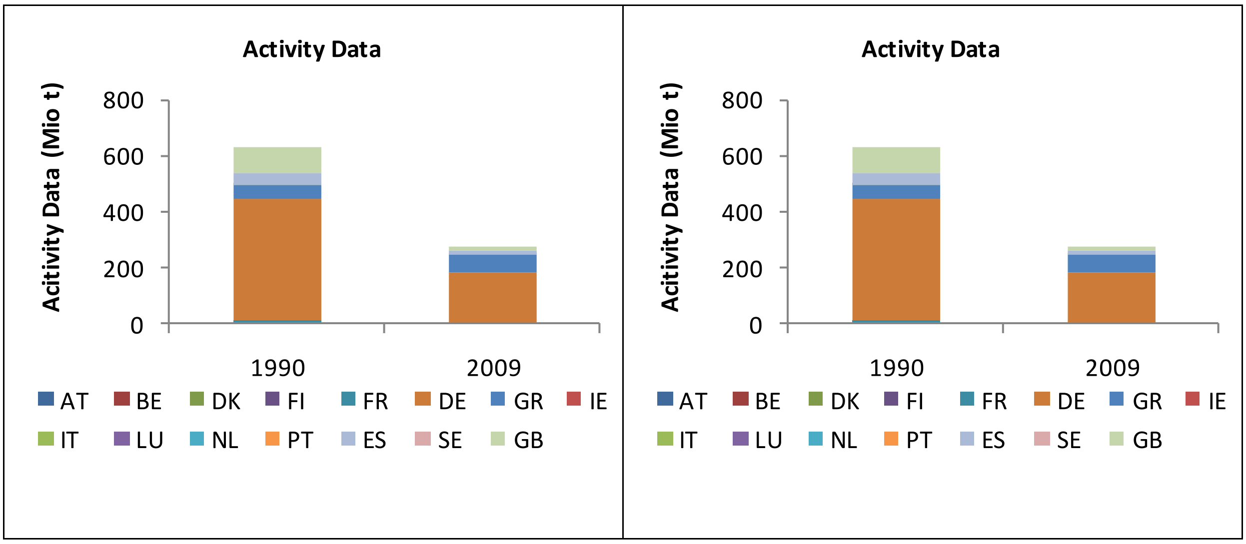
Figure 3.88).

**Table 3.89 1B1a Coal Mining: Member States contribution to $CH_4$ emissions and information on method applied and emission factor**

| Member State | CH4 emissions (Gg CO2 equivalents) | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg CO2 equivalents) | (%) | (Gg CO2 equivalents) | (%) | | |
| Austria | 11 | IE,NO | IE,NO | - | - | - | -11 | -100% | T1 | CR |
| Belgium | 299 | NO | NO | - | - | - | -299 | -100% | D | D |
| Denmark | NO | NO | NO | - | - | - | - | - | NA | NA |
| Finland | NO | NO | NO | - | - | - | - | - | NA | NA |
| France | 4,016 | NA,NO | NA,NO | - | - | - | -4,016 | -100% | CR | CS |
| Germany | 18,415 | 3,745 | 2,764 | 36.3% | -981 | -26% | -15,651 | -85% | T2 | CS |
| Greece | 1,095 | 1,387 | 1,370 | 18.0% | -17 | -1% | 274 | 25% | T1 | D |
| Ireland | NE,NO | NO | NO | - | - | - | - | - | NO | NO |
| Italy | 55 | 25 | 16 | 0.2% | -10 | -38% | -39 | -71% | T1 | D,CS |
| Luxembourg | NO | NO | NO | - | - | - | - | - | NA | NA |
| Netherlands | NA | NA | NA | - | - | - | - | - | NA | NA |
| Portugal | 66 | IE,NO | IE,NO | - | - | - | -66 | -100% | T1 | D |
| Spain | 1,794 | 673 | 610 | 8.0% | -63 | -9% | -1,184 | -66% | CS,T2 | CS |
| Sweden | NO | NO | NO | - | - | - | - | - | NA | NA |
| United Kingdom | 18,271 | 2,783 | 2,860 | 37.5% | 78 | 3% | -15,410 | -84% | CS | CS |
| **EU-15** | **44,022** | **8,613** | **7,619** | **100.0%** | **-994** | **-12%** | **-36,402** | **-83%** | | |

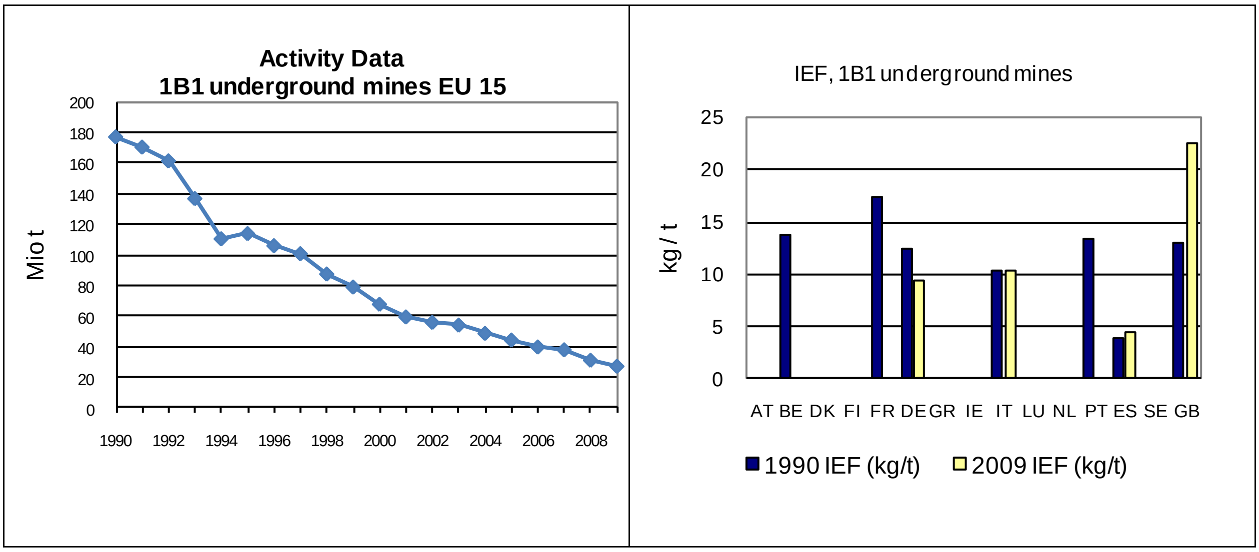
*For methodological issues and remarks on completeness see Table 3.88.*
*Abbreviations explained in the Chapter 'Units and abbreviations'.*

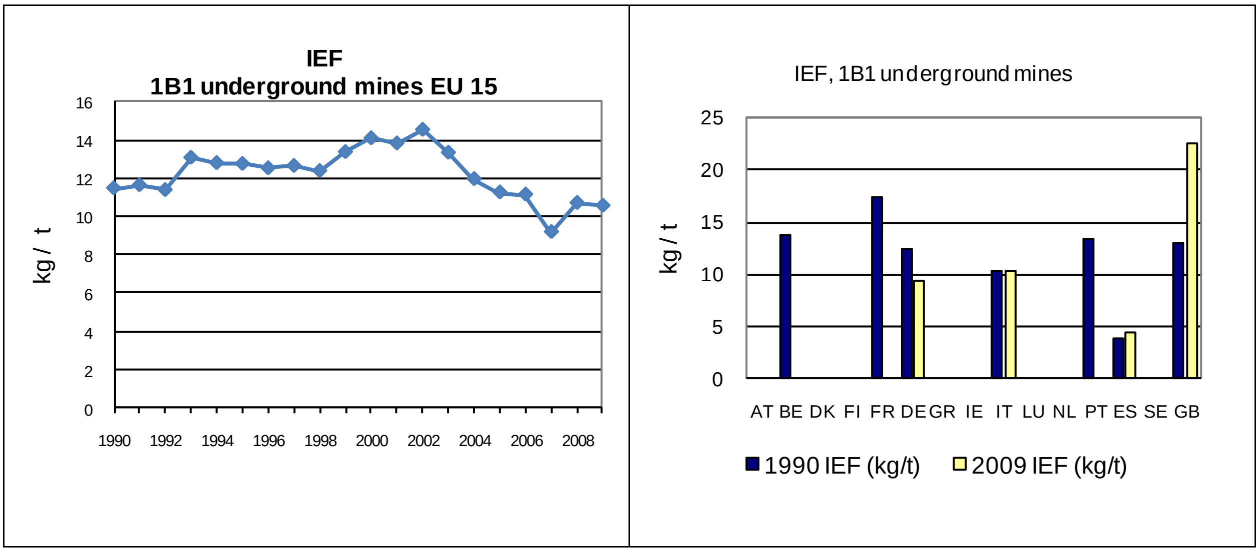
**Figure 3.88** **1B1a Coal Mining and Handling: Contribution of MS to $CH_4$ Emission and Activity Data**




In 2009 most fugitive emissions from coal mines were due to underground mines. Within the EU-15 coal mining in underground mines decreased substantially (84 %) (Figure 3.89). The strong change in underground mining activities is opposed by a moderate change in the implied emissions factor for $CH_4$ emissions (with a maximum of 15 kg/t (2002) and a minimum of 9 kg/t (2007)).

**Figure 3.89** **1B1ai Underground Mines: Activity Data and Implied Emission Factors for EU-15 and the emitting countries of $CH_4$**






Overall, in the EU-15 coal production from surface mines decreased by 45 % between 1990 and 2009 (Figure 3.90). Coal mining in surface mines decreased in all Member States except in Greece.

**Figure 3.90 1B1aii Surface Mines: Activity Data and Implied Emission Factors for EU-15 and the emitting countries of $CH_4$**

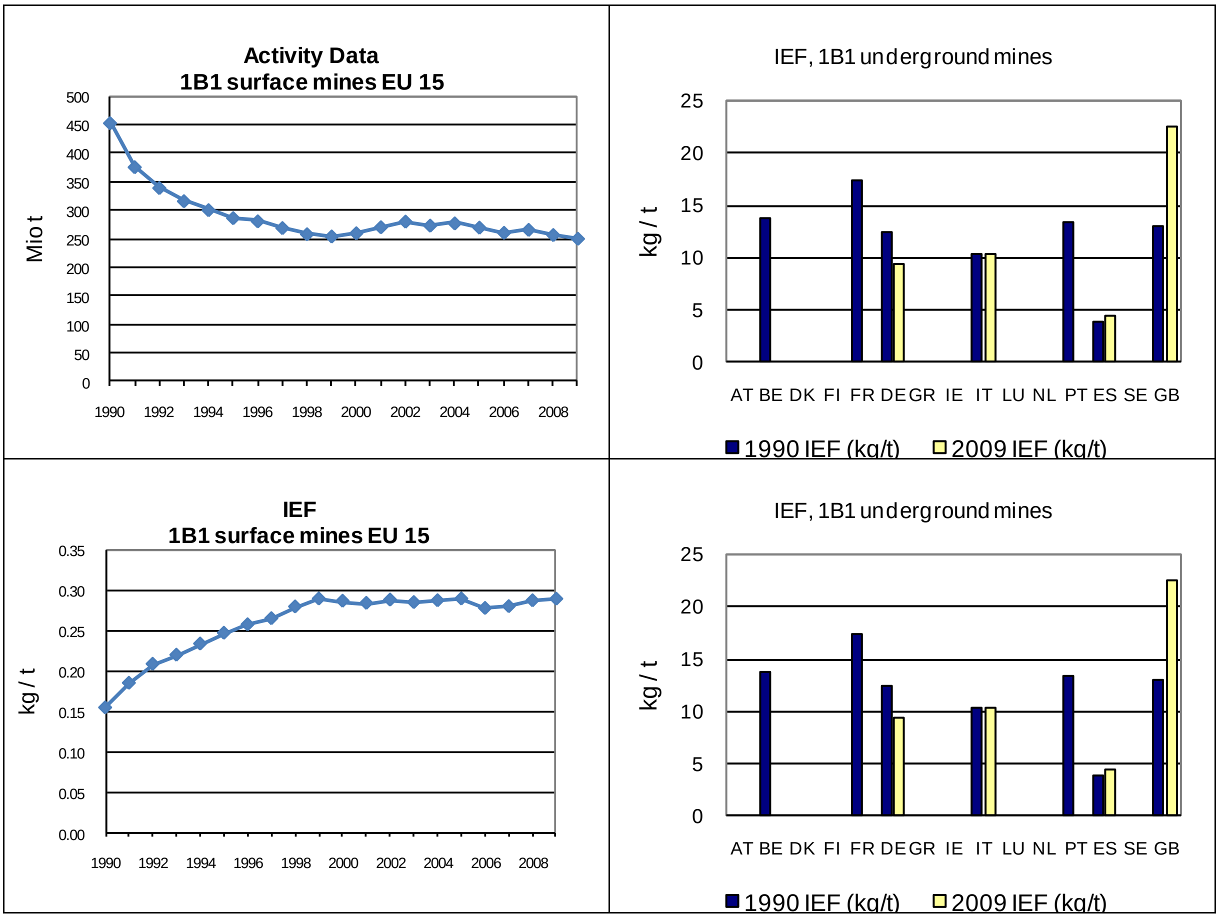



Table 3.90 provides information on the contribution of Member States to EU-15 recalculations in $CH_4$ from 1B1 Solid fuels for 1990 and 2008.

**Table 3.90** **1B1 Fugitive Emissions from Solid Fuels: Contribution of MS to EU-15 recalculations in $CH_4$ for 1990 and 2008 (difference between latest submission and previous submission in Gg of $CO_2$ equivalents and percent)**

| | 1990 | | 2008 | | Main explanations |
|---|---|---|---|---|---|
| | Gg CO2 equiv. | Percent | Gg CO2 equiv. | Percent | |
| Austria | 0 | 0.0 | 0 | 0.0 | |
| Belgium | 0 | 0.0 | 0 | 0.0 | |
| Denmark | 0 | 0.0 | 0 | 0.0 | |
| Finland | 0 | 0.0 | 0 | 0.0 | |
| France | -2 | -0.1 | -34 | -36.2 | Update of activity data |
| Germany | 0 | 0.0 | 0 | 0.0 | |
| Greece | 0 | 0.0 | 0 | 0.0 | |
| Ireland | - | - | 0 | 0.0 | |
| Italy | 0 | 0.0 | 0 | 0.0 | |
| Luxembourg | 0 | 0.0 | 0 | 0.0 | |
| Netherlands | 0 | 0.0 | 0 | 0.0 | |
| Portugal | 0 | 0.0 | 0 | 0.0 | |
| Spain | 0 | 0.0 | 0 | 0.0 | |
| Sweden | 0 | 0.0 | 0 | 0.0 | |
| UK | 0 | 0.0 | 0 | 0.0 | |
| **EU-15** | **-2** | **0.0** | **-35** | **-0.4** | |

### 3.2.6.2 Fugitive emissions from oil and natural gas (1B2) (EU-15)

Fugitive emissions from oil and natural gas correspond to the total fugitive emissions from oil and gas activities. Fugitive emissions may arise from equipment exhaust (non-combustion), leakages, upsets and mishaps at any point in the chain from production through final use. Emissions from flaring are also included (the combustion is considered a non-productive activity) (Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories).

Fugitive emissions from 1B2 Oil and natural gas include all emissions from exploration, production, processing, transport, and handling of oil and natural gas. They account for 1.1 % of the total GHG emissions in 2009 and for 82 % of all fugitive emissions in the EU-15.

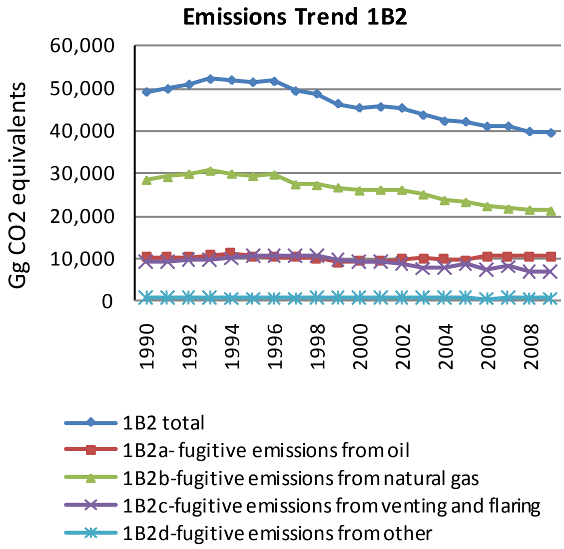
Of all fugitive emissions from oil and natural gas, in 2009:

- 48 % were $CH_4$ emissions from natural gas (exploration, production, processing, transport and distribution).
- 24 % were $CO_2$ emissions from oil (exploration, production, transport, refining and storage and distribution)
- 14 % were $CO_2$ emissions due to flaring

This source category includes two key source categories:

- $CO_2$ from 1B2a Oil
- $CH_4$ from 1B2b Natural Gas

**Figure 3.91 1B2-Fugitive Emissions Oil and Natural Gas: Trend**




Fugitive emissions from oil and natural gas arose in all Member States (Table 3.91). Total greenhouse gas emissions from 1B2 decreased by 20 % between 1990 and 2009 (Figure 3.92). This trend was mainly due to the reduction of fugitive $CH_4$ emissions from natural gas activities, which decreased by 25 % over that period.

In 2009, 78% of all fugitive GHG emissions from oil and natural gas were emitted by four countries: France, Germany, Italy and the United Kingdom. The largest reductions (in absolute terms) were observed in the United Kingdom (mainly $CH_4$ emissions) and in Italy (both $CH_4$ and $CO_2$ emissions), while emissions increased most in Portugal.

**Table 3.91 1B2 Fugitive emissions from oil and natural gas: Member States' contributions**

| Member State | GHG emissions in 1990 (Gg $CO_2$ equivalents) | GHG emissions in 2009 (Gg $CO_2$ equivalents) | $CO_2$ emissions in 1990 (Gg) | CO2 emissions in 2009 (Gg) | $CH_4$ emissions in 1990 (Gg $CO_2$ equivalents) | CH4 emissions in 2009 (Gg $CO_2$ equivalents) |
|---|---|---|---|---|---|---|
| Austria | 300 | 539 | 102 | 265 | 198 | 274 |
| Belgium | 610 | 505 | 84 | 117 | 525 | 388 |
| Denmark | 344 | 375 | 300 | 258 | 44 | 117 |
| Finland | 231 | 162 | 219 | 115 | 11 | 46 |
| France | 6,111 | 4,984 | 4,508 | 3,894 | 1,553 | 1,042 |
| Germany | 9,336 | 9,002 | 1,715 | 1,658 | 7,620 | 7,343 |
| Greece | 162 | 180 | 70 | 8 | 92 | 172 |
| Ireland | 131 | 35 | IE,NO | IE,NO | 131 | 35 |
| Italy | 10,654 | 7,088 | 3,344 | 2,170 | 7,298 | 4,906 |
| Luxembourg | 16 | 42 | 0 | 0 | 16 | 42 |
| Netherlands | 2,418 | 1,830 | 775 | 1,066 | 1,643 | 764 |
| Portugal | 210 | 1,306 | 156 | 646 | 52 | 658 |
| Spain | 2,270 | 2,721 | 1,656 | 2,191 | 614 | 530 |
| Sweden | 321 | 920 | 304 | 898 | 16 | 18 |
| United Kingdom | 16,143 | 9,902 | 5,778 | 4,599 | 10,323 | 5,266 |
| **EU-15** | **49,258** | **39,590** | **19,011** | **17,884** | **30,136** | **21,601** |

*For For methodological issues and remarks on completeness see Table 3.92.*
*Abbreviations explained in the Chapter 'Units and abbreviations'.*

Table 3.92 provides information on the methodologies used by EU-15 Member States.

**Table 3.92 1B2 –Fugitive Emissions from Oil and Gas: Methodological Issues according to NIRs (submitted in 2011) and Member State information of EU-15 Member States**

| Member State | Methodology |
|---|---|
| *Austria* | **General:** 1 B 2 a i Oil Exploration, 1 B 2 a iii Transport, 1 B 2 b Natural Gas Exploration and 1 B 2 b i Natural Gas Production/Processing, except $CO_2$ emissions from processing of sour gas, are included in 1 B 2 a ii. $CO_2$ emissions from 1 B 2 a iv Refining/Storage due to combustion are included in 1 A 1 b Petroleum Refining, fugitive $CO_2$ emissions are assumed to be negligible. 1 B 2 a v Distribution of oil products also includes storage in storage tanks and refinery dispatch station – only NMVOC emissions are estimated as $CH_4$ emissions are assumed to be negligible. $CO_2$ emissions from 1 B 2 c Venting/Flaring are included in 1 A 1 b Petroleum Refining. $CH_4$ emissions from 1 B 2 c Venting/Flaring are included in 1 B 2 a iv Petroleum Refining<br>**Activity data:** national energy balance, Association of the Austrian Petroleum Industry, Austrian Natural Gas and District Heat Association., E-Control (Austrian Energy Regulator)<br>**Emission factor:** IPCC Reference Manual, country specific |
| *Belgium* | **General**: $CO_2$ of the refineries were allocated to the sectors 1A1a for the involved combined heat-power installations of the refineries, 1B2c for the flaring emissions and 1A1b for the total emissions excluding the emissions of the combined heat-power installations and excluding the emissions from flaring activities. The emissions of $CH_4$ reported in 1B2a also contain the emissions of flaring activities, as a consequence these $CH_4$ emissions are allocated in category 1B2a and not in category 1A1b.<br>**Activity data:** The activity data reported in the category 1B2b is the annual total natural gas amount consumed in Belgium. These activity data originate from SYNERGRID, the federation of the gridoperators of gas and electricity.<br>**Emission factor:** plant specific, country specific<br>**Methodological changes compared to previous submission:** Activity Data in the sector 1B2b3 in the Brussels region was revised for the year 2008 following the finalization of the 2008 energy balance of the region. Activity Data in the sector 1B2b4 in the Brussels region was revised for the complete time series in order to be consistent with sector 1B2b3. |
| *Denmark* | **General:** 1B2a: Fugitive emissions from oil include emissions from offshore activities and refineries. 1B2b: Fugitive emissions from natural gas include emissions from transmission and distribution of natural gas. Emissions from gas storage are included in the transmission. 1B2c: Venting and flaring include activities onshore and offshore. Flaring occur both offshore and onshore in gas treatment and storage plants and in refineries. Venting occurs in gas storage plants. Venting of gas is assumed to be negligible in extraction and in refineries as controlled venting enters the gas flare system.<br>**Activity data:** Danish gas transmission company DONG Energy, Danish Energy Agency, Danish energy statistics, A/S Dansk Shell, 2009 and Statoil A/S, Danish Gas Technology Centre and the Danish gas distribution companies, Energinet.dk<br>**Emission factor:** EMEP/EEA Guidebook (2009), country specific, national studies, UK Emission Factor Database ,Danish EPA |
| *Finland* | **General:** There is no exploration or production of oil or natural gas in Finland.$CO_2$, $CH_4$ and $N_2O$ emissions from flaring at oil refineries and in the petrochemical industry, fugitive methane emissions from oil refining and methane emissions from gas transmission and distribution were included.<br>**Activity data:** Energy Statistics (Energy Statistics, Yearbook 2009), flares reported to the VAHTI system<br>**Emission factor:** IPCC guidelines |
| *France* | **General:** Emissions from exploration, production, transport, refining were included. There are 14 refineries in France. The fugitive $CO_2$ emissions from the gas extraction site 'bassin de Lacq' decreased along with production strongly. The production of petrol emits $CO_2$ and $CH_4$, but compared to the transformation of petroleum products much less.<br>**Activity data:** national and plant statistics<br>**Emission factor**: country specific, extraction Tier 1 (liquid) and 3 (gaseous fuel), refining Tier 2/3, pipeline compressors (tier 3), transport Tier 2/3 |
| *Germany* | **General**: Emissions from 1 B 2 b i are included in 1 B 2 a i<br>**Activity data**: Jahresbericht des Wirtschaftsverbandes Erdöl- und Erdgasgewinnung e.V. (WEG), Jahresbericht Mineralöl-Zahlen, Mineralölwirtschaftsverband<br>**Emission factor**: IPCC GPG default emission factors, country specific |
| *Greece* | **General**: Extraction, processing, storage, transmission/distribution were included. The introduction of natural gas in the Greek energy system started in 1996. Emissions estimated according to the Tier 1 methodology described in the IPCC Good Practice Guidance (IPCC 2000). Emissions from crude oil transport are reported under venting, while emissions from LPG transport are reported under Other (1.B.2d - Other)<br>**Activity data:** national energy balance, Public Gas Corporation, international institutes and databases<br>**Emission factor:** IPCC Guidelines, IPCC Good Practice Guidancev |

| Member State | Methodology |
|---|---|
| ***Ireland*** | **General:** Ireland has no oil industries and therefore fugitive emissions of greenhouse gases are limited to those associated with natural gas production and distribution.<br>**Activity data:** energy balance, reports to the department of communications energy and natural resources (DCENR) under the OSPARConvention<br>**Emission factor:** country specific |
| ***Italy)*** | **General**: Fugitive $CO_2$ emissions reported in 1B2 referred to fugitive emissions in refineries during petroleum production processes, e.g. fluid catalytic cracking and flaring, and emissions from the production of oil and natural gas. $CH_4$ emissions reported in 1B2 referred mainly to the production of oil and natural gas and to the transmission in pipelines and distribution of natural gas. $CO_2$ and $CH_4$ fugitive emissions from oil exploration are included in those from production because no detailed information is available. $N_2O$ emissions from flaring in oil exploration and in refining activities are reported under oil flaring. Emissions from transport and distribution of oil result as not occurring. $CO_2$ and $CH_4$ emissions from gas exploration are also included in those from production while $CH_4$ emissions from other leakage are included in distribution emission estimates.<br>**Activity Data:** National Energy Balance, specific industry data<br>**Emission factor**: IPCC GPG (2000)<br>**Methodological changes compared to previous submission:** $CO_2$ and $CH_4$ from 1B2C.1.1. Disaggregation of fugitive emissions from oil among venting, flaring and production. Addition of natural gasoline production; $CO_2$ and $CH_4$ from 1B2C.2.1. Disaggregation of fugitive emissions from oil among venting, flaring and production. Emissions from flaring in refineries have been moved from 1.B.2.C.2.1 to 1.B.2.D. Addition of natural gasoline production<br>$N_2O$ from 1B2C.2.1. Emissions from flaring in refineries have been moved from 1.B.2.C.2.1 to 1.B.2.D<br>$CO_2$ and $CH_4$ from 1B2C.2.2. Disaggregation of fugitive emissions from oil among venting, flaring and production<br>$CO_2$ from 1B2D. Emissions from flaring in refineries have been moved from 1.B.2.C.2.1 to 1.B.2.D. Reallocation of fugitive emissions from petroleum refining between production processes and flaring<br>$CH_4$ from 1B2D. Emissions from flaring in refineries have been moved from 1.B.2.C.2.1 to 1.B.2.D<br>$N_2O$ from 1B2D. Emissions from flaring in refineries have been moved from 1.B.2.C.2.1 to 1.B.2.D.<br>Addition of $N_2O$ emissions from flaring in refineries |
| ***Luxembourg*** | **General:** In Luxembourg, fugitive emissions only occur from natural gas transmission, distribution and leakages (IPCC Sub-categories 1B2b3, 1B2b4 and 1B2b5). Other fugitive emissions are not occurring in Luxembourg.<br>With regards to natural gas, methane emissions from leaks or accidental events are included in IPCC sub-categories 1B2b3 − Transmission and 1B2b4 − Distribution, hence notation key IE used in IPCC sub-category 1B2b5 − Other Leakage.<br>**Activity Data:** national natural gas consumption: national statistics<br>**Emission factor**: 2006 IPCC Guidelines default emission factors for natural gas transmission and distribution. (2006 IPCC Guidelines Tier 1 approach has been applied). |
| ***Netherlands*** | **General:** The fugitive emissions – mostly $CH_4$ – from category 1B2 comprise non-fuel combustion emissions from flaring and venting, emissions from oil and gas production, emissions from gas transport (compressor stations) and gas distribution networks (pipelines for local transport) and oil refining. The fugitive $CO_2$ emissions from refineries are included in the combustion emissions reported in category 1A1b. In addition, the combustion emissions from exploration and production are reported under 1A1c. From the 2007 submission the process emissions of $CO_2$ from a hydrogen plant of a refinery (about 0.9 Tg $CO_2$ per year) are reported in this category. Refinery data specifying these fugitive $CO_2$ emissions are available from 2002 onwards (environmental report from the plant) and re-allocated from 1A1b to 1B2a-iv for 2002 onwards.<br>**Activity data:** plant and country specific<br>**Emission factor:** country specific Tier 3. Since 2004, the gas distribution sector annually records the number of leaks found per material, and any future possible trends in the emission factors will be derived from these data. |
| ***Portugal*** | **General:** Extraction and production of crude oil did never occur in the Portuguese territory. Therefore, fugitive emissions comprised only those resulting from refining, storage and transport of crude oil, other raw materials, intermediate products and final products - particularly gasoline - from terminal receiving of crude oil and other petroleum products till delivering to final consumer. There is no production of natural gas in Portugal. The use of natural gas in Portugal was initiated only in 1997 (DGEG). All natural gas is imported and received through shipping transport from Algeria and Nigeria as Liquefied Natural Gas (LNG). There are also no major processing operations in Portugal.<br>**Activity data:** plant and country specific, GALP (the company operating all refineries in Portugal), PETROGAL, TRANSGAS, General-Directorate for Energy and Geology (DGEG)<br>**Emission factor:** IPCC Good Practice (IPCC,2000), EMEP/CORINAIR, plant specific, USEPA |
| ***Spain*** | **Activity Data:** OILGAS, Enciclopedia Nacional del Petróleo, Petroquímica y Gas, SEDIGAS |

| Member State | Methodology |
|---|---|
| | **Emission factors:** estadística de prospección y producción de hidrocarburos, country specific, EMEP/CORINAR Guidebook, IPCC GPG 2000 |
| ***Sweden*** | **General:** According to 2006 IPCC Guidelines, emissions from hydrogen production plants should be reported in this sector. Since 2005, one such facility is in operation in Sweden, and another one was taken into operation in 2006. Emissions from these facilities are reported in CRF 1B2ai in accordance with 2006 IPCC Guidelines. In Sweden, crude oil is transported to and from the country by tankers. In response to recommendations from the UNFCCC expert review teams, Sweden estimates for the first time in the 2010 submission inventory emissions of $CH_4$ from transport of crude oil.<br>**Activity data:** plant specific, report to the EU ETS system, Statistics Sweden, Swedish EPA<br>**Emission factor:** plant specific, country specific and default, IPCC guidelines, 2000 Good Practice Guidance |
| ***United Kingdom*** | **General:** Emissions occurred from oil and gas production facilities, gas and oil terminals, gas processing facilities, oil refineries, gas transmission networks, and storage and distribution of petrol. Most of the UK's oil and gas production occurs offshore but there are a number of mostly small onshore production sites as well.<br>**Activity data:** Oil and Gas UK trade association (through their annual emissions reporting mechanism to the UK regulatory agency (the Department of Energy & Climate Change), called the Environmental Emissions Monitoring System (EEMS), for years prior to 1995 emission totals are based on an internal Oil and Gas UK summary report produced in 1998, UK Petroleum Industry Association, UK Energy Statistics<br>**Emission factor:** plant specific and aggregated, calculated by UK Institute of Petroleum |

### $CO_2$ from Oil (1B2a)

Fugitive emissions from oil correspond to fugitive emissions from oil exploration, fugitive emissions from the production of crude oil, fugitive emissions resulting from the loading and unloading of crude oil from tankers, fugitive emissions from the refining of oil and from storage in tanks and emissions (primarily NMVOCs) from transport and handling of oil products.(Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories).

$CO_2$ emissions from 1B2a ‘Fugitive $CO_2$ emissions from oil’ account for 0.3 % of total EU-15 GHG emissions in 2009 and for 20 % of all fugitive emissions in the EU-15. Between 1990 and 2009, $CO_2$ emissions from this source increased by 11 % in the EU-15 (Table 3.93). By contrast, during the same period 1990-2009, $CH_4$ emissions of this source category were reduced by 37 %.

Together France, Italy and Spain accounted for 70 % of the EU-15 total $CO_2$ emissions of 1B2a ‘Fugitive $CO_2$ emissions from oil’ (Table 3.93). All three Member States used higher tier methods for the estimation of 1B2a. During the period 1990-2009, the largest decreases in $CO_2$ emissions (in absolute terms) were observed in Italy and the United Kingdom, while emissions increased most in the Netherlands and in Sweden.

**Table 3.93** **1B2a Fugitive $CO_2$ emissions from oil: Member States' contributions and information on method applied and emission factor**

| Member State | CO2 emissions in Gg | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg CO2 equivalents) | (%) | (Gg CO2 equivalents) | (%) | | |
| Austria | 43 | 135 | 163 | 1.7% | 28 | 21% | 120 | 279% | CS | CS |
| Belgium | NA,NO | NA,NO | NA,NO | - | - | - | - | - | NA | NA |
| Denmark | NA | NA | NA | - | - | - | - | - | NA | NA |
| Finland | 1.0 | 1.5 | 1.4 | 0.0% | 0.0 | -2% | 0 | 43% | CS | D |
| France | 3,428 | 3,551 | 3,220 | 34.1% | -330 | -9% | -207 | -6% | CR | CS |
| Germany | 1 | 1 | 1 | - | - | - | - | - | T1,T2 | CS,D |
| Greece | 0 | 0.02 | 0.03 | 0.0% | 0.009 | 43% | -0.24 | - | T1 | D |
| Ireland | NO | NO | NO | - | - | - | - | - | NE,NO | NA |
| Italy | 2,366 | 1,447 | 1,434 | 15.2% | -12 | -1% | -932 | -39% | T1,T2 | D,CS |
| Luxembourg | NA,NO | NA,NO | NA,NO | - | - | - | - | - | NA | NA |
| Netherlands | 0 | 847 | 1,013 | 10.7% | 166 | 20% | 1,013 | - | D,CS | CS,D |
| Portugal | 105 | 502 | 393 | 4.2% | -109 | -22% | 288 | 275% | M | D,PS |
| Spain | 1,477 | 1,825 | 1,938 | 20.5% | 113 | 6% | 461 | 31% | CR,T1,T2 | D,PS |
| Sweden | 234 | 827 | 819 | 8.7% | -8 | -1% | 585 | 250% | T1,T2,T3 | CS,PS |
| United Kingdom | 859 | 286 | 456 | 4.8% | 170 | 60% | -403 | -47% | T2 | CS,PS |
| **EU-15** | **8,514** | **9,421** | **9,439** | **100.0%** | **17** | **0%** | **925** | **11%** | | |

*For methodological issues and remarks on completeness see Table 3.92.*
*Abbreviations explained in the Chapter 'Units and abbreviations'.*

## $CH_4$ from Natural gas (1B2b)

Fugitive emissions from natural gas correspond to emissions from the production of gas, gas gathering systems and gas separation plants, emissions from pipelines for long distance and local transport of methane, compressor stations and their maintenance facilities, and the release of gas at point of use, including residential, commercial, industrial and electricity generation users (Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories).

$CH_4$ emissions from 1B2b 'Fugitive $CH_4$ emissions from natural gas' account for 0.5 % of total EU-15 GHG emissions in 2009 and for 40 % of all fugitive emissions in the EU-15. Between 1990 and 2009, $CH_4$ emissions from this source decreased by 25 % in the EU-15 (Table 3.94).

In 2009, 66 % of the EU-15 $CH_4$ emissions from 1B2b were emitted by three Member States: Germany, Italy and the United Kingdom (Table 3.94). All three Member States used higher tier methods for the estimation of the emissions from 1B2b. The emission decreases between 1990 and 2009 observed in the United Kingdom (-66 %) and in Germany (-41 %) contributed most significantly to the overall reduction in the EU-15 between 1990 and 2009.

Various parameters (e.g. pipelines length, PJ gas consumed, $m^3$ gas produced, see Table 3.96) were used as activity data for calculation of the sub categories of 1B2b by Member States and thus a meaningful implied emission factor could not be calculated for the EU-15.

**Table 3.94** **1B2b Fugitive $CH_4$ emissions from natural gas: Member States' contributions and information on method applied and emission factor**

| Member State | $CH_4$ emissions (Gg CO2 equivalents) | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg CO2 equivalents) | (%) | (Gg CO2 equivalents) | (%) | | |
| Austria | 101 | 115 | 121 | 9.1% | 6 | 5% | 20 | 20% | CS,T1,T2,T3 | CS,D |
| Belgium | 6 | 7 | 4 | 0.3% | -3 | -44% | -2 | -36% | 0.0 | 0.0 |
| Denmark | 33 | 97 | 123 | 9.3% | 27 | 27% | 91 | 276% | CR,CS | CR,PS |
| Finland | 8 | 9 | 10 | 0.8% | 1 | 9% | 3 | 36% | T1 | D |
| France | 95 | 39 | 39 | 3.0% | 0 | -1% | -55 | -59% | CR | CS |
| Germany | 836 | 495 | 491 | 37.0% | -4 | -1% | -345 | -41% | CS,T1,T2 | CS,D |
| Greece | 42 | 19 | 19 | 1.4% | 0 | 0% | -23 | -55% | T1 | D |
| Ireland | NO | NO | NO | - | - | - | - | - | T1 | D |
| Italy | 214 | 258 | 246 | 18.6% | -12 | -5% | 33 | 15% | T2 | CS |
| Luxembourg | NA,NO | NA,NO | NA,NO | - | - | - | - | - | NA | NA |
| Netherlands | 17 | 11 | 11 | 0.8% | 0 | -2% | -6 | -35% | D,T1b | D |
| Portugal | 51 | 62 | 64 | 4.8% | 2 | 3% | 13 | 25% | CR,OTH | CR,OTH |
| Spain | 58 | 41 | 40 | 3.1% | -1 | -1% | -18 | -31% | CR,T1 | CR,CS,D |
| Sweden | 16 | 18 | 18 | 1.4% | 0 | 1% | 2 | 14% | CS,T1,T2 | CS,D,PS |
| United Kingdom | 408 | 146 | 137 | 10.4% | -9 | -6% | -271 | -66% | T2,T3 | CS,PS |
| **EU-15** | **1,885** | **1,319** | **1,326** | **100.0%** | **7** | **1%** | **-560** | **-30%** | | |

*For methodological issues and remarks on completeness see Table 3.92.*
*Abbreviations explained in the Chapter 'Units and abbreviations'.*

### $CO_2$ from Venting and Flaring (1B2c)

Fugitive emissions from venting and flaring correspond to the release and/or combustion of excess gas at facilities for the production of oil or gas and for the processing of gas (Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories).

In 2009 fugitive $CO_2$ emissions from 1B2c Venting and Flaring accounted for 0.2 % of total GHG emissions in 2009 and for 12 % of all fugitive emissions in the EU-15. The United Kingdom used a higher tier method for the estimation of emissions from 1B2c and was responsible for more than two thirds of the emissions from this source.

Between 1990 and 2009, $CO_2$ emissions from this source decreased by 12 % in the EU-15 (Table 3.95).

**Table 3.95 1B2c Fugitive $CO_2$ emissions from venting and flaring: Member States' contributions and information on method applied and emission factor**

| Member State | CH4 emissions (Gg CO2 equivalents) | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg CO2 equivalents) | (%) | (Gg CO2 equivalents) | (%) | | |
| Austria | IE | IE | IE | - | - | - | - | - | NA | NA |
| Belgium | IE,NO | IE,NO | IE,NO | - | - | - | - | - | NA | NA |
| Denmark | 2 | 4 | 2 | 0.2% | -1 | -36% | 1 | 31% | CR,CS | CR,PS |
| Finland | 0 | 0 | 0 | 0.0% | 0 | - | 0 | - | CS | CS |
| France | 9 | 5 | 5 | 0.4% | 0 | 1% | -4 | -47% | CR | CS |
| Germany | 1 | 2 | 1 | 0.1% | 0 | - | 0 | - | T1,T2 | CS,D |
| Greece | 40 | 40 | 41 | 3.2% | 1 | 2% | 1 | 2% | T1 | D |
| Ireland | IE,NO | IE,NO | IE,NO | - | - | - | - | - | NA | NA |
| Italy | 12 | 11 | 9 | 0.7% | -1 | -13% | -3 | -23% | T2 | CS |
| Luxembourg | NO | NO | NO | - | - | - | - | - | NA | NA |
| Netherlands | 1,252 | 390 | 348 | 27.1% | -41 | -11% | -904 | -72% | T2 | PS |
| Portugal | 1 | 1 | 1 | 0.0% | 0 | -33% | 0 | 9% | CR,OTH | CR,OTH |
| Spain | 136 | 35 | 34 | 2.6% | -1 | -4% | -102 | -75% | CR,CS,T1 | CR,CS |
| Sweden | 0 | 0 | 0 | 0.0% | 0 | 32% | 0 | 21% | T2 | CS |
| United Kingdom | 1,409 | 775 | 845 | 65.7% | 69 | 9% | -564 | -40% | T3 | CS |
| **EU-15** | **2,862** | **1,261** | **1,286** | **100.0%** | **25** | **2%** | **-1,576** | **-55%** | | |

*For methodological issues and remarks on completeness see Table 3.92.*
*Abbreviations explained in the Chapter 'Units and abbreviations'.*

**Table 3.96 1B2b Fugitive $CH_4$ emissions from natural gas: Information on activity data, emission factors by Member State**

| | | 1990 | | | | | 2009 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Activity data | | | | | Activity data | | | | |
| Member State | GHG source category | Description | Unit | Value | Implied emission factor (kg/unit) | $CH_4$ emissions (Gg) | Description | Unit | Value | Implied emission factor (kg/unit) | $CH_4$ emissions (Gg) |
| ***Austria*** | Natural Gas | | | | | 4.59 | | | | | 6.78 |
| | i. Exploration | Gas produced | 10^6 m^3 | 1288 | IE | IE | Gas produced | 10^6 m^3 | 1670 | IE | IE |
| | ii. Production (4) / Processing | gas produced | 10^6 m^3 | 1288 | IE | IE | gas produced | 10^6 m^3 | 1670 | IE | IE |
| | iii. Transmission | Pipelines length (km) | km | 3628 | 494.56 | 1.79 | Pipelines length (km) | km | 6574 | 494.56 | 3.25 |
| | iv. Distribution | Distribution network length | km | 11672 | 239.81 | 2.80 | Distribution network length | km | 28533 | 123.61 | 3.53 |
| | v. Other Leakage | Gas consumed | PJ | NO | NO | NO | Gas consumed | PJ | NO | NO | NO |
| | at industrial plants and power stations | Gas consumed | PJ | NO | NO | NO | Gas consumed | PJ | NO | NO | NO |
| | in residential and commercial sectors | Gas consumed | PJ | NO | NO | NO | Gas consumed | PJ | NO | NO | NO |
| ***Belgium*** | Natural Gas | | | | | 24.71 | 0.0% | 0 | | | 18.32 |
| | i. Exploration | (spec) | 0 | NO | NO | NO | (spec) | 0 | NO | NO | NO |
| | ii. Production (4) / Processing | (speci | 0 | NO | NO | NO | (speci | 0 | NO | NO | NO |
| | iii. Transmission | (e.g. PJ gas consumed) | PJ | 341 | 5979.11 | 2.04 | (e.g. PJ gas consumed) | PJ | 629 | 4197.04 | 2.64 |
| | iv. Distribution | PJ gas consumed | PJ | 341 | 66474.61 | 22.67 | PJ gas consumed | PJ | 629 | 24937.15 | 15.68 |
| | v. Other Leakage | (speci) | 0 | NO | NO | NO | (speci) | 0 | NO | NO | NO |
| | at industrial plants and power stations | (spec) | 0 | NO | NO | NO | (spec) | 0 | NO | NO | NO |
| | in residential and commercial sectors | (spec) | 0 | NO | NO | NO | (spec) | 0 | NO | NO | NO |
| ***Denmark*** | Natural Gas | | | | | 0.42 | 0.0% | 0 | | | 0.14 |
| | i. Exploration | 0.0% | 0 | IE | IE | IE | 0.0% | 0 | IE | IE | IE |
| | ii. Production (4) / Processing | Gas produced | 10^6 m^3 | 5137 | IE | IE | Gas produced | 10^6 m^3 | 8559 | IE | IE |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | iii. Transmission | Gas transmission | 10^6 m^3 | 2739 | 62.03 | 0.17 | Gas transmission | 10^6 m^3 | 6500 | 1.42 | 0.01 |
| | iv. Distribution | Gas distributed | 10^6 m^3 | 1905 | 133.16 | 0.25 | Gas distributed | 10^6 m^3 | 2890 | 46.57 | 0.13 |
| | v. Other Leakage | Incl. in transmission | 0 | IE | IE | IE | Incl. in transmission | 0 | IE | IE | IE |
| | at industrial plants and power stations | 0.0% | 0 | IE | IE | IE | 0.0% | 0 | IE | IE | IE |
| | in residential and commercial sectors | 0.0% | 0 | IE | IE | IE | 0.0% | 0 | IE | IE | IE |
| ***Finland*** | Natural Gas | | | | | 0.17 | 0.0% | 0 | | | 1.67 |
| | i. Exploration | (specify) | 0 | NO | NO | NO | (specify) | 0 | NO | NO | NO |
| | ii. Production (4) / Processing | (e.g. PJ gas produced) | 0 | NO | NO | NO | (e.g. PJ gas produced) | 0 | NO | NO | NO |
| | iii. Transmission | PJ gas consumed | PJ | 92 | 1855.49 | 0.17 | PJ gas consumed | PJ | 145 | 3245.32 | 0.47 |
| | iv. Distribution | PJ gas distributed via local networks | PJ | 5 | NO | NO | PJ gas distributed via local networks | PJ | 7 | 165016.50 | 1.20 |
| | v. Other Leakage | t of natural gas released from pipelines | 0 | NO | NO | NO | t of natural gas released from pipelines | 0 | NO | NO | NO |
| | at industrial plants and power stations | NO | 0 | NO | NO | NO | NO | 0 | NO | NO | NO |
| | in residential and commercial sectors | NO | 0 | NO | NO | NO | NO | 0 | NO | NO | NO |
| ***France*** | Natural Gas | | | | | 69.03 | 0.0% | 0 | | | 47.81 |
| | i. Exploration | (specify) | 0 | NO | NO | NO | (specify) | 0 | NO | NO | NO |
| | ii. Production (4) / Processing | PJ Production | PJ | 309 | 2614.24 | 0.81 | PJ Production | PJ | 109 | 352.06 | 0.04 |
| | iii. Transmission | PJ Consumed | PJ | 1055 | 64640.52 | 68.23 | PJ Consumed | PJ | 1607 | 29719.81 | 47.77 |
| | iv. Distribution | (specify) | 0 | IE | IE | IE | (specify) | 0 | IE | IE | IE |
| | v. Other Leakage | (specify) | 0 | NO | NO | NO | (specify) | 0 | NO | NO | NO |
| | at industrial plants and power stations | (specify) | 0 | NO | NO | NO | (specify) | 0 | NO | NO | NO |
| | in residential and commercial sectors | (specify) | 0 | NO | NO | NO | (specify) | 0 | NO | NO | NO |
| ***Germany*** | Natural Gas | | | | | 322.97 | | | | | 329.18 |
| | i. Exploration | numbers of wells drilled | number | IE | IE | IE | numbers of wells drilled | number | IE | IE | IE |
| | ii. Production (4) / Processing | production and processing | TJ | 631232 | 91.04 | 57.47 | production and processing | TJ | 459650 | 89.08 | 40.95 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | iii. Transmission | pipelines and containers | TJ | 2292780 | 12.89 | 29.56 | pipelines and containers | TJ | 2936953 | 13.29 | 39.03 |
| | iv. Distribution | distribution net | km | 245852 | 811.74 | 199.57 | distribution net | km | 447039 | 428.64 | 191.62 |
| | v. Other Leakage | gas consumed | TJ | 893519 | 40.71 | 36.37 | gas consumed | TJ | 1370848 | 42.00 | 57.58 |
| | at industrial plants and power stations | gas consumed | TJ | IE | IE | IE | gas consumed | TJ | IE | IE | IE |
| | in residential and commercial sectors | gas consumed | TJ | 893519 | 40.71 | 36.37 | gas consumed | TJ | 1370848 | 42.00 | 57.58 |
| ***Greece*** | Natural Gas | | | | | 0.46 | 0.0% | 0 | | | 5.45 |
| | i. Exploration | (specify) | 0 | NO | NO | NO | (specify) | 0 | NO | NO | NO |
| | ii. Production (4) / Processing | Natural gas production | 10^6 m^3 | 123 | 3708.46 | 0.46 | Natural gas production | 10^6 m^3 | 11 | 351.36 | 0.00 |
| | iii. Transmission | Length of transmission pipeline | km | NO | NO | NO | Length of transmission pipeline | km | 1266 | 2551.12 | 3.23 |
| | iv. Distribution | Length of distribution mains | km | NO | NO | NO | Length of distribution mains | km | 3600 | 615.00 | 2.21 |
| | v. Other Leakage | (e.g. PJ gas consumed) | 0 | 11567 | IE | IE | (e.g. PJ gas consumed) | 0 | 248776 | IE | IE |
| | at industrial plants and power stations | NG consumption | TJ | 5783 | IE | IE | NG consumption | TJ | 124388 | IE | IE |
| | in residential and commercial sectors | NG Consumption | 0 | 5783 | IE | IE | NG Consumption | 0 | 124388 | IE | IE |
| ***Ireland*** | Natural Gas | | | | | 6.24 | 0.0% | 0 | | | 1.67 |
| | i. Exploration | 0.0% | 0 | IE | IE | IE | 0.0% | 0 | IE | IE | IE |
| | ii. Production (4) / Processing | PJ of Gas produced | PJ | 79 | 14330.75 | 1.13 | PJ of Gas produced | PJ | 13 | 454.35 | 0.01 |
| | iii. Transmission | (e.g. PJ gas consumed) | 0 | IE | IE | IE | (e.g. PJ gas consumed) | 0 | IE | IE | IE |
| | iv. Distribution | PJ of gas consumed | PJ | 24 | 214519.35 | 5.12 | PJ of gas consumed | PJ | 66 | 25218.83 | 1.67 |
| | v. Other Leakage | (e.g. PJ gas consumed) | PJ | NO | NO | NO | (e.g. PJ gas consumed) | PJ | NO | NO | NO |
| | at industrial plants and power stations | 0.0% | PJ | NO | NO | NO | 0.0% | PJ | NO | NO | NO |
| | in residential and commercial sectors | 0.0% | PJ | NO | NO | NO | 0.0% | PJ | NO | NO | NO |
| ***Italy*** | Natural Gas | | | | | 336.33 | 0.0% | 0 | | | 223.24 |
| | i. Exploration | not available | 0 | NA | IE | IE | not available | 0 | NA | IE | IE |
| | ii. Production (4) / Processing | (Mm3 gas produced) | 10^6 m^3 | 17296 | 2899.93 | 50.16 | (Mm3 gas produced) | 10^6 m^3 | 7909 | 1599.99 | 12.65 |
| | iii. Transmission | (Mm3 gas transported) | 10^6 m^3 | 45684 | 822.12 | 37.56 | (Mm3 gas transported) | 10^6 m^3 | 76900 | 434.29 | 33.40 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | iv. Distribution | (Mm3 gas transported) | 10^6 m^3 | 20632 | 12049.80 | 248.61 | (Mm3 gas transported) | 10^6 m^3 | 33975 | 5215.15 | 177.18 |
| | v. Other Leakage | (specify) | 0 | NA | IE | IE | (specify) | 0 | NA | IE | IE |
| | at industrial plants and power stations | (specify) | 0 | NA | IE | IE | (specify) | 0 | NA | IE | IE |
| | in residential and commercial sectors | (specify) | 0 | NA | IE | IE | (specify) | 0 | NA | IE | IE |
| | Natural Gas | | | | | 0.77 | 0.0% | 0 | | | 2.00 |
| | i. Exploration | gas exploration | 0 | NO | NO | NO | gas exploration | 0 | NO | NO | NO |
| | ii. Production (4) / Processing | gas produced | 0 | NO | NO | NO | gas produced | 0 | NO | NO | NO |
| | iii. Transmission | gas consumed | TJ | 18 | 13120.17 | 0.24 | gas consumed | TJ | 47 | 13070.24 | 0.61 |
| ***Luxembourg*** | iv. Distribution | gas consumed | TJ | 17933 | 30.07 | 0.54 | gas consumed | TJ | 46577 | 29.95 | 1.40 |
| | v. Other Leakage | (specify) | 0 | IE | IE | IE | (specify) | 0 | IE | IE | IE |
| | at industrial plants and power stations | gas leakage | 0 | IE | IE | IE | gas leakage | 0 | IE | IE | IE |
| | in residential and commercial sectors | gas leakage | 0 | IE | IE | IE | gas leakage | 0 | IE | IE | IE |
| | Natural Gas | | | | | 17.79 | 0.0% | 0 | | | 19.01 |
| | i. Exploration | number of wells drilled/tested | number | 79 | IE | IE | number of wells drilled/tested | number | 31 | IE | IE |
| | ii. Production (4) / Processing | gas produced | PJ | 2292 | IE | IE | gas produced | PJ | 2363 | IE | IE |
| | iii. Transmission | gas transported | PJ | 2648 | 2137.02 | 5.66 | gas transported | PJ | 3128 | 1953.39 | 6.11 |
| ***Netherlands*** | iv. Distribution | natural gas distribution network | 10^3 km | 100 | 121283.21 | 12.13 | natural gas distribution network | 10^3 km | 124 | 104449.39 | 12.90 |
| | v. Other Leakage | 0.0% | 0 | IE | IE | IE | 0.0% | 0 | IE | IE | IE |
| | at industrial plants and power stations | 0.0% | 0 | IE | IE | IE | 0.0% | 0 | IE | IE | IE |
| | in residential and commercial sectors | 0.0% | 0 | IE | IE | IE | 0.0% | 0 | IE | IE | IE |
| | Natural Gas | | | | | NO | 0.0% | 0 | | | 28.86 |
| | i. Exploration | 0.0% | 0 | NO | NO | NO | 0.0% | 0 | NO | NO | NO |
| ***Portugal*** | ii. Production (4) / Processing | 0.0% | 0 | NO | NO | NO | 0.0% | 0 | NO | NO | NO |
| | iii. Transmission | gas consumed | Gg | NO | NO | NO | gas consumed | Gg | 5375 | 5368.27 | 28.86 |
| | iv. Distribution | gas consumed | Gg | NO | NO | NO | gas consumed | Gg | IE | IE | IE |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | v. Other Leakage | 0.0% | 0 | NO | NO | NO | 0.0% | 0 | IE | IE | IE |
| | at industrial plants and power stations | gas consumed | 10^3 m^3 | NO | NO | NO | gas consumed | 10^3 m^3 | IE | IE | IE |
| | in residential and commercial sectors | gas consumed | 10^3 m^3 | NO | NO | NO | gas consumed | 10^3 m^3 | IE | IE | IE |
| ***Spain*** | Natural Gas | | | | | 19.99 | 0.0% | 0 | | | 21.98 |
| | i. Exploration | 0.0% | 0 | IE | IE | IE | 0.0% | 0 | IE | IE | IE |
| | ii. Production (4) / Processing | PJ gas produced (NCV) | PJ | 51 | 70657.76 | 3.62 | PJ gas produced (NCV) | PJ | 1 | 70657.76 | 0.05 |
| | iii. Transmission | PJ gas (NCV) | PJ | 218 | 759.33 | 0.17 | PJ gas (NCV) | PJ | 1341 | 496.75 | 0.67 |
| | iv. Distribution | PJ gas consumed (NCV) | PJ | 226 | 71758.21 | 16.20 | PJ gas consumed (NCV) | PJ | 1350 | 15749.07 | 21.27 |
| | v. Other Leakage | (e.g. PJ gas consumed) | 0 | NE | NE | NE | (e.g. PJ gas consumed) | 0 | NE | NE | NE |
| | at industrial plants and power stations | 0.0% | 0 | NE | NE | NE | 0.0% | 0 | NE | NE | NE |
| | in residential and commercial sectors | 0.0% | 0 | NE | NE | NE | 0.0% | 0 | NE | NE | NE |
| ***Sweden*** | Natural Gas | | | | | NO | 0.0% | 0 | | | NO |
| | i. Exploration | 0.0% | 0 | NO | NO | NO | 0.0% | 0 | NO | NO | NO |
| | ii. Production (4) / Processing | 0.0% | 0 | NO | NO | NO | 0.0% | 0 | NO | NO | NO |
| | iii. Transmission | Pressure levelling losses | TJ | NO | NO | NO | Pressure levelling losses | TJ | NO | NO | NO |
| | iv. Distribution | (e.g. PJ gas consumed) | 0 | NO | NO | NO | (e.g. PJ gas consumed) | 0 | NO | NO | NO |
| | v. Other Leakage | 0.0% | 0 | NO | NO | NO | 0.0% | 0 | NO | NO | NO |
| | at industrial plants and power stations | 0.0% | 0 | NO | NO | NO | 0.0% | 0 | NO | NO | NO |
| | in residential and commercial sectors | 0.0% | 0 | NO | NO | NO | 0.0% | 0 | NO | NO | NO |
| ***United Kingdom*** | Natural Gas | | | | | 405.04 | 0.0% | 0 | | | 204.47 |
| | i. Exploration | None | t | 225518 | 15.66 | 3.53 | None | t | 22880 | 45.00 | 1.03 |
| | ii. Production (4) / Processing | None | PJ | 1709 | 12758.51 | 21.81 | None | PJ | 2248 | 1388.88 | 3.12 |
| | iii. Transmission | None | TJ | IE | IE | IE | None | TJ | IE | IE | IE |
| | iv. Distribution | gas consumed | PJ | 1573 | 240730.77 | 378.78 | gas consumed | PJ | 3083 | 64676.72 | 199.40 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | v. Other Leakage | (specify) | 0 | 244841 | 3.75 | 0.92 | (specify) | 0 | 272877 | 3.37 | 0.92 |
| | at industrial plants and power stations | None | 0 | NO | NO | NO | None | 0 | NO | NO | NO |
| | in residential and commercial sectors | Natural gas supply | TJ | 244841 | 3.75 | 0.92 | Natural gas supply | TJ | 272877 | 3.37 | 0.92 |

Table 3.97 and Table 3.98 provide information on the contribution of Member States to EU-15 recalculations in $CO_2$ and $CH_4$ from 1B2 'Oil and natural gas' for 1990 and 2007 and main explanations for the largest recalculations in absolute terms.

**Table 3.97 1B2 Fugitive $CO_2$ emissions from Oil and natural gas: Contribution of MS to EU recalculations in $CO_2$ for 1990 and 2008 (difference between latest submission and previous submission in Gg of $CO_2$ equivalents and percent)**

| | 1990 | | 2008 | | Main explanations |
|---|---|---|---|---|---|
| | Gg CO2 equiv. | Percent | Gg CO2 equiv. | Percent | |
| Austria | 0 | 0.0 | 0 | 0.0 | |
| Belgium | 0 | 0.0 | 0 | 0.0 | |
| Denmark | 0 | 0.1 | 0 | 0.0 | |
| Finland | 0 | 0.0 | 0 | 0.3 | EF corrected. |
| France | 0 | 0.0 | 4 | 0.1 | |
| Germany | 273 | 18.9 | 307 | 20.9 | new CS emission factor for flares in refineries |
| Greece | 0 | 0.0 | 0 | 0.1 | Updated AD |
| Ireland | 0 | 0.0 | 0 | 0.0 | |
| Italy | 3 | 0.1 | 6 | 0.3 | addition of natural gasoline production; addition of CO2 emissions from transmission and distribution of natural gas |
| Luxembourg | - | 0.0 | - | 0.0 | |
| Netherlands | 0 | 0.0 | 0 | 0.0 | |
| Portugal | 0 | 0.2 | -99 | -11.5 | AD from Refineries has been revised based on EU-ETS data. |
| Spain | 0 | 0.0 | -15 | -0.7 | - Entering the emission factors of IPCC 2000 Good Practice Guidance for offshore plataforms instead of previous default CORINAIR emission factors. This has as consequence that the EFs have been armonized between onshore and offshore plataforms.<br>- Revision of the reported emissions for a refinery plant after having detected an error when entering for 2008 the same figures as for 2007. |
| Sweden | 0 | -0.1 | 94 | 11.8 | Revised activity data due to more complete information. |
| UK | 0 | 0.0 | -141 | -3.2 | - Revision to method for calculation of weighted average composition of natural gas<br>- Revisions to EEMS<br>- New source - gas leakage at point of use<br>- Change to reporting. Offshore oil and gas processing activities reported separately to aid transparency. |
| **EU-15** | **275** | **1.5** | **155** | **0.9** | |

**Table 3.98** **1B2 Fugitive $CH_4$ emissions from Oil and natural gas: Contribution of MS to EU-15 recalculations in $CH_4$ for 1990 and 2008 (difference between latest submission and previous submission in Gg of $CO_2$ equivalents and percent)**

| | 1990 | | 2008 | | Main explanations |
|---|---|---|---|---|---|
| | Gg CO2 equiv. | Percent | Gg CO2 equiv. | Percent | |
| Austria | -1 | -0.6 | 2 | 0.8 | Elimination of transcription error |
| Belgium | 0 | 0.0 | 0 | 0.0 | |
| Denmark | 0 | 0.1 | -1 | -1.1 | EF corrected according to conversion between Sm3 and Nm3. |
| Finland | 0 | -0.7 | 0 | 0.0 | |
| France | -1,234 | -44.3 | -729 | -38.0 | Mise a jour de la méthodologie d'estimation des émissions par GDF |
| Germany | -20 | -0.3 | 186 | 2.6 | - improved CS emission factors for storage of mineral products<br>- improved CS emission factors for refueling processes<br>- marginal changes in energy balance<br>- new CS emission factor for flares in refineries |
| Greece | 0 | 0.0 | 12 | 7.5 | Updated AD |
| Ireland | 0 | 0.1 | 0 | 0.6 | Inclusion of an additional source of fugitive methane emissions from Oil Refining and Storage |
| Italy | 0 | 0.0 | -40 | -0.8 | addition of natural gasoline production |
| Luxembourg | -2 | -9.8 | -5 | -10.4 | Activity data was revised, in the previous submission, the energy of gas consumed was calculated based on GCV, and this was recalculated now based on NCV (1990-2009). |
| Netherlands | 4 | 0.3 | 6 | 0.7 | |
| Portugal | 1 | 1.1 | 0 | 0.0 | AD from Refineries has been revised based on EU-ETS data. |
| Spain | 27 | 4.7 | 5 | 0.9 | - Entering the emission factors of IPCC 2000 Good Practice Guidance for offshore plataforms instead of previous default CORINAIR emission factors. This has as consequence that the EFs have been armonized between onshore and offshore plataforms.<br>- Updating of background information (network length as per operation and material type). This has enabled reestimation for those regions that have actual consumption of natural gas. |
| Sweden | -4 | -18.1 | -3 | -14.8 | Revised activity data due to more complete information. |
| UK | 19 | 0.2 | -21 | -0.4 | - Revision to method for calculation of weighted average composition of natural gas<br>- Revisions to EEMS<br>- New source - gas leakage at point of use<br>- Change to reporting. Offshore oil and gas processing activities reported separately to aid transparency. |
| **EU-15** | **-1,209** | **-3.9** | **-589** | **-2.6** | |

# 3.3 Methodological issues and uncertainties (EU-15)

The previous section presented for each EU-15 key source in CRF Sector 1 an overview of the Member States' contributions to the key source in terms of level and trend, and information on methodologies, emission factors, completeness and qualitative uncertainty estimates. Detailed information on national methods and circumstances is available in the Member States' national inventory reports.

Table 3.99 shows the total EU-15 uncertainty estimates for the sector 'Energy' excluding 1A3 'Transport' and the uncertainty estimates for the relevant gases for each source category. For those emissions for which no split by source category was available, uncertainty estimates were made for stationary combustion as a whole. The highest level uncertainty was estimated for $N_2O$ from 1A4 (biomass) and the lowest for $CO_2$ from 1A1b (gaseous fuels). With regard to trend $CH_4$ from 1A1 (biomass) shows the highest uncertainty estimates, $CO_2$ from 1A1a (solid fuels) the lowest. For a description of the Tier 1 uncertainty analysis carried out for the EU-15 see Chapter 1.7.

**Table 3.99 Sector 1 Energy (excl. 1A3b and 1B): Uncertainty estimates for EU-15**

| Source category | Fuel | Gas | Emissions 1990 | Emissions 2009 | Emission trends 1990-2009 | Level uncertainty estimates based on MS uncertainty estimates | Trend uncertainty estimates based on MS uncertainty estimates |
|---|---|---|---|---|---|---|---|
| 1.A.1.a Public electricity and heat production | Gaseous | $CO_2$ | 60,419 | 255,377 | 323% | 1.2% | 3.6 |
| 1.A.1.a Public electricity and heat production | Liquid | $CO_2$ | 123,501 | 43,678 | -65% | 3.1% | 4.4 |
| 1.A.1.a Public electricity and heat production | Other | $CO_2$ | 12,660 | 32,295 | 155% | 2.9% | 4.4 |
| 1.A.1.a Public electricity and heat production | Solid | $CO_2$ | 752,396 | 556,020 | -26% | 2.0% | 0.4 |
| 1.A.1.b Petroleum refining | Gaseous | $CO_2$ | 3,846 | 12,098 | 215% | 1.1% | 3.3 |
| 1.A.1.b Petroleum refining | Liquid | $CO_2$ | 97,195 | 102,064 | 5% | 4.6% | 1.2 |
| 1.A.1.b Petroleum refining | Other | $CO_2$ | 174 | 35 | -80% | 7.2% | 6.0 |
| 1.A.1.b Petroleum refining | Solid | $CO_2$ | 97,195 | 102,064 | 5% | 2.4% | 4.7 |
| 1.A.1.c Manufacture of solid fuels | Gaseous | $CO_2$ | 16,968 | 20,408 | 20% | 2.5% | 1.0 |
| 1.A.1.c Manufacture of solid fuels | Liquid | $CO_2$ | 3,316 | 2,336 | -30% | 10.7% | 7.0 |
| 1.A.1.c Manufacture of solid fuels | Other | $CO_2$ | 456 | 504 | 11% | 5.3% | 6.7 |
| 1.A.1.c Manufacture of solid fuels | Solid | $CO_2$ | 82,793 | 24,680 | -70% | 3.2% | 3.6 |
| 1.A.2.a Iron and Steel | Gaseous | $CO_2$ | 17,446 | 13,925 | -20% | 1.7% | 0.6 |
| 1.A.2.a Iron and Steel | Liquid | $CO_2$ | 7,520 | 3,996 | -47% | 4.2% | 1.8 |
| 1.A.2.a Iron and Steel | Other | $CO_2$ | 3 | 1 | -75% | 0.0% | - |
| 1.A.2.a Iron and Steel | Solid | $CO_2$ | 93,103 | 50,542 | -46% | 1.9% | 1.0 |
| 1.A.2.b Non-Ferous Metals | Gaseous | $CO_2$ | 2,390 | 3,977 | 66% | 1.6% | 1.9 |
| 1.A.2.b Non-Ferous Metals | Liquid | $CO_2$ | 3,642 | 2,822 | -23% | 6.5% | 1.1 |
| 1.A.2.b Non-Ferous Metals | Other | $CO_2$ | 9 | 5 | -42% | 0.0% | 6.4 |
| 1.A.2.b Non-Ferous Metals | Solid | $CO_2$ | 3,351 | 367 | -89% | 6.7% | 4.5 |
| 1.A.2.c Chemicals | Gaseous | $CO_2$ | 27,778 | 28,216 | 2% | 2.0% | 1.1 |
| 1.A.2.c Chemicals | Liquid | $CO_2$ | 36,797 | 19,479 | -47% | 2.4% | 1.3 |
| 1.A.2.c Chemicals | Other | $CO_2$ | 3,603 | 5,815 | 61% | 20.0% | 17.3 |
| 1.A.2.c Chemicals | Solid | $CO_2$ | 7,523 | 3,424 | -54% | 5.1% | 1.8 |
| 1.A.2.d Pulp, Paper and Print | Gaseous | $CO_2$ | 10,580 | 15,392 | 45% | 2.0% | 1.6 |
| 1.A.2.d Pulp, Paper and Print | Liquid | $CO_2$ | 9,549 | 3,916 | -59% | 2.6% | 1.3 |
| 1.A.2.d Pulp, Paper and Print | Other | $CO_2$ | 1,234 | 1,255 | 2% | 6.1% | 0.4 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1.A.2.d Pulp, Paper and Print | Solid | $CO_2$ | 3,456 | 770 | -78% | 3.0% | 4.3 |
| 1.A.2.e Food Processing, Beverages and Tobacco | Gaseous | $CO_2$ | 12,682 | 20,240 | 60% | 1.8% | 1.2 |
| 1.A.2.e Food Processing, Beverages and Tobacco | Liquid | $CO_2$ | 13,947 | 6,662 | -52% | 4.4% | 1.4 |
| 1.A.2.e Food Processing, Beverages and Tobacco | Other | $CO_2$ | 147 | 39 | -74% | 6.4% | 4.4 |
| 1.A.2.e Food Processing, Beverages and Tobacco | Solid | $CO_2$ | 4,841 | 1,338 | -72% | 4.3% | 2.0 |
| 1.A.2.f Other | Gaseous | $CO_2$ | 103,558 | 118,850 | 15% | 1.5% | 0.7 |
| 1.A.2.f Other | Liquid | $CO_2$ | 122,484 | 87,773 | -28% | 5.7% | 2.6 |
| 1.A.2.f Other | Other | $CO_2$ | 3,277 | 12,250 | 274% | 3.0% | 7.3 |
| 1.A.2.f Other | Solid | $CO_2$ | 138,805 | 45,234 | -67% | 2.1% | 1.5 |
| 1.A.4.a Commercial/Institutional | Gaseous | $CO_2$ | 60,114 | 99,224 | 65% | 4.8% | 1.8 |
| 1.A.4.a Commercial/Institutional | Liquid | $CO_2$ | 75,892 | 43,881 | -42% | 4.9% | 2.1 |
| 1.A.4.a Commercial/Institutional | Other | $CO_2$ | 1,048 | 3,104 | 196% | 4.6% | 11.7 |
| 1.A.4.a Commercial/Institutional | Solid | $CO_2$ | 27,789 | 2,099 | -92% | 9.7% | 6.2 |
| 1.A.4.b Residential | Gaseous | $CO_2$ | 161,940 | 230,837 | 43% | 6.2% | 1.6 |
| 1.A.4.b Residential | Liquid | $CO_2$ | 169,468 | 130,201 | -23% | 5.2% | 1.0 |
| 1.A.4.b Residential | Other | $CO_2$ | 86 | 72 | -17% | 6.5% | 1.0 |
| 1.A.4.b Residential | Solid | $CO_2$ | 74,513 | 10,858 | -85% | 8.0% | 5.6 |
| 1.A.4.c Agriculture/Forestry/Fisheries | Gaseous | $CO_2$ | 8,716 | 10,073 | 16% | 7.5% | 1.0 |
| 1.A.4.c Agriculture/Forestry/Fisheries | Liquid | $CO_2$ | 56,758 | 49,680 | -12% | 6.5% | 0.8 |
| 1.A.4.c Agriculture/Forestry/Fisheries | Other | $CO_2$ | 40 | 60 | 48% | 6.4% | 3.0 |
| 1.A.4.c Agriculture/Forestry/Fisheries | Solid | $CO_2$ | 3,712 | 435 | -88% | 9.7% | 8.9 |
| 1.A.5.a Stationary | Gaseous | $CO_3$ | 565 | 616 | 9% | 4.5% | 4.5 |
| 1.A.5.a Stationary | Liquid | $CO_2$ | 2,215 | 673 | -70% | 4.5% | 4.5 |
| 1.A.5.a Stationary | Other | $CO_2$ | 24 | 0 | -100% | 0.0% | 6.4 |
| 1.A.5.a Stationary | Solid | $CO_2$ | 4,667 | 10 | -100% | 4.5% | 4.5 |
| 1.A.5.b Mobile | Gaseous | $CO_2$ | 0 | 0 | - | 0.0% | - |
| 1.A.5.b Mobile | Liquid | $CO_2$ | 13,672 | 5,062 | -63% | 11.4% | 5.0 |
| 1.A.5.b Mobile | Other | $CO_3$ | 0 | 0 | - | 0.0% | - |
| 1.A.5.b Mobile | Solid | $CO_2$ | 0 | 0 | - | 0.0% | - |
| 1.A.1 Energy Industries | Biomass | $CH_4$ | 107 | 1,574 | 1365% | 53.8% | 969.2 |
| 1.A.1 Energy Industries | Gaseous | $CH_4$ | 257 | 686 | 167% | 33.8% | 129.0 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1.A.1 Energy Industries | Liquid | $CH_4$ | 158 | 91 | -42% | 47.9% | 17.4 |
| 1.A.1 Energy Industries | Other | $CH_4$ | 25 | 46 | 85% | 30.7% | 23.1 |
| 1.A.1 Energy Industries | Solid | $CH_4$ | 418 | 207 | -50% | 46.3% | 18.5 |
| 1.A.2 Manufacturing industries and construction | Biomass | $CH_4$ | 161 | 212 | 32% | 48.0% | 12.3 |
| 1.A.2 Manufacturing industries and construction | Gaseous | $CH_4$ | 237 | 746 | 215% | 121.4% | 553.4 |
| 1.A.2 Manufacturing industries and construction | Liquid | $CH_4$ | 186 | 111 | -40% | 51.9% | 12.6 |
| 1.A.2 Manufacturing industries and construction | Other | $CH_4$ | 14 | 22 | 50% | 40.9% | 24.1 |
| 1.A.2 Manufacturing industries and construction | Solid | $CH_4$ | 699 | 300 | -57% | 44.7% | 16.1 |
| 1.A.4 Other Sectors | Biomass | $CH_4$ | 6,065 | 4,511 | -26% | 57.5% | 46.4 |
| 1.A.4 Other Sectors | Gaseous | $CH_4$ | 644 | 1,776 | 176% | 44.1% | 107.3 |
| 1.A.4 Other Sectors | Liquid | $CH_4$ | 443 | 316 | -29% | 54.4% | 10.1 |
| 1.A.4 Other Sectors | Other | $CH_4$ | 19 | 23 | 23% | 66.6% | 111.1 |
| 1.A.4 Other Sectors | Solid | $CH_4$ | 4,266 | 555 | -87% | 49.8% | 23.1 |
| 1.A.5 Other | Biomass | $CH_4$ | 0 | 0 | -98% | 0.0% | 43.4 |
| 1.A.5 Other | Gaseous | $CH_4$ | 0 | 0 | 310% | 0.0% | 218.0 |
| 1.A.5 Other | Liquid | $CH_4$ | 37 | 9 | -76% | 0.0% | 22.7 |
| 1.A.5 Other | Other | $CH_4$ | 0 | 0 | -100% | 0.0% | 61.4 |
| 1.A.5 Other | Solid | $CH_4$ | 210 | 0 | -100% | 0.0% | 36.4 |
| 1.A.1 Energy Industries | Biomass | $N_2O$ | 171 | 1,008 | 489% | 53.4% | 189.6 |
| 1.A.1 Energy Industries | Gaseous | $N_2O$ | 390 | 1,102 | 183% | 347.8% | 1321.5 |
| 1.A.1 Energy Industries | Liquid | $N_2O$ | 1,154 | 962 | -17% | 208.6% | 28.0 |
| 1.A.1 Energy Industries | Other | $N_2O$ | 180 | 545 | 203% | 163.4% | 298.6 |
| 1.A.1 Energy Industries | Solid | $N_2O$ | 7,154 | 4,966 | -31% | 66.1% | 12.4 |
| 1.A.2 Manufacturing industries and construction | Biomass | $N_2O$ | 446 | 745 | 67% | 185.0% | 86.9 |
| 1.A.2 Manufacturing industries and construction | Gaseous | $N_2O$ | 813 | 1,068 | 31% | 214.9% | 191.4 |
| 1.A.2 Manufacturing industries and construction | Liquid | $N_2O$ | 3,230 | 2,674 | -17% | 153.0% | 12.7 |
| 1.A.2 Manufacturing industries and construction | Other | $N_2O$ | 67 | 171 | 157% | 67.6% | 113.5 |
| 1.A.2 Manufacturing industries and con- | Solid | $N_2O$ | 2,252 | 806 | -64% | 54.4% | 41.2 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| struction | | | | | | | |
| 1.A.4 Other Sectors | Biomas s | $N_2O$ | 1,057 | 1,482 | 40% | 221.5% | 87.3 |
| 1.A.4 Other Sectors | Gaseous | $N_2O$ | 792 | 1,303 | 65% | 69.7% | 63.3 |
| 1.A.4 Other Sectors | Liquid | $N_2O$ | 3,643 | 2,939 | -19% | 201.6% | 16.1 |
| 1.A.4 Other Sectors | Other | $N_2O$ | 23 | 92 | 296% | 60.4% | 183.4 |
| 1.A.4 Other Sectors | Solid | $N_2O$ | 1,046 | 203 | -81% | 52.7% | 24.3 |
| 1.A.5 Other | Biomas s | $N_2O$ | 0 | 0 | -94% | 0.0% | 34.3 |
| 1.A.5 Other | Gaseous | $N_2O$ | 1 | 2 | 76% | 0.0% | 1131.3 |
| 1.A.5 Other | Liquid | $N_2O$ | 225 | 126 | -44% | 0.0% | 41.5 |
| 1.A.5 Other | Other | $N_2O$ | 439 | 229 | -48% | 0.0% | 20.9 |
| 1.A.5 Other | Solid | $N_2O$ | 15 | 0 | -99% | 0.0% | 59.7 |
| Total | | all | 2,483,294 | 2,350,995 | -5% | 1.1% | 0.5 |

*Note:* *Emissions are in Gg $CO_2$ equivalents; trend uncertainty is presented as percentage points; the sum of the source category emissions may not be the total sector emissions because uncertainty estimates are not available for all source categories; uncertainty estimates for Portugal are not included.*

Table 3.100 shows the total EU-15 uncertainty estimates for the sector 1.B 'Fugitive emissions' and the uncertainty estimates for the relevant gases for each source category. The highest level and trend uncertainties were estimated for $CH_4$ from 1B2c and the lowest for $CO_2$ from 1B2b.

**Table 3.100 1B Fugitive Emissions: Uncertainty estimates for EU-15**

| Source category | Gas | Emissions 1990 | Emissions 2009 | Emission trends 1990-2009 | Level uncertainty estimates based on MS uncertainty estimates | Trend uncertainty estimates based on MS uncertainty estimates |
|---|---|---|---|---|---|---|
| 1.B.1.a Coal Mining and Handling | $CO_2$ | 9 | 0 | -100% | 0.0% | - |
| 1.B.1.b Solid Fuel Transformation | $CO_2$ | 1,277 | 1,016 | -20% | 33.8% | 6.6 |
| 1.B.1.c Other | $CO_2$ | 5 | 4 | -14% | 7.1% | 13.0 |
| 1.B.2.a Oil | $CO_2$ | 8,514 | 9,421 | 11% | 121.5% | 53.3 |
| 1.B.2.b Natural Gas | $CO_2$ | 3,270 | 2,283 | -30% | 19.5% | 18.3 |
| 1.B.2.c Venting and Flaring | $CO_2$ | 6,449 | 5,735 | -11% | 150.0% | 143.7 |
| 1.B.2.d Other | $CO_2$ | 778 | 662 | -15% | 0.0% | - |
| 1.B.1.a Coal Mining and Handling | $CH_4$ | 44,022 | 8,613 | -80% | 0.0% | - |
| 1.B.1.b Solid Fuel Transformation | $CH_4$ | 238 | 145 | -39% | 20.6% | 35.3 |
| 1.B.1.c Other | $CH_4$ | 1,807 | 134 | -93% | 9.0% | 6.3 |
| 1.B.2.a Oil | $CH_4$ | 1,885 | 1,230 | -35% | 88.6% | 3.9 |
| 1.B.2.b Natural Gas | $CH_4$ | 25,379 | 19,230 | -24% | 7.4% | 3.8 |
| 1.B.2.c Venting and Flaring | $CH_4$ | 2,862 | 1,261 | -56% | 23.5% | 7.2 |
| 1.B.2.d Other | $CH_4$ | 10 | 10 | - | 18.3% | 8.1 |
| 1.B.1.a Coal Mining and Handling | $N_2O$ | 0 | 0 | - | 11.7% | 3.7 |
| 1.B.1.b Solid Fuel Transformation | $N_2O$ | 2 | 1 | -56% | 24.9% | 11.2 |
| 1.B.1.c Other | $N_2O$ | 0 | 0 | -17% | 0.0% | - |
| 1.B.2.a Oil | $N_2O$ | 39 | 33 | -15% | 30.6% | 56.3 |
| 1.B.2.b Natural Gas | $N_2O$ | 0 | 0 | - | 0.0% | - |
| 1.B.2.c Venting and Flaring | $N_2O$ | 59 | 49 | -16% | 107.3% | 8.4 |
| 1.B.2.d Other | $N_2O$ | 11 | 12 | 5% | 0.0% | - |
| Total | all | 96,617 | 49,841 | -48% | 20.7% | 21 |

*Note: Emissions are in Gg $CO_2$ equivalents; trend uncertainty is presented as percentage points; the sum of the source category emissions may not be the total sector emissions because uncertainty estimates are not available for all source categories; uncertainty estimates for Portugal are not included.*

Table 3.101 shows the total EU-15 uncertainty estimates for the sector 1A3 ‘Transport’ and the uncertainty estimates for the relevant gases for each source category. The highest uncertainty was estimated for $N_2O$ from 1A3d and the lowest for $CO_2$ from 1A3c. With regard to trend $N_2O$ from 1A3a shows the highest uncertainty estimates, $CO_2$ from 1A3e the lowest.

Table 3.101 1A3 Transport: Uncertainty estimates for EU-15

| Source category | Gas | Emissions 1990 | Emissions 2009 | Emission trends 1990-2009 | Level uncertainty estimates based on MS uncertainty estimates | Trend uncertainty estimates based on MS uncertainty estimates |
|---|---|---|---|---|---|---|
| 1.A.3.a Civil aviation | $CO_2$ | 488 | 359 | -26% | 6.6% | 3 |
| 1.A.3.a Civil aviation | $CO_2$ | 13,237 | 17,976 | 36% | 4.6% | 1 |
| 1.A.3.b Road transport | $CO_2$ | 362,786 | 259,441 | -28% | 5.4% | 1 |
| 1.A.3.b Road transport | $CO_2$ | 266,862 | 505,711 | 90% | 4.2% | 2 |
| 1.A.3.b Road transport | $CO_2$ | 7,283 | 6,071 | -17% | 7.2% | 7 |
| 1.A.3.b Road transport | $CO_2$ | 494 | 1,811 | 267% | 3.8% | 10 |
| 1.A.3.c Railways | $CO_2$ | 7,783 | 5,309 | -32% | 3.7% | 2 |
| 1.A.3.c Railways | $CO_2$ | 63 | 19 | -70% | 1.1% | 8 |
| 1.A.3.c Railways | $CO_2$ | 0 | 0 | - | - | - |
| 1.A.3.c Railways | $CO_2$ | 0 | 0 | - | - | - |
| 1.A.3.d Navigation | $CO_2$ | 6,698 | 6,347 | -5% | 6.8% | 3 |
| 1.A.3.d Navigation | $CO_2$ | 9,323 | 10,473 | 12% | 7.3% | 1 |
| 1.A.3.d Navigation | $CO_2$ | 1,104 | 1,294 | 17% | 2.7% | 1 |
| 1.A.3.d Navigation | $CO_2$ | 0 | 0 | - | - | - |
| 1.A.3.d Navigation | $CO_2$ | 0 | 0 | - | - | - |
| 1.A.3.e Other | $CO_2$ | 4,720 | 4,329 | -8% | 31.0% | 8 |
| 1.A.3.e Other | $CO_2$ | 0 | 0 | - | - | - |
| 1.A.3.e Other | $CO_2$ | 1,741 | 3,245 | 86% | 12.2% | 5 |
| 1.A.3.e Other | $CO_2$ | 0 | 0 | - | - | - |
| 1.A.3.a Civil aviation | $CH_4$ | 12 | 8 | -30% | 61.9% | 15 |
| 1.A.3.b Road transport | $CH_4$ | 4,536 | 1,207 | -73% | 16.4% | 11 |
| 1.A.3.c Railways | $CH_4$ | 12 | 8 | -29% | 60.1% | 15 |
| 1.A.3.d Navigation | $CH_4$ | 53 | 53 | 1% | 54.3% | 6 |
| 1.A.3.e Other | $CH_4$ | 16 | 19 | 19% | 47.3% | 12 |
| 1.A.3.a Civil aviation | $N_2O$ | 147 | 187 | 28% | 149.8% | 31 |
| 1.A.3.b Road transport | $N_2O$ | 5,264 | 7,561 | 44% | 27.7% | 10 |
| 1.A.3.c Railways | $N_2O$ | 346 | 334 | -3% | 146.8% | 30 |
| 1.A.3.d Navigation | $N_2O$ | 148 | 151 | 2% | 202.7% | 37 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 1.A.3.e Other | $N_2O$ | 84 | 126 | 50% | 89.2% | 43 |
| Total | all | 693,740 | 855,786 | 23% | 3.0% | 1 |

*Note:* *Emissions are in Gg $CO_2$ equivalents; trend uncertainty is presented as percentage points; the sum of the source category emissions may not be the total sector emissions because uncertainty estimates are not available for all source categories; uncertainty estimates for Portugal are not included..*

## 3.4 Sector-specific quality assurance and quality control (EU-15)

There are several activities for improving the quality of GHG emissions from energy: Before and during the compilation of the EU GHG inventory, several checks are made of the Member States data in particular for time series consistency of emissions and implied emission factors, comparisons of implied emission factors across Member States and checks of internal consistency. In the second half of the year, the EU internal review is carried out for selected source categories. In 2006 the following source categories have been reviewed by Member States experts: 1A1 'Energy industries', 1A2a 'Iron and steel production' and 1.B 'Fugitive emissions from fuels'. In 2005, the EU internal review was carried out for the first time. In this pilot exercise two Member States experts reviewed the source categories 1A2 'Manufacturing industries' and 1A3 'Transport'. In 2008, $N_2O$ from road transport were subject to the EU internal review.

Since the inventory 2005 plant-specific data is available from the EU Emission Trading Scheme (EU ETS). This information has been used by EU Member States for quality checks and as input for calculating total $CO_2$ emissions for the sectors Energy and Industrial Processes in this report (see Section 1.4.2).

After the annual compilation of the GHG inventory Eurostat checks with Member States remaining differences found when comparing the Member States’ reference approach with the Eurostat reference approach. This crosscheck between the the European energy reporting system and the EU GHG inventory system is an important QA/QC element of the EU GHG inventrory compilation.

The quality of the EU GHG inventory is directly affected by the quality of Member States and EU energy statistics systems. Currently EU energy statistics are collected on the basis of gentlemen's' agreement. The Joint Eurostat/IEA/UNECE energy questionnaires are used for gathering nationally collected data. Since its creation in the early fifties, when the European energy statistics were essentially a collection of the main national aggregated data, the system has followed the development of energy policies and markets and adapted to meet new demands. Recent developments have been:

- a new questionnaire (in 2000) covering Renewable Energy Sources; intensive efforts at national level and EU financial support since the early 1990's lead to the successful adoption of this questionnaire alongside the already established existing four joint questionnaires
- expanded electricity questionnaire (in 2004) to allow coherence with the UNFCCC $CO_2$ emissions reporting system
- development of CHP (2004) statistics, following pilot projects over a decade

In 2007 the Commission presented the energy statistics regulation as part of the energy package. This regulation aims at collecting detailed statistical data on energy flows by energy commodity at annual and monthly level. It ensures harmonised and coherent reporting of national energy data, which is indispensable for the assessment of EU energy policies and targets. The content and structure of this regulation reflects the essence of the existing European statistical system, a system that is part of the international energy statistical system, and is in direct link with the national statistical structures (classifications) and methodologies. It also has concrete links to other statistical domains, such as economic, environment, trade and business statistics. These links provide an additional dimension in safeguarding data quality assurance. The energy statistics regulation was adopted by the European Parliament and Council in 2008 and is in force since 2009.

The European energy statistics system and the quality of the EU inventory is directly affected by this regulation that should:

- ensure a stable and institutional basis for energy statistics in the EU,
- guarantee long-term availability of energy data for EU policies,
- reinforce available resources for the production of the basic energy statistics at national level

The energy statistics regulation should help improving the QA/QC of the EU inventory as it should:

- make available more detailed energy statistics by fuel,
- allow the estimation of $CO_2$ emissions from energy with the reference and sectoral approach
- assure the quality of the underlying energy statistics
- improve timeliness of energy statistics
- provide a formal legal framework assuring consistency between national and Eurostat data

Moreover, Article 6, paragraph 2 stipulates that:

*'Every reasonable effort shall be undertaken to ensure coherence between energy data declared in the energy statistics regulation, and data declared in accordance with Commission Decision No 280/2004/EC of the European Parliament and of the Council concerning a mechanism for monitoring Community greenhouse gas emissions and for implementing the Kyoto Protocol'.*

It also foresees the further development of the energy statistics system setting a time frame for the production of more detailed data on renewable energy and final energy consumption, stating:

*'With a view to improving the quality of energy statistics, the Commission (Eurostat), in collaboration with the Member States, shall make sure that these statistics are comparable, transparent, detailed and flexible by:*

*a) reviewing the methodology used to generate renewable energy statistics in order to make available additional, pertinent, detailed statistics on each renewable energy source, annually and in a cost effective manner. The Commission (Eurostat) shall present and disseminate the statistics generated from 2010 (reference year) onwards*

*b) reviewing and determining the methodology used at national and Community level to generate final energy consumption statistics (sources, variables, quality, costs) based on the current state of play, existing studies and feasibility pilot-studies, as well as cost-benefit analysis yet to be conducted; and evaluating the findings of the pilot studies and cost benefit analysis with the view to establishing breakdown keys for final energies by sector and main energy uses and gradually integrating the resulting elements in the statistics from 2012 (reference year) onwards.'*

The first annual statistics based were submitted to Eurostat on the basis of Energy Statistics Regulation in November 2010. The following improvements were observed:

- Information submission was more timely than in previous years, resulting to the availability of complete reference approach tables for 2009 by the end of February 2011;
- More detailed data are also used for the calculation of the reference approach, (availability of data on international aviation);
- More detailed energy balances are published by Eurostat.

## 3.5 Sector-specific recalculations (EU-15)

Table 3.102 shows that in the energy sector the largest recalculations in absolute terms in 1990 and 2008 were made for $CO_2$. In relative terms, the largest recalculations are found in $N_2O$ emissions. They were +1.2 % and +3.7 % in 1990 and 2008, respectively.

**Table 3.102 Sector 1 Energy: Recalculations of total GHG emissions and recalculations of GHG emissions for the years 1990 and 2008 by gas in Gg ($CO_2$-eq.) and percentage**

| 1990 | $CO_2$ | | $CH_4$ | | $N_2O$ | | HFCs | | PFCs | | $SF_6$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Gg | percent | Gg | percent | Gg | percent | Gg | percent | Gg | percent | Gg | percent |
| Total emissions and removals | -17,295 | -0.6% | 13,980 | 3.2% | 8,543 | 2.2% | 47 | 0.2% | 6 | 0.0% | 11 | 0.1% |
| Energy | 20,012 | 0.6% | -722 | -0.8% | 333 | 1.2% | NO | NO | NO | NO | NO | NO |
| **2008** | | | | | | | | | | | | |
| Total emissions and removals | -21,852 | -0.7% | 14,673 | 4.9% | 9,128 | 3.2% | 660 | 1.1% | 77 | 2.7% | -2,603 | -29.0% |
| Energy | 28,412 | 0.9% | -1,193 | -2.7% | 1,067 | 3.7% | NO | NO | NO | NO | NO | NO |

*NO: not occurring*

Table 3.103 provides an overview of Member States' contributions to EU-15 recalculations. In absolute terms, Germany and the UK had the most influence on $CO_2$ recalculations in the EU-15 in 2008. The German and UK recalculations are due to a variety of changes, which are reported in chapter 3.2 in the source categories subchapters. $N_2O$ recalculations were mainly influenced by France due to a revision of COPERT equations. Further explanations for the largest recalculations by Member State are provided in Section 10.1.

**Table 3.103 Sector 1 Energy: Contribution of Member States to EU-15 recalculations for 1990 and 2007 by gas (difference between latest submission and previous submission Gg of $CO_2$ equivalents)**

| | 1990 | | | | | | 2008 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $CO_2$ | $CH_4$ | $N_2O$ | HFCs | PFCs | $SF_6$ | $CO_2$ | $CH_4$ | $N_2O$ | HFCs | PFCs | $SF_6$ |
| Austria | 0 | -1 | 0 | NO | NO | NO | 278 | -5 | 11 | NO | NO | NO |
| Belgium | -539 | 10 | 1 | NO | NO | NO | 1,482 | -5 | 58 | NO | NO | NO |
| Denmark | -200 | 2 | -72 | NO | NO | NO | -57 | -1 | -47 | NO | NO | NO |
| Finland | -33 | 0 | -2 | NO | NO | NO | 73 | 0 | -1 | NO | NO | NO |
| France | -2,589 | -688 | 501 | NO | NO | NO | -688 | -536 | 977 | NO | NO | NO |
| Germany | 29,450 | -31 | -40 | NO | NO | NO | 37,253 | -476 | 27 | NO | NO | NO |
| Greece | -159 | -20 | 0 | NO | NO | NO | 178 | 0 | 48 | NO | NO | NO |
| Ireland | 3 | -11 | -14 | NO | NO | NO | 157 | -3 | -37 | NO | NO | NO |
| Italy | -46 | 1 | 14 | NO | NO | NO | -2,108 | -38 | 41 | NO | NO | NO |
| Luxembourg | -288 | -2 | 1 | NO | NO | NO | -202 | -4 | -2 | NO | NO | NO |
| Netherlands | -52 | -5 | 0 | NO | NO | NO | -176 | -54 | 7 | NO | NO | NO |
| Portugal | 0 | -20 | -16 | NO | NO | NO | -224 | -11 | -51 | NO | NO | NO |
| Spain | -2,101 | 27 | 10 | NO | NO | NO | -2,267 | -36 | 42 | NO | NO | NO |
| Sweden | -18 | -4 | 0 | NO | NO | NO | -592 | 8 | -5 | NO | NO | NO |
| UK | -3,416 | 19 | -48 | NO | NO | NO | -4,696 | -30 | 0 | NO | NO | NO |
| **EU-15** | **20,012** | **-722** | **333** | **NO** | **NO** | **NO** | **28,412** | **-1,193** | **1,067** | **NO** | **NO** | **NO** |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

## 3.6 Comparison between the sectoral approach and the reference approach (EU-15)

The IPCC reference approach for $CO_2$ from fossil fuels for the EU-15 is based on Eurostat energy data (NewCronos database, April 2011 version). This submission includes the reference approach tables for 1990–2009.

Energy statistics are submitted to Eurostat by Member States on an annual basis with the five joint Eurostat/IEA/UNECE questionnaires on solid fuels, oil, natural gas, electricity and heat, and renewables and wastes. On the basis of this information Eurostat compiles the annual energy balances which are used for the estimation of $CO_2$ emissions from fossil fuels by Member State and for the EU-15 as a whole.

The Eurostat data for the EU-15 IPCC reference approach includes activity data, net calorific values and carbon emission factors as available in the Eurostat NewCronos database. In the CRF Table 1.A(b) some fuel categories are grouped and average net calorific values are used: 'Orimulsion' is included in 'Residual fuel oil'. 'Natural gas liquids' is included in 'Crude oil'. 'Other kerosene' is included in 'Total kerosene'. 'Anthracite', 'Coking coal' and 'Other bituminous coal' are referred to in the Eurostat NewCronos database as 'Hard coal' and are included in CRF Table 1.A(b) under 'Other bituminous coal'. 'Solid biomass', 'Liquid biomass' and 'Gas biomass' is included in 'Total biomass'. For international bunkers, only fuel consumption for international navigation is available in the NewCronos database; data on international aviation is taken from the EU-15 sectoral approach. For the calculation of $CO_2$ emissions, the IPCC default carbon emission factors are used in the Eurostat database.

The IPCC reference approach method at EU-15 level is a four-step process.

- **Step 1:** For each Member State, annual data on energy production, imports, exports, international bunkers (except international aviation) and stock changes are available in the Eurostat database in fuel specific units (i.e. kt (= 1 000 tonnes)) for solid fuels and petroleum products, TJ for natural gas). The apparent consumption in TJ is calculated for each Member State by using country-specific average net calorific values. These net calorific values are updated annually for solid fuels together with the energy data in the NewCronos database; for petroleum products the net calorific values are kept constant. For groups of fuels average weighted net calorific values are used, which is the case for 'Other bituminous coal' and 'Lignite'.

- **Step 2:** The EU-15 CRF Table 1.A(b) are calculated by adding the relevant Member State activity and emission data, as calculated under Step 1. The net calorific values provided for the EU-15 in CRF Table 1.A(b) are calculated from dividing apparent consumption in TJ by apparent consumption in fuel-specific units for each fuel. Therefore, these net calorific values are 'implied calorific values'; there are no fuel-specific net calorific values at EU-15 level.

- **Step 3:** Fuel consumption from international aviation is included in Tables 1.A(b) from the Table 1.C from the EU-15 sectoral approach.

- **Step 4:** For the calculations of carbon stored in Tables 1.A(d), Eurostat data on non-energy use of fuels are used, as reported by Member States in the joint questionnaire. For the fraction of carbon stored and carbon emission factors IPCC default values are taken (IPCC, 1997).

Table 3.104 shows the apparent energy consumption from fossil fuel combustion from 1990 to 2009 as provided in Tables 1.A(b). Total fossil fuel energy consumption was at 1990 levels in 2009 after a strong decline 2008-2009 mainly due to the economic recession. Large increases had gas consumption (+64 %), whereas solid fuel combustion declined by 42 %.

Table 3.105 compares EU-15 $CO_2$ emissions calculated with the IPCC reference approach based on Eurostat data and the sectoral approach available from Member States. The reference approach and the sectoral approach, decreased by 6.9 % and 7.8 % respectively between 1990 and 2009; the percentage differences between the two data sets are below 0.6 % for all years.

**Table 3.104 Reference Approach: Apparent EU-15 energy consumption (in PJ) (Eurostat data)**

| Fuel types | 1990 | 1995 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Liquid Fuels | 22,125 | 23,233 | 23,459 | 24,008 | 23,797 | 23,944 | 23,811 | 23,680 | 23,330 | 22,630 | 22,510 | 21,344 |
| Solid Fuels | 12,435 | 9,874 | 9,013 | 9,104 | 9,011 | 9,295 | 9,273 | 8,943 | 9,114 | 9,221 | 8,404 | 7,258 |
| Gaseous Fuels | 9,352 | 11,537 | 14,216 | 14,559 | 14,654 | 15,336 | 15,761 | 16,147 | 15,836 | 15,705 | 16,089 | 15,356 |
| **Total** | **43,912** | **44,643** | **46,689** | **47,672** | **47,462** | **48,574** | **48,845** | **48,771** | **48,280** | **47,556** | **47,003** | **43,958** |

**Table 3.105 IPCC Reference approach (Eurostat data) and sectoral approach (Member State data) for EU-15 (in Tg)**

| CO2 emissions | 1990 | 1995 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sectoral approach | 3,129 | 3,068 | 3,137 | 3,211 | 3,203 | 3,254 | 3,260 | 3,243 | 3,220 | 3,163 | 3,104 | 2,884 |
| Reference approach | 3,112 | 3,056 | 3,130 | 3,203 | 3,192 | 3,266 | 3,275 | 3,252 | 3,231 | 3,170 | 3,121 | 2,897 |
| Percentage difference | 0.5% | 0.4% | 0.2% | 0.3% | 0.3% | -0.4% | -0.5% | -0.3% | -0.4% | -0.2% | -0.6% | -0.4% |

Table 3.107 and Table 3.108 provide an overview by Member State on differences between the Eurostat and national reference approach for 1990 and 2008. The differences can occur due to differences in the basic energy data or due to differences when calculating $CO_2$ emissions from the basic energy data.

The main reasons for diverging energy data are:

- the use of different calorific values (CV) mainly for oil products, BKB (lignite briquettes) and patent fuels. For BKB and patent fuels, Eurostat is using the same CV for all countries which differs from the calorific values used by the Member States;
- small differences in the basic energy balance data reported by Member States to Eurostat (in the joint questionnaires) and to the Commission and the UNFCCC (in the CRF tables).

The main reasons for diverging $CO_2$ emissions are:

- differences in the treatment of non-energy use of fossil fuels and carbon stored;
- the use of country-specific emission factors. The Eurostat reference approach uses the IPCC default emission factors.

To explain and resolve these differences Eurostat launched a project for harmonisation of the two (joint questionnaires and CRF) reporting systems of energy data and for revision of reported energy data back to 1990. Recently Eurostat has revised the CVs for liquid fuels which led to improved consistency with MS energy balance data which is also reflected in the comparisons below.

Table 3.106 shows the comparison between Eurostat and national reference approach for apparent consumption and $CO_2$ from fuel combustion for the EU-15 MS. For the EU-15 as a whole there is a difference of -0.5 % between the two approaches for apparent consumption in 2009. Most MS are within 2 %. No differences of more than 4 % can be observed.

The differences of $CO_2$ emissions for 2009 range from +10 % (Greece) to -8 % (Finland). The reasons for these large differences have to be further analysed. For the EU-15 as a whole the difference for $CO_2$ emissions is -0.6 % in 2009.

**Table 3.106 Comparison between Eurostat and national reference approach for $CO_2$ from fuel combustion for EU-15 (CRF 1.A)(25)**

| 1990 | Eurostat reference approach | | National reference approach | | Percentage difference | |
|---|---|---|---|---|---|---|
| | Apparent consumption (TJ) | CO2 emissions (Gg) | Apparent consumption (TJ) | CO2 emissions (Gg) | Apparent consumption (TJ) | CO2 emissions (Gg) |
| Liquid fossil fuels | 22,124,639 | 1,420,787 | 22,285,860 | 1,442,371 | 0.7% | 1.5% |
| Solid fossil fuels | 12,434,888 | 1,178,310 | 12,629,486 | 1,187,882 | 1.6% | 0.8% |
| Gaseous fossil fuels | 9,351,992 | 513,257 | 9,405,757 | 510,786 | 0.6% | -0.5% |
| **Total** | **43,911,519** | **3,112,354** | **44,325,185** | **3,141,320** | **0.9%** | **0.9%** |
| **2008** | Eurostat reference approach | | National reference approach | | Percentage difference | |
| | Apparent consumption (TJ) | CO2 emissions (Gg) | Apparent consumption (TJ) | CO2 emissions (Gg) | Apparent consumption (TJ) | CO2 emissions (Gg) |
| Liquid fossil fuels | 22,509,846 | 1,434,641 | 22,590,928 | 1,425,875 | 0.4% | -0.6% |
| Solid fossil fuels | 8,403,845 | 795,591 | 8,428,723 | 789,792 | 0.3% | -0.7% |
| Gaseous fossil fuels | 16,089,129 | 891,166 | 15,974,135 | 889,254 | -0.7% | -0.2% |
| **Total** | **47,002,820** | **3,121,399** | **46,995,600** | **3,105,047** | **0.0%** | **-0.5%** |
| **2009** | Eurostat reference approach | | National reference approach | | Percentage difference | |
| | Apparent consumption (TJ) | CO2 emissions (Gg) | Apparent consumption (TJ) | CO2 emissions (Gg) | Apparent consumption (TJ) | CO2 emissions (Gg) |
| Liquid fossil fuels | 21,344,286 | 1,358,275 | 21,320,525 | 1,345,757 | -0.1% | -0.9% |
| Solid fossil fuels | 7,257,585 | 688,053 | 7,315,818 | 692,120 | 0.8% | 0.6% |
| Gaseous fossil fuels | 15,355,883 | 850,807 | 15,101,507 | 841,235 | -1.7% | -1.1% |
| **Total** | **43,957,754** | **2,897,135** | **43,739,707** | **2,879,242** | **-0.5%** | **-0.6%** |

**Table 3.107 Comparison between Eurostat and national reference approach for apparent consumption for EU-15 (CRF 1.A)(26)**

| 2009 | Liquid fuels | | | Solid fuels | | | Gaseous fuels | | | Total fuels | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | National | Eurostat | Difference | National | Eurostat | Difference | National | Eurostat | Difference | National | Eurostat | Difference |
| | PJ | PJ | % | PJ | PJ | % | PJ | PJ | % | PJ | PJ | % |
| AT | 518 | 508 | 2% | 122 | 121 | 0% | 316 | 300 | 5% | 956 | 930 | 3% |
| BE | 971 | 982 | -1% | 136 | 126 | 8% | 634 | 633 | 0% | 1,742 | 1,741 | 0% |
| DK | 282 | 295 | -5% | 184 | 168 | 9% | 163 | 163 | 0% | 629 | 626 | 0% |
| FI | 376 | 391 | -4% | 226 | 218 | 3% | 146 | 146 | 0% | 748 | 755 | -1% |
| FR | 3,298 | 3,463 | -5% | 471 | 466 | 1% | 1,607 | 1,610 | 0% | 5,376 | 5,540 | -3% |
| DE | 4,314 | 4,415 | -2% | 3,023 | 2,999 | 1% | 2,944 | 3,206 | -8% | 10,281 | 10,620 | -3% |
| GR | 703 | 671 | 5% | 341 | 353 | -3% | 122 | 124 | -2% | 1,166 | 1,148 | 2% |
| IE | 305 | 298 | 2% | 89 | 90 | -2% | 180 | 179 | 1% | 574 | 568 | 1% |
| IT | 3,045 | 2,847 | 7% | 538 | 534 | 1% | 2,674 | 2,675 | 0% | 6,256 | 6,056 | 3% |
| LU | 98 | 97 | 1% | 4 | 3 | 32% | 47 | 47 | 0% | 149 | 146 | 1% |
| NL | 1,238 | 1,282 | -3% | 313 | 310 | 1% | 1,466 | 1,464 | 0% | 3,018 | 3,057 | -1% |
| PT | 493 | 482 | 2% | 120 | 120 | 0% | 177 | 177 | 0% | 789 | 779 | 1% |
| ES | 2,496 | 2,477 | 1% | 444 | 441 | 1% | 1,312 | 1,309 | 0% | 4,252 | 4,227 | 1% |
| SE | 535 | 499 | 7% | 76 | 81 | -5% | 46 | 51 | -10% | 657 | 630 | 4% |
| GB | 2,649 | 2,636 | 0% | 1,230 | 1,226 | 0% | 3,267 | 3,271 | 0% | 7,147 | 7,133 | 0.2% |
| EU15 | 21,321 | 21,344 | 0% | 7,316 | 7,258 | 1% | 15,102 | 15,356 | -2% | 43,740 | 43,958 | -0.5% |

(25) Minus means that Member State-based estimates are lower than the Eurostat-based estimates.

(26) Minus means that Member State-based estimates are lower than the Eurostat-based estimates.

**Table 3.108 Comparison between Eurostat and national reference approach for $CO_2$ from fuel combustion for EU-15 (CRF 1.A)(27)**

| 2009 | Liquid fuels | | | Solid fuels | | | Gaseous fuels | | | Total fuels | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | National | Eurostat | Difference | National | Eurostat | Difference | National | Eurostat | Difference | National | Eurostat | Difference |
| | Tg | Tg | % | Tg | Tg | % | Tg | Tg | % | Tg | Tg | % |
| AT | 34 | 33 | 2% | 11 | 12 | -2% | 18 | 17 | 6% | 63 | 61 | 2% |
| BE | 56 | 57 | -1% | 13 | 12 | 8% | 35 | 35 | 0% | 103 | 103 | 0.2% |
| DK | 20 | 21 | -4% | 17 | 16 | 10% | 9 | 9 | 1% | 46 | 46 | 2% |
| FI | 24 | 26 | -9% | 21 | 21 | -2% | 8 | 8 | -5% | 52 | 55 | -6% |
| FR | 210 | 226 | -7% | 44 | 44 | 1% | 89 | 89 | 0% | 343 | 359 | -4% |
| DE | 272 | 264 | 3% | 285 | 289 | -1% | 161 | 178 | -9% | 718 | 731 | -2% |
| GR | 50 | 47 | 6% | 42 | 35 | 19% | 7 | 7 | -3% | 98 | 89 | 10% |
| IE | 21 | 21 | 1% | 9 | 9 | 1% | 10 | 10 | 3% | 41 | 40 | 2% |
| IT | 194 | 186 | 4% | 49 | 49 | -1% | 151 | 149 | 2% | 395 | 385 | 3% |
| LU | 7 | 7 | 2% | 1 | 0 | 144% | 3 | 3 | 2% | 10 | 10 | 5% |
| NL | 53 | 64 | -17% | 29 | 29 | 2% | 81 | 80 | 1% | 164 | 173 | -5% |
| PT | 32 | 32 | 2% | 11 | 11 | -3% | 10 | 10 | 1% | 53 | 53 | 1% |
| ES | 165 | 167 | -1% | 42 | 41 | 2% | 74 | 73 | 1% | 280 | 280 | 0% |
| SE | 33 | 32 | 4% | 6 | 8 | -25% | 2 | 3 | -17% | 41 | 42 | -2% |
| GB | 175 | 176 | -1% | 113 | 114 | -1% | 184 | 182 | 1% | 472 | 472 | 0.1% |
| EU15 | 1,346 | 1,358 | -1% | 692 | 688 | 1% | 841 | 851 | -1% | 2,879 | 2,897 | -1% |

([27]) Minus means that Member State-based estimates are lower than the Eurostat-based estimates.

## 3.7 Responses of EU 15 Member States to UNFCCC Reviews

Table provides an overview of EU 15 member state's response to the UNFCCC Review findings in the Energy sector.

**Table 3.109 EU 15 member State's responses to UNFCC review findings in 1A1 Energy.**

| Sector | Gas | Member State | Comment UNFCCC report of the review of the 2010 submission | MS comment |
|---|---|---|---|---|
| Civil aviation: liquid fuels | $CO_2$ | GR | 45. The ERT noted that the data on jet kerosene in the CRF tables are high compared with the IEA data. Also, the Party's inventory includes the consumption of aviation gasoline for civil aviation, while no such consumption is included in the IEA data. Greece explained that, since there is a discrepancy between the number of LTOs and the corresponding fuel consumption from the national energy balance, the adjustment applied to the estimate for the base year5 is continuously applied in the estimation of $CO_2$ emissions from civil aviation. The ERT recommends that Greece continue its efforts to estimate the country-specific share of LTOs and the corresponding fuel consumption, and report any progress on this matter in its next annual submission. | Implemented in 2011 NIR section 3.2.5.2, 3.2.5.5-6 |
| Civil aviation: liquid fuels | $CO_2$, $CH_4$ and $N_2O$ | GB | 45. The data contained in DUKES are used to estimate emissions from civil aviation. This means that only fuel used in England, Wales, Scotland and Northern Ireland and any oil supplied from the United Kingdom to the Channel Islands and the Isle of Man are included. However, as previous ERTs have noted, direct flights operate to Gibraltar and Bermuda, which should also be considered under civil aviation according to the IPCC good practice guidance but which are currently reported under international bunkers (aviation). The current methodology leads to an underestimation of the emissions from domestic aviation reported under the energy sector. The ERT reiterates the recommendation made in previous review reports that the United Kingdom reallocate the fuel consumption for and the emissions from all direct flights between the United Kingdom and its OTs, which are currently reported under international bunkers (aviation), to civil aviation, consistent with the methodological approach provided in the IPCC good practice guidance. Since the Party did not submit revised estimates as requested by the ERT, an adjustment was calculated for this category (see chapter II.G of this report). | Implemented |
| Civil aviation: liquid fuels | $CO_2$, $CH_4$ and $N_2O$ | IE | 55. Ireland has reported all fuel consumption for and associated emissions from civil aviation under jet fuel. The ERT noted that the energy balance contains information on the use of both aviation gasoline and jet fuel. During the review, Ireland informed the ERT that the fuel consumption used for civil aviation is calculated by EPA, and that that is the source of the split between fuel uses in the energy balance. The ERT recommends that Ireland, in its next annual submission, report the consumption of aviation gasoline and the associated emissions separately from the information for jet fuel, in order to increase transparency. | The timing of Ireland's draft ARR 2010 did not allow sufficient time for this recommendation to be implemented in submission 2011. The inventory agency has plans to improve reporting of domestic aviation in 2012. |
| Feedstocks and non-energy use of fuels | | BE | 39. Emissions from non-energy use of fuels and related emissions (emissions from recovered fuels from processes) are allocated to the categories manufacturing industries and construction, ammonia production and other (chemical industry). For coal oils and tars (from coking coal), gas/diesel oil and residual fuel oil the notation key "NE" has been used in the CRF tables, but no explanation has been provided on table 9(a). According to the Party, non-energy use of fuel is relevant for natural gas and other fuels only. The ERT recommends that the Party apply notation keys adequately in the CRF tables; specifically, the notation key "NE" should be replaced by the notation key "not occurring" ("NO") for coal oils, gas/diesel oil and residual fuel oil. | Implemented |

| Sector | Gas | Member State | Comment UNFCCC report of the review of the 2010 submission | MS comment |
|---|---|---|---|---|
| Feedstocks and non-energy use of fuels | | FI | 37. The PCC plants do not measure their $CO_2$ emissions or the amount of $CO_2$ captured. Therefore, the amount of $CO_2$ transferred to PCC is estimated based on the amount of PCC produced. The calculated amount of stored $CO_2$ is subtracted from the subcategory other and a negative emission figure is in fact reported in this subcategory. Finland has provided further information on this methodology in the 2010 annual submission, thereby improving transparency. The information exchanged during the review has improved the ERT's understanding of this country-specific method. The ERT recommends that Finland further develop the reporting of $CO_2$ captured in the PCC production process in terms of the proportion of $CO_2$ from fossil fuels and of $CO_2$ from biomass fuels to increase the transparency of reporting on the trend of $CO_2$ emissions. In its response to the draft annual review report, Finland indicated that it has provided the data in the Appendix 3-c, pp. 137 in the NIR. The ERT identified that Finland has provided the share of fossil fuels of total transferred $CO_2$ in the Appendix 3-c of the NIR but no detail has been provided on, for example, the amounts of fossil fuels and biomass used, which would increase transparency. Finland responded to this, stating that giving the amount of fossil fuels and biomass in the NIR would mean the disclosure of confidential data, as some of the fuels are used only by one or two of the six plants capturing $CO_2$. | Finland does not agree with the ERT recommendation |
| Feedstocks and non-energy use of fuels | | FI | 38. Finland considers that the principles of $CO_2$ capture and storage (CCS) mentioned in the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (hereinafter referred to as the 2006 IPCC Guidelines) can be applied to the PCC production process and indicates that, according to the 2006 IPCC Guidelines, once $CO_2$ is captured, there is no differentiated treatment between biogenic carbon and fossil carbon. Finland calculates the amount of $CO_2$ absorbed during PCC production process in which the $CO_2$ source is the combustion of mixed fuels which are a combination of fossil and biomass fuels. Since Finland reported separately $CO_2$ emissions from biomass combustion and did not include it in the total inventory, this amount of $CO_2$ should not be subtracted from total national inventory. For this reason, the ERT recommends that Finland report separately $CO_2$ emissions from fossil fuels and $CO_2$ emissions from biomass fuels captured in the PCC production process and subtract only $CO_2$ emissions from fossil fuel combustion. Finland does not agree with the ERT's recommendation and reasoning as it would lead to double counting of emissions to the atmosphere ($CO_2$ emissions from biomass are reported in the LULUCF sector, or under Article 3, paragraph 3 activities and forest management under Kyoto Protocol as harvesting losses). Finland further noted that the approach to treat the capture and storage of fossil and biomass $CO_2$ in the same way is consistent with the 2006 IPCC Guidelines (Volume 2, Chapter 6), and that this approach is consistent with the actual changes in atmospheric $CO_2$ concentration. Finland does not understand why the abatement measure, capture and storage of biomass $CO_2$, is not allowed to be taken into account in the inventory in accordance with the guidance of the IPCC. | Finland does not agree with the ERT recommendation |
| Feedstocks and non-energy use of fuels | | GB | 40. Previous ERTs have identified that several fuels used as feedstocks for non-energy purposes are reported in CRF table 1.A(d), while the section in the NIR regarding feedstocks and non-energy use of fuels refers only to the section explaining the use of natural gas as a feedstock for the production of NH3, methanol and acetic acid. The United Kingdom provided the previous ERT with relevant information on this issue, which was recommended to be included in its next NIR. However, the transparency of the NIR has not been improved in the 2010 submission. The present ERT reiterates the recommendation of previous ERTs that the United Kingdom, in the NIR of its next annual submission, include relevant information on all fuel types used as feedstocks and for non-energy uses, including information on the data sources for the fractions of carbon stored. In addition, the ERT recommends that additional information be reported in CRF table 1.A(d) indicating from which categories in the energy sector carbon stored is subtracted and where associated $CO_2$ emissions are allocated, in order to improve the transparency of the reporting. | Information is available in Annex 3.3.9. CRF table 1A(d) not improved. |

| Sector | Gas | Member State | Comment UNFCCC report of the review of the 2010 submission | MS comment |
|---|---|---|---|---|
| Feedstocks and non-energy use of fuels | | GR | 40. Following the recommendation of the previous ERT, Greece allocated a part of natural gas, petroleum coke and solid fuels used as feedstock in manufacturing industries to the industrial processes sector. However, the ERT identified a discrepancy in the figures for natural gas consumption reported for ammonia production in the NIR and in CRF table 1.A(d). In response, Greece explained that table 3.9 of the NIR and CRF table 1.A(d) include only the quantities of the fuels used as feedstock and allocated to the energy sector and do not include the amounts of the fuels used as feedstock and allocated to the industrial processes sector. This is not in line with the Revised 1996 IPCC Guidelines. The ERT recommends that Greece report properly in CRF tables 1.A(b) and 1.A(d) all feedstocks and non-energy use of fuels (as identified in the national energy balance), the associated $CO_2$ emissions and the category/sector under which they are allocated in the inventory. | Implemented |
| Feedstocks and non-energy use of fuels | | GR | 41. The ERT found that a part of the natural gas used as feedstock (non-energy use) is still accounted for in the energy sector under chemical industry, and that this leads to large inter-annual variation and low implied emission factors (IEFs) for $CO_2$, $CH_4$ and $N_2O$ emissions from gaseous fuels. A similar problem was identified by the ERT in relation to the lubricants included in liquid fuels for iron and steel which are used for non-energy purposes. During the review, Greece recalculated and resubmitted all emission estimates related to the non-energy use of natural gas, reallocating natural gas used as feedstock to ammonia production (industrial processes sector) and leaving only the energy use of natural gas in the subcategory chemical industry (energy sector). Greece also used revised AD to estimate emissions from the non-energy use of natural gas in hydrogen production and reported these emissions under petroleum refining. The ERT noted that there are still inconsistencies between the amount of natural gas used as feedstock for ammonia production and/or for hydrogen production in refineries and the updated data on natural gas reported in CRF table 1.A(d), and recommends that Greece check the consistency of these figures and correct them as necessary. | Implemented |
| Feedstocks and non-energy use of fuels | | IE | 52. Ireland indicated that work was ongoing to analyse whether emissions from the non-energy use of fuels, such as lubricants and bitumen, could be estimated. During the review, the ERT found that a small amount of white spirit included in the energy balance was not included in the inventory estimates. In response to questions raised by the ERT, Ireland explained that it would include the consumption of white spirit in the CRF tables in its future annual submissions. Further, Ireland stated that estimates of emissions from the non-energy use of fuels would be reassessed and revised if necessary. The ERT recommends that Ireland report on the results of this work in its next annual submission. | White spirit is now included in the CRF Submission for 2011. |
| Feedstocks and non-energy use of fuels | | LU | 37. According to CRF table 1.A(b), imports of anthracite are included in other bituminous coal. On the other hand, in CRF table 1.A(d) there is no reference to the nonenergy use of anthracite. The Party explained that anthracite and other coal products are used by the steel industry as reducing agents (approximately 38 kt in 2008). In the sectoral approach, these emissions are reported under industrial processes (iron and steel). Nevertheless, to international statistics, this consumption is not reported as a non-energy use by the competent reporting authority (i.e. the Ministry of Economics and Foreign Trade). The ERT asked the Party for a further explanation as to why there is such a significant difference between the reference and sectoral approaches, and Luxembourg stated that this explanation will be included in its next annual submission. Furthermore, it will discuss with the competent reporting authority (which from now on will be STATEC) whether it would be possible to declare these consumptions as non-energy use in the future. The ERT recommends that the Party continue discussing this issue with the designated authorities and provide detailed explanations for the differences between the reference and sectoral approaches in the next annual submission. | Not yet implemented |

| Sector | Gas | Member State | Comment UNFCCC report of the review of the 2010 submission | MS comment |
|---|---|---|---|---|
| Feedstocks and non-energy use of fuels | | PT | 44. As in previous submissions, Portugal has reported in its NIR that emissions from mineral oil used as lubricant and from bitumen used in road paving are included in the reference approach but are not part of the sectoral approach. Portugal informed the ERT that it will try to improve this category in the near future, making use of the AD that are already available and the 2006 IPCC Guidelines. The ERT reiterates the recommendation made in previous review reports that Portugal continue to make efforts to improve its estimates of emissions from the use of feedstocks and include estimates of combustion emissions from feedstock and non-energy use of fuels in the sectoral approach in its next annual submission. | Under Development - Portugal reiterates its commitment to review this issue in the next annual submission |
| International bunker fuels | | AT | 48. For the estimates of emissions from international bunkers, a tier 3a methodology from the core inventory of air emissions (CORINAIR) was applied for the period 2000–2008, while the MEET model was applied for the 1990–1999 period. According to the NIR, emissions from international aviation bunkers include flights according to visual flight rules and instrument flight rules for national landing/take-off (LTO) and national cruise, consistent with the approach taken for domestic civil aviation. Nevertheless, the ERT recommends that Austria explain in more detail how it has ensured consistency across the time series from 1990 to 2008 using the different models (CORINAIR and MEET). | On basis of the year 2000, Austria has already shown (in NIR 2010) that both methods provide similar results. Further explanations, also on the barriers for trend extrapolation (concerning flight routes and operated aircraft for the years before 2000) are included in NIR 2011. |
| International bunker fuels | | AT | 49. Regarding emissions from international marine bunkers (inland navigation on the river Danube), Austria has reported these emissions separately from the emissions from navigation for the period 1990–2008 for the first time in its 2010 submission, in response to recommendations made in previous review reports. While the ERT commends this, it also recommends that Austria improve the transparency of this section of the NIR with regard to the sources of data used to differentiate between domestic and international marine fuel use. | Information is included in the NIR. |
| International bunker fuels | | BE | 37. Regarding marine bunkers, the Flemish Region is the only coastal region of Belgium, and two subcategories are distinguished: navigation on Flemish territory and navigation which is allocated to the international bunkers. $CO_2$ emissions are calculated in the Flemish Region by using EFs from the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories (hereinafter referred to as the Revised 1996 IPCC Guidelines) and the AD from the Flemish energy balance. For the first time, in the 2010 submission, the emissions of $CO_2$ from international sea fishing are added to the emissions from marine bunkers. The NIR uses the term “local bunkering”, which can be confusing. The ERT recommends that Belgium replace the term local bunkering with international bunkers. | Implemented |
| International bunker fuels | | BE | 38. Regarding aviation bunkers, the figures in the NIR for 2008 differ from data from the International Energy Agency (IEA) for jet kerosene: 58,002 TJ and 85,484 TJ, respectively. From 2008 onwards, the regional airports have been included in the new oil balance, which was not the case for the previous years. The Party has argued that the 2008 figures cannot be accurately compared with 2007 or previous years, given the change in collecting data in 2008. The Party also stated that temporary figures were reported in the 2010 submission and that corrections will be reported for the 2011 submission. Furthermore, the Party stated that the inclusion of the regional airports in the national balance does not impact domestic aviation figures, as these are collected on a regional level and consequently are already included in the regional balances. Figures from previous years are not much different from 2008 (i.e. 53,499 TJ for 2007 and 52,047 TJ for 2008) and therefore it is not possible to isolate and analyse the impact of the inclusion of regional airports. During the review, Belgium explained that it had contacted the administration responsible for the national energy balance in order to clarify this discrepancy for the year 2008. The ERT recommends that Belgium clarify this issue and report on the results in its next annual submission. | Unclear if action has been taken |

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| International bunker fuels | | DK | 52. For navigation, the international fuel total, as reported by DEA, accounts for the fuel sold in mainland Denmark to international ferries, international warships, other ships with foreign destinations, tank vessels and foreign fishing boats, together with transport to Greenland and the Faroe Islands. In Greenland, all marine fuel sales are considered to be domestic. In the Faroe Islands, only fuels sold to local ships and fishing vessels are considered to be domestic. The NIR acknowledges that, in order to be in line with the IPCC good practice guidance, the fuels used in navigation between ports in mainland Denmark, Greenland and the Faroe Islands should be considered as domestic. The ERT agrees with this and recommends that Denmark make efforts to acquire the necessary data to allocate these fuels as domestic (see para. 66 below). | Denmark has included fuel consumption and emissions from navigation between Denmark, Greenland and the Faroe Islands under national navigation in accordance with the IPCC good practice guidance. |
| International bunker fuels | | FI | 32. Finland reported emissions from international bunker fuels on the basis of fuel sales using country-specific $CO_2$ EFs and non-$CO_2$ EFs from the Revised 1996 IPCC Guidelines. Finland indicated the possibility of minor double counting with domestic navigation where there are both international and domestic ports. The ERT recommends that Finland address this issue and ensure that emissions are not double counted in the next annual inventory submission. | Additional description has been added-NIR Section 3.8 |
| International bunker fuels | | GB | 39. The fuel consumption for international aviation as reported in CRF table 1.C is within 5 per cent of that reported to the IEA from 1999 to 2008. The differences in the data relating to international marine bunkers are more significant, with a difference between the reporting in the CRF tables and the IEA data of around 15 per cent for the earlier years of the time series and of close to 6 per cent for the later years. The United Kingdom informed the ERT that the Digest of United Kingdom Energy Statistics (DUKES) provides to the IEA the volume of bunker fuel allocated to domestic and international shipping, while in the inventory, the DUKES volume from international bunker fuel is allocated to international bunker fuel and military mobile combustion. The ERT recommends that the United Kingdom include this information in its next annual submission. | Implemented |
| International bunker fuels | | GR | 38. During the review, the ERT noted that the consumption of fuel for international aviation reported in the CRF tables is systematically higher than the IEA data. The ERT also noted that jet kerosene used for international aviation has not been reported in CRF table 1.A(b) for the period 2006–2008 and that for the other years of the time series the data in CRF tables 1.A(b) and 1.C do not correlate. In response to a question raised by the ERT on this matter, Greece stated that "total inland consumption" from the energy balance includes both domestic and bunker fuels and that this amount is further disaggregated on the basis of the LTO data. However, to ensure consistency with the national energy balance, the fuel used for international aviation has not been reported in the reference approach. This is not in line with the Revised 1996 IPCC Guidelines. The ERT recommends that Greece cross-check data on jet kerosene, correct them in CRF tables 1.A(b) and 1.C and ensure time-series consistency in its next annual submission. | Implemented in 2011 NIR section 3.2.1. |
| International bunker fuels | | GR | 39. Greece reports $CH_4$ and $N_2O$ emissions from lubricants from marine bunkers as "NE", owing to a lack of appropriate EFs. However, since the Party reports emissions of these gases from lubricants used for national navigation, the ERT recommends that Greece provide estimates for the non-estimated gases using the EFs for navigation in its next annual submission. | Implemented |

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| International bunker fuels | | IE | 51. The ERT considers that the Party has not yet improved the explanation of the method used to distinguish between emissions from domestic and international navigation bunkers, as was recommended in the previous review report.11 The ERT reiterates the recommendation that the Party explain in detail how emissions from domestic and international segments are disaggregated between the two categories in its next annual submission (see para. 55 below). | Information is provided in NIR 2011. Fuels are split by domestic and international in the National Energy Balance. |
| International bunker fuels | | IT | 36. Fuel consumption for international aviation, as reported in CRF table 1.C, is 5 per cent lower than according to IEA data from 1990 to 2000 and 2 per cent higher from 2004 onwards. For international marine bunkers, IEA figures are higher than those in the CRF tables by about 100 per cent until 1998. Part of the discrepancy is due to a different split between international and domestic navigation for both residual fuel oil and gas/diesel oil. Discrepancies exist between CRF tables 1.C and 1.A(b) in relation to residual fuel oil (international marine bunkers) for all years of the time series. Italy responded during the review that it will resolve this issue, and the ERT recommends that it do so in the next annual submission. | The issue of discrepancy has been solved |
| International bunker fuels | | LU | 35. In Luxembourg, all jet kerosene is used on international flights, a very specific situation because it is a small country with no domestic flights using jet kerosene. At the moment, the share between domestic and international flights (90:10) of the use of aviation gasoline is based on expert judgement. During the review, the Party claimed that the improvement of this share is not a priority, because it seems to be quite appropriate, according to informal discussion with contacts involved in private leisure aviation and the company selling the fuel at the airport. The ERT reiterates the recommendation of the previous ERT that, in order to improve the transparency of the NIR, Luxembourg include references for the expert judgement and assumptions used in the allocation of fuels in its next annual submission. | Not yet implemented |
| International bunker fuels | | LU | 36. Table 3-11 of the NIR presents "GB 2009" as a source of EFs for international bunkers (aviation), but this reference could not be found by the ERT in the list of references at the end of the document. In response to a question raised by the ERT, the Party explained that this refers to the EMEP/EEA air pollutant emission inventory guidebook 2009, formerly known as the EMEP/CORINAIR emission inventory guidebook. Further explanation regarding the EFs adopted was also provided during the review. For aviation gasoline, default EFs were taken from the 2006 IPCC Guidelines, because they correspond better to Luxembourg's modern fleet of small airplanes burning aviation gasoline, particularly for the EFs for $CH_4$ and $N_2O$, because they are technology dependant. The ERT recommends that Luxembourg include this information in its next annual submission. | Information is included in the NIR. |
| International bunker fuels | | PT | 42. Portugal reports in the NIR that emissions from aviation bunkers are estimated using a tier 2a method. The figures in the NIR for fuel consumption for international aviation and navigation differ from those reported in the reference approach and to the IEA. Since the General Directorate of Energy and Geology reports directly to the IEA, discrepancies between these data and the Party's estimates are expected. Portugal also informed the ERT that it is making efforts to bring the split between domestic and international fuel consumption into line with the IPCC good practice guidance. The ERT welcomes this planned improvement and recommends that, in the NIR of its next annual submission, Portugal document the results of its efforts to achieve a split between domestic and international fuel consumption in the reference approach that is fully consistent with the IPCC good practice guidance. | Implemented |

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| Navigation: gas/diesel oil | $CO_2$ | BE | 43. The ERT noted an unusually high $CO_2$ IEF for gas/diesel oil in 2008 (74.46 t/TJ) for navigation. The Party has stated that the high IEF for 2008 is because temporary figures have been used in the Flemish Region in the 2010 submission and that updated figures for 2008 will be used in the 2011 submission. The ERT recommends that the Party provide updated figures in its next annual submission. | Implemented |
| Navigation: liquid fuels | $CO_2$, $CH_4$ and $N_2O$ | IE | 57. The ERT noted that the energy balance contains data on marine bunkers but no information on the use of fuels in national navigation. However, Ireland has reported a consumption of 57.95 TJ gas/diesel oil in 2008 under navigation, although no explanations are provided in the NIR as to how this figure was derived from the energy balance. The ERT recommends that the Party provide clear explanations as to how AD for navigation are established, in the NIR of its next annual submission. | Additional information is provided in NIR 2011. The inventory agency has already arranged meetings with Energy Balance provider to address these issues in 2011, for reporting in Submission 2012. |
| Navigation: liquid fuels | $CO_2$, $CH_4$ and $N_2O$ | IE | 58. In addition, the ERT found that the trend in total liquid fuel consumption for navigation displays a drop of 52.1 per cent between 2001 (1,662.08 TJ) and 2002 (795.33 TJ) and of 93.4 per cent between 2005 (792.24 TJ) and 2006 (52.65 TJ). The consumption of residual oil in 2005 is estimated at 742.24 TJ and is reported as "NO" for the following years (2006-2008). During the review, Ireland explained to the ERT that the consumption of residual oil had been incorrectly allocated for the period 1990-2005. The ERT recommends that Ireland improve the reporting of data for national navigation and provide explanations in the NIR for the fluctuations in the time series in its next annual submission. | The timing of Ireland's draft ARR 2010 did not allow sufficient time for this recommendation to be implemented in submission 2011. The inventory agency has already arranged meetings with Energy Balance provider to address these issues in 2011, for reporting in Submission 2012. |
| Oil and natural gas | $CH_4$ and $N_2O$ | DK | 70. Denmark has updated the $CH_4$ and $N_2O$ EFs from flaring in refineries. The $CH_4$ EF is based on the chemical composition of the flared gas provided by one of the two Danish refineries. The NIR reports that the $N_2O$ EFs were adopted from the recently published reference by the European Environment Agency (EMEP/EEA Air Pollutant Emission Inventory Guidebook 2009. Technical Guidance to Prepare National Emission Inventories8). However, the ERT noted that this reference does not provide EF values for $N_2O$ from flaring in oil refineries. To improve transparency, the ERT recommends that Denmark provide sufficient and accurate background information for the selection of these EFs. | The correct reference for the $N_2O$ emissions factor is EMEP/CORINAIR, 2007: Emission Inventory Guidebook, prepared by the UNECE/EMEP Task Force on Emissions Inventories and Projections, 2007 update. The emission factor refers to flaring offshore as no emission factor is given in the reference for flaring in refineries. |
| Oil and natural gas | $CO_2$ | DK | 67. $CO_2$ emissions from flaring in refineries, offshore installations and natural gas plants were estimated using plant-specific $CO_2$ EF data available under the EU ETS. During the review, Denmark informed the ERT that these $CO_2$ EFs were estimated according to the tier 3 method based on the carbon content of the flared gas. To improve transparency, the ERT recommends that Denmark provide brief background information about the nature of the estimation of these $CO_2$ EFs under the EU ETS, focusing on their adequacy in relation to the IPCC good practice guidance. | A general description of the EU ETS data is included in chapter 1.4.10 in the 2011 NIR. Chapter 3.5.2 in the NIR 2011 include a short description of the methodologies behind the EU ETS data for fugitive emissions. As only EU ETS data on higher Tiers are applied in the national emission inventory data are found highly adequate in relation to the IPCC Good Practice Guidance. |

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| Oil and natural gas: gaseous fuels | $CH_4$ | AT | 56. In the previous review report, it was recommended that Austria implement a hightier methodology to estimate emissions from this key category. The Party highlights in the NIR that it has adopted a tier 3 method to estimate emissions from natural gas transmission and distribution. However, in CRF table summary 3, emissions from this category are still mistakenly listed as being estimated using a tier 1 method. The recalculations resulting from this change in methodology led to a reduction in the estimated $CH_4$ emissions for all years in the period 1990–2007, and in the 2010 submission this category is not identified as a key category by level or trend, although Austria has identified it as a qualitative key category. The Party explained that the change in the methodology consisted mainly of a disaggregation of the pipelines and distribution networks depending on the material of the pipeline and applying the corresponding EFs for the materials of those pipelines, which is in line with the IPCC good practice guidance. The result was a drop in the IEF for the transmission and distribution category from 2,900 kg $CH_4$/km to 415.10 kg $CH_4$/km for pipelines and from 649.74 kg $CH_4$/km to 108.39 kg $CH_4$/km for distribution networks. However, the new data were taken not from a recent study but from a study from 1999. During the centralized review, Austria provided the ERT with an explanation for this situation, including more detailed information and references. The ERT recommends that Austria include this information in the NIR of its next annual submission. | In NIR 2011 the full reference is included. |
| Oil and natural gas: gaseous fuels | $CH_4$ and $CO_2$ | IT | 41. The $CH_4$ IEF for natural gas production and processing declined from 2,911.93 kg/Mm3 gas produced in 1990 to 1,611.10 kg/Mm3 in 2008, while the $CO_2$ IEF stayed constant. During the review, Italy explained that gas operators supplied information about natural gas production and processing activities and $CH_4$ emissions in their environmental report. The $CH_4$ EFs for the whole time series were calculated taking into account this information. For $CO_2$, the IPCC default EF has not been modified, as no specific information is available. To improve transparency, the ERT recommends that Italy include this information in the NIR and also provide a discussion on the drivers behind this trend. | Additional information has been provided in the NIR. |
| Oil and natural gas: liquid fuels | $CH_4$ and $CO_2$ | IT | 40. The methods used for estimating fugitive emissions from petroleum refining (process emissions resulting from restoration of the catalyst and flaring emissions) are not well documented in the NIR. In response to a question raised by the ERT during the review week, Italy indicated that total fugitive emissions from petroleum refineries are compared and balanced with the total crude oil losses reported in the national energy balance. These emissions are then distributed between the different process sources on the basis of average EFs agreed and verified with the national association of industrial operators (Unione Petrolifera) and updated annually, from the year 2000, on the basis of data supplied by the plants within the framework of the EU ETS. In the context of the EU ETS, refineries report $CO_2$ emissions from flaring and from processes separately. The ERT recommends that Italy include this information in the category-specific section on fugitive emissions in the NIR in order to improve the transparency of the description of methods. | Additional information has been provided in the NIR. |
| Oil and natural gas: Natural gas | $CH_4$ | PT | 48. The ERT identified significant fluctuations in the trends of $CH_4$ emissions from natural gas transmission between 1997 and 2008, ranging from -69.6 per cent to 207.6 per cent. Portugal explained in the NIR that the main fluctuation occurs from 2003 onwards, mainly due to the inclusion of cushion gas in the estimates and the expansion of the natural gas distribution network. The decline in emissions from 2004 to 2007 is the result of a stabilization in the pipeline extension in the residential and services sectors coupled with improvements in pipeline quality and other general gains in efficiency. The increase in 2008 resulted mainly from corrections to the reported values for natural gas losses. The ERT recommends that Portugal investigate this issue further, ensuring time-series consistency, and document its findings in its next annual submission. | Unclear if action has been taken |

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| Oil and natural gas: Oil | $CO_2$ | PT | 47. The ERT identified significant fluctuations in the trends of $CO_2$ emissions from refining and storage; the inter-annual changes of $CO_2$ emissions for 1991/1992, 1993-1997, 1999-2001 and 2002/2003 range from -12.8 per cent to 400.2 per cent. Portugal informed the ERT that it is making efforts, together with the refineries, to improve emission estimates of storage in tanks, fugitive emissions, catalysts regeneration, and sulphur recovery. These will be used to improve the inventory methodologies and EFs for the coming years after the application of validation procedures. The ERT recommends that Portugal improve the time-series consistency in this category and encourages Portugal to document the results of its efforts in the NIR of its next annual submission. | Under Development - Emissions have been estimated and reported for practically all categories, except for $N_2O$ from flaring. |
| Other: liquid fuels | $CO_2$, $CH_4$ and $N_2O$ | PT | 49. Emissions from military navigation and military ground transport are not mentioned in the NIR. Portugal informed the previous ERT that these emissions are included under navigation and road transportation. To increase transparency, the ERT reiterates the recommendation that, in the NIR of its next annual submission, Portugal either provide information to clarify the inclusion of these emissions or obtain the data necessary to estimate and report emissions from military navigation and military ground transport separately. | Implemented |
| Reference Approach | | AT | 46. In response to a question raised during the centralized review, Austria provided the ERT with additional explanations for the differences between the sectoral and reference approaches, namely highlighting table 20 of the NIR. However, the ERT did not find that table 20 of the NIR was sufficient to transparently explain the differences, namely the quantification of coke oven coke and biofuels contributing to the difference between the reference and sectoral approaches. Given the large differences between the estimates reported by Austria of $CO_2$ emissions calculated using the reference and sectoral approaches, in particular for solid fuels, the ERT recommends that Austria reorganize section 3.2.1 of its NIR, including table 20, to more transparently and clearly explain the reasons for the differences, and make better use of the documentation boxes of the CRF tables, placing emphasis on explaining the differences in the reporting of emissions from solid fuels. | The difference has been explained in more detail in NIR 2011. A graph showing the two approaches in time series has been included and the quantification of difference with regard to solid fuels and natural gas is elaborated on in NIR 2011. |
| Reference Approach | | BE | 35. The comparison of the reference approach with the sectoral approach shows differences between –4.3 per cent (in 2002) and +4.0 per cent (in 2000). However, since 2005 the difference has remained under 2.0 per cent, reaching 1.3 per cent in 2008. The main reasons for the differences between the reference and sectoral approaches are that the reference approach was performed using the national energy balance while the sectoral approach used regional energy balances. This explains the differences found in the comparison of the two approaches for naphtha, for instance. This explanation, and other reasons, have been addressed in the NIR. Belgium has established a working group on energy balances under the National Climate Commission to improve harmonization of the regional and national energy balances for the future. Consultations have taken place on different areas and adaption of the legislation may still be required in some cases. The ERT welcomes the Party's efforts in trying to harmonize the regional and national energy balances and encourages Belgium to continue improving the work in this regard. The ERT also recommends that the Party provide detailed information in the NIR about the impact of the measures already implemented that aim to reduce the differences between the reference and sectoral approaches. | Some additional information provided |

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| Reference Approach | | FI | 31. The previous review report recommended that Finland include in future annual submissions an annex providing the national energy balances used in the top-down reference calculation in order to increase the transparency of the comparison between the energy balance and the GHG inventory. Finland indicated in its NIR (page 440) that this annex will be included in the 2011 submission, as the finalized energy balance was not available for the preparation of the 2010 submission. The ERT reiterates the recommendation from the previous review report that Finland include this annex in its next annual submission. | The Annex is included (Annex 4) |
| Reference Approach | | GB | 37. The ERT noted that the apparent energy consumption in the reference approach and the apparent energy consumption (excluding feedstocks and non-energy use of fuels) reported in CRF table 1.A(c) are almost identical, even though a significant fuel consumption is listed for non-energy purposes in CRF table 1.A(d). The ERT reiterates the recommendation made in the previous review report that the United Kingdom correct this inconsistency in its next annual submission and that it properly report fuel quantities in the respective tables. | This has been revised within the latest CRF submission. |
| Reference Approach | | GR | 36. For 2008, the estimates of apparent consumption and $CO_2$ emissions derived from the reference approach were 1.0 per cent lower and 0.2 per cent higher, respectively, than those derived from the sectoral approach. Greece attributes this to statistical differences in fuel consumption, losses and the use of different EFs for the two approaches. The ERT noted that the difference between the estimates derived from the two approaches, especially for gaseous fuels, could also be caused by the incorrect consideration of gas works gas as a secondary gaseous fuel, which is reported in the sectoral approach but not in the reference approach. The ERT recommends that Greece allocate gas work gas to the secondary solid fuels in its next annual submission. | Implemented in 2011 NIR section 3.2.1. |
| Reference Approach | | GR | 37. Apparent consumption in the reference approach corresponds closely to the data provided to the International Energy Agency (IEA). However, the ERT found discrepancies with the IEA data, especially with regard to the stock change for liquid and gaseous fuels. This may have been caused by the incorrect consideration of non-energy use of fuels in the reference approach. The ERT noted that, according to the Revised 1996 IPCC Guidelines, in the reference approach the amount of fuel reallocated to the industrial processes sector should be indicated in CRF table 1.A(d) and not extracted from the stock change, as was done by Greece. The ERT recommends that Greece follow the IPCC approach for its next annual submission. | Implemented in 2011 NIR section 3.2.1. |
| Reference Approach | | IE | 48. However, as identified in the previous review report,10 there are some discrepancies between the data reported to the International Energy Agency (IEA) and the data reported in the CRF tables related to energy consumption. Since the differences between the estimates calculated using the sectoral and reference approaches are very small, and for its 2010 annual submission Ireland has used data taken directly from the IEA/Eurostat questionnaire, the differences between the IEA data and the data in the CRF tables could be due to differences in the net calorific values used. The ERT recommends that Ireland verify the reasons for the differences and report on the outcome of its analysis in its next annual submission. | The timing of Ireland's draft ARR 2010 did not allow sufficient time for this recommendation to be implemented in submission 2011. The inventory agency will work with Energy Balance provider to address these issues in 2011, for reporting in Submission 2012. |

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| Reference Approach | | LU | 31. $CO_2$ emissions from fuel combustion were calculated using the reference approach and the sectoral approach. For 2008, the $CO_2$ emission estimates for the reference approach are 2.24 per cent lower than those for the sectoral approach. The difference in estimated $CO_2$ emissions between the reference and the sectoral approach was greater than in 2008 for several years between 1995 and 2007, ranging between 6.81 per cent lower and 1.72 per cent higher. Explanations are provided in the documentation box of the CRF table and also in the NIR. In response to questions raised by the ERT during the review, the Party stated that it is planning to implement the improvements highlighted in table 3-9 of the NIR for its next annual submission. The ERT acknowledges that Luxembourg is in a transition phase regarding the compilation of energy statistics and reiterates the recommendation of the previous review report that the Party implement these measures as soon as possible. | The planned improvements have been implemented and the differences between reference approach and sectoral approach have significantly decreased. |
| Reference Approach | | LU | 32. According to section 3.2.1.1 of the NIR, whenever AD for a fuel consumption category are in the range of 0-0.5 kt, Luxembourg has reported these data as "NO", owing to lack of precision in the data from the statistical office of the European Union (Eurostat), which does not allow decimal numbers and therefore reports zero values. Hence, estimations are not provided in those cases. This is the case, for example, for building- and plant-site fuel machinery reported under other (stationary (1.A.5.a)), which was reported as "NO" in the CRF table for 2008. Luxembourg informed the ERT that in the revised energy balance (2000-2009) used for the preparation of the inventory for the 2011 annual submission this issue has been solved. However, it remains for the years 1990-1999, for which old energy balances need to be taken into account and the needed detailed data might not be available anymore. The ERT recommends that the Party seek the necessary data in the old energy balances and gather the original fuel consumption data sent to Eurostat, in order to estimate the relevant emissions. If fuel consumption AD cannot be obtained for these categories, but the Party acknowledges that such consumption does occur, the ERT recommends that the Party adopt a conservative approach by considering fuel consumption to be equal to 0.5 ktoe. | Further investigations are planned |
| Reference Approach | | LU | 33. It is not clear from the NIR whether the fraction of carbon oxidized adopted to calculate emission estimates is the IPCC default value or the Eurostat default value. Furthermore, it is not clear whether the same fraction was applied in the reference and sectoral approaches. In response to questions raised by the ERT during the review, the Party stated that it plans to implement a revision to the reference approach, in order to streamline EFs, NCVs and also oxidation factors. During this revision, the oxidation factors will be adjusted to the IPCC default values for both the reference and the sectoral approach. During the current review, the ERT noted that in some cases in the sectoral approach, when default EFs from the 2006 IPCC Guidelines were applied, no oxidation factor was applied, and hence all carbon was considered to be oxidized into $CO_2$. The ERT recommends that the Party implement the planned improvements regarding the streamlining of oxidation factors, EFs and NCVs in both the reference and sectoral approaches for its next annual submission. | Oxidation factors have been streamlined |
| Reference Approach | | LU | 34. The comparison between the data submitted to the UNFCCC and to the International Energy Agency shows that liquid fossil stock changes have been reported with both positive and negative values, affecting the calculation of apparent consumption. During the review, the Party informed the ERT that this issue will be considered in its next annual submission. The ERT recommends that the Party clarify this matter in its 2011 annual submission. | Should be solved becasue the the IEA questionnaires have been used for the reference approach. In addition the comparison with Eurostat data shows the same values for stock changes. |

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| Road transportation: all fuels | $CH_4$ and $N_2O$ | IE | 56. The ERT noted that Ireland has improved the transparency of its reporting for this category by discussing the time-series trends for the transport sector. However, the ERT considers that some of the important parameters used in the tier 3 estimation of emissions from road transportation have not yet been provided in the NIR. In response to a question raised by the ERT during the review, Ireland provided information on vehicle distribution, annual distance travelled by vehicle type, trip speed and distribution between road types. To enhance the transparency of the estimates of emissions from road transportation and to allow for a proper review of the model, the ERT recommends that Ireland include this information in an annex to the NIR in its next annual submission. | Additional information is provided in NIR 2011. |
| Road transportation: all fuels | $CO_2$, $CH_4$ and $N_2O$ | PT | 45. For the first time, Portugal has used the COPERT IV model to estimate the emissions from road transportation. $CO_2$ emission estimates are based on a tier 2 method and non-$CO_2$ emissions are based on a tier 3 method. As a result of this methodological change, $N_2O$ emission estimates have been reduced significantly, resulting in a reduction of around 60 per cent in 2007 compared with the previous submission. Portugal has used country-specific information, where available (e.g. net calorific value, fleet, distance travelled), and default values where country-specific information is not available (e.g. average trip length). The ERT welcomes this improvement and recommends that Portugal justify in the NIR that the default parameters used are appropriate or develop country-specific values. | Unclear if action has been taken |
| Road transportation: liquid and gaseous fuels | $CO_2$, $CH_4$ and $N_2O$ | GB | 43. Emissions of $CH_4$ and $N_2O$ from the use of LPG for road transportation and all emissions from the use of natural gas for road transportation are currently reported as "NE". According to the NIR and additional information provided to the ERT by the United Kingdom, $CH_4$ and $N_2O$ emissions from road transportation are estimated on the basis of information on vehicle kilometres travelled split by the petrol and diesel fuel types. Since this information is considered to be complete, this implies that $CH_4$ and $N_2O$ emissions from the use of LPG and natural gas for road transportation are included in the emission estimates for petrol and diesel. The United Kingdom also informed the ERT that the consumption of natural gas (and the related $CO_2$ emissions) is included under other categories in DUKES. The ERT recommends that the United Kingdom report these emissions as "IE" in its next annual submission and include transparent information on the reporting of the category in the NIR. | Implemented |
| Road transportation: liquid fuels | all gases | LU | 41. The ERT commends Luxembourg for the use of the COPERT IV model for its previous annual submission and for the efforts that the Party is making in order to better characterize the emissions under this category, owing to the large numbers of commuters and vehicles in transit through the country. These efforts include an extensive study to better estimate emissions from both the fuel tourism and from Luxembourg's fleet. The ERT recommends that Luxembourg provide, in its next annual submission, an explanation for the significant fluctuations in the implied emission factor of $N_2O$ for diesel oil and gasoline across the years of the time series. | Unclear if action has been taken |

| Sector | Gas | Member State | Comment UNFCCC report of the review of the 2010 submission | MS comment |
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| Road transportation: liquid fuels | $CH_4$ and $N_2O$ | BE | 45. Belgium reported in the NIR on recalculations of non-$CO_2$ transport emissions due to switching the COPERT III-based methodology to COPERT IV. This change in method was performed in the Flemish region for the entire time series, in the Walloon region for the years 2007 and 2008, but was not performed in the Brussels-Capital Region. The ERT noted that these recalculations resulted in a significant decrease of $N_2O$ emissions between 2006 and 2007. The ERT commends Belgium for its efforts in switching to an improved version of the COPERT model. However, the ERT recommends that Belgium use the same emission methodology for non-$CO_2$ emissions from road transportation for all regions and for the entire time series in order to maintain consistency and the same level of accuracy in its next annual submission. | Implemented for the the Brussels region for the complete time series, but not yet for the Walloon region for the years before 2007. |
| Road transportation: liquid fuels | $CO_2$ | GR | 47. The ERT also noted that inadequate information is provided in the NIR on the methodology used to split the AD for road transportation into the different calculation categories. The ERT recommends that Greece provide more detailed information on and justification for the AD on vehicle fleet population by class, fuel consumption rate, distance travelled and fuel use. | Implemented in 2011 NIR section 3.2.5.2 |
| Road transportation: liquid fuels | $CO_2$ | GR | 46. The ERT noted that Greece continues to apply the method used by the ERT in the initial review6 for calculating the consumption of lubricants for road transportation, which is based on the average lubricant consumption/fuel consumption ratio for the cluster of countries for the whole time series rather than on the data from the national energy statistics. The present ERT reiterates the recommendation of previous ERTs that Greece verify the data on lubricants used for road transportation and report thereon in its next annual submission. | Implemented in 2011 NIR section 3.2.5.2, figures 3.7 – 3.10 |
| Road transportation: liquid fuels, biofuels | $CO_2$ | FI | 40. Finland calculated fuel consumption and emissions from transport using the LIPASTO models developed by VTT. The submodels used for road transportation include LIISA. The NIR provides information on the models, general methodologies, fuel consumption and EFs used. Finland indicated, for example, that it uses the EFs of fossil transport fuels based on the product analysis carried out by Neste Oil laboratories. However, the EFs of biofuels are initial estimates justified by expert judgement. The ERT recommends that Finland provide additional information including documentation on how these EFs are derived by expert judgement, in order to improve transparency. | The calculation of bio-shares has been revised. The methodologies are described in corresponding sections of NIR. Table 3.2-3 includes $CO_2$ emissions factors for both fossil shares and biogenic shares of transport fuels. See NIR Table 3.2-3, Sections 3.3, 3.3.2.2, 3.3.2.6, 3.3.3.3, 3.3.4.3, 3.3.4.6, 3.3.5.3 and 3.4.2.3. |
| Stationary combustion: all fuels | $CO_2$ | IE | 53. Ireland uses estimates of $CO_2$ emissions reported under the EU ETS for its reporting of the energy industries category. However, the ERT noted that the fuel consumption data provided in the CRF tables are taken from the national energy balance. Because the fuel consumption data used to derive estimates of $CO_2$ emissions do not correspond to the data from the energy balance, the resulting implied emission factors (IEFs) are not comparable to those of other reporting Parties. During the review, Ireland confirmed that this was the case and also explained that the estimation of $CH_4$ and $N_2O$ emissions was based on the data from the energy balance presented in the CRF tables. This means that the data basis for the estimation and reporting of $CO_2$ and non-$CO_2$ emissions is not consistent. However, the ERT noted that fuel consumption is not consistently lower or higher in the EU ETS data compared with the data in the energy balance for individual categories. However, the ERT believes that emissions of $CH_4$ and $N_2O$ have not been clearly underestimated, while $CO_2$ emissions have been accurately estimated. The ERT strongly recommends that Ireland use consistent data for estimating emissions of all GHGs for its next annual submission. | The timing of Ireland's draft ARR 2010 did not allow sufficient time for this recommendation to be implemented in submission 2011. The inventory agency has already arranged meetings with Energy Balance provider to address these issues in 2011, for reporting in Submission 2012. |

| Sector | Gas | Member State | Comment UNFCCC report of the review of the 2010 submission | MS comment |
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| Stationary combustion: all fuels | $CO_2$, $CH_4$ and $N_2O$ | GB | 42. With regard to emissions from fuels used in manufacturing industries and construction, the United Kingdom has reported all emissions under the category other (manufacturing industries and construction), except for emissions from iron and steel. This significantly reduces the transparency of the inventory. Given that the United Kingdom's energy statistics are disaggregated according to the same categories as required in the CRF tables, previous ERTs have identified that the Party should have the institutional arrangements and/or capacity to report these emissions under the appropriate categories. Previous ERTs have recommended that the United Kingdom allocate these emissions to the appropriate categories in its future annual submissions. In response to questions raised by the previous ERT, the United Kingdom indicated that disaggregating data is possible but would require substantial work, and it indicated its plan to include these disaggregated data in its 2010 submission. However, this plan has still not been implemented. The present ERT reiterates the recommendation of previous ERTs and strongly recommends that the United Kingdom continue its efforts to allocate these emissions to different categories, and report thereon in its next annual submission. | Not yet implemented but work is ongoing and of high priority. The UK expects to be able to report at a more detailed level within the 1990-2010 inventory. |
| Stationary combustion: gaseous | $CO_2$ | BE | 42. The $CO_2$ IEF for other (manufacturing industries and construction) has been detected by the ERT as being unusually large for the years of 2006 and 2007. According to the Party, incorrect AD were reported in 2006 and 2007 in the Walloon Region and the corrected data will be reported in the 2011 submission. The energy consumption data originate from the regional energy balances of the three regions. $CO_2$ emissions were calculated by using default EFs from the Revised 1996 IPCC Guidelines. The ERT recommends that the Party report the corrected data in its next annual submission. | AD and IEF have been revised |
| Stationary combustion: gaseous and liquid fuels | $CO_2$ | GR | 43. The ERT noted that the estimates of emissions of $CO_2$, $CH_4$ and $N_2O$ from combustion of gaseous and liquid fuels in petroleum refining were recalculated for the years 2005-2007, on the basis of the plant-specific data of refineries on the amounts of natural gas and naphtha used for hydrogen production. However, it was only during the review that Greece provided detailed explanations of the recalculations made for the entire time series and the assumptions made. The ERT recommends that Greece report relevant information, including on recalculations of AD and EFs for the entire time series, as provided to the ERT during the review, in its next annual submission. | Implemented in 2011 NIR section 3.2.4.2. |
| Stationary combustion: gaseous and liquid fuels | $CO_2$ | GR | 44. The ERT found significant changes in the EFs for domestic and imported natural gas presented in the Party's 2010 NIR compared with those reported in the previous NIR. In response to a question raised by the ERT, Greece indicated that the $CO_2$ EF for natural gas was calculated for each year of the time series using country-specific data on the chemical composition of natural gas, and that for public electricity and heat production for the years 2005–2008 the EFs were based on plant-specific data (from the EU ETS reports). The ERT commends Greece's efforts to use country-specific and plant-specific EFs for key categories, and recommends that the Party include information on the data on chemical composition used to calculate the $CO_2$ EFs for natural gas and the background data used for the calculation of plant-specific EFs in its next annual submission. | Implemented in 2011 NIR section 3.2.4.2. |
| Stationary combustion: gaseous fuels | $CH_4$ and $N_2O$ | GR | 49. The changes in the IEFs for gaseous fuels in the subcategories food processing, beverages and tobacco, commercial/institutional and residential within the time series are large (e.g. the $N_2O$ IEF changes from 2.5 kg/TJ for the period 1990-1995 to 1 kg/TJ for the period 1998-2008). Greece attributes these changes to the introduction of the use of natural gas after 1995, which was used in addition to or instead of the gas works gas previously used. The ERT noted that, in accordance with the Revised 1996 IPCC Guidelines, gas works gas is considered a secondary solid fuel and should not be reported under gaseous fuels. The ERT recommends that Greece reallocate gas works gas to the appropriate fuel group in its next annual submission. | Implemented in 2011 NIR section 3.2.4.8 |

| Sector | Gas | Member State | Comment UNFCCC report of the review of the 2010 submission | MS comment |
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| Stationary combustion: liquid | $CO_2$ | BE | 40. The ERT noted that the inter-annual change (–6.7 per cent) in the $CO_2$ implied emission factor (IEF) for petroleum refining between 2007 (66.44 t/TJ) and 2008 (61.99 t/TJ) was unusually large compared with other years. The Party has stated that the reported figures for 2008 were temporary figures in the 2010 submission and that updated figures will be provided in the 2011 submission. This will result in an IEF for $CO_2$, which deviates from the 2007 value by less than 0.1 per cent. The AD for petroleum refining are taken from the Flemish energy balance, because Belgium's refineries are exclusively located in Flanders. $CO_2$ emissions are reported to the responsible authorities by the Belgian Petroleum Federation and the petroleum refining companies. Since 2005 (i.e. emissions for 2004), these emissions have been reported by the companies on an obligatory basis. However, in the NIR, there is no information on the methodology used for these calculations and no indication of whether it is in line with the IPCC good practice guidance. The ERT recommends that, in its next annual submission, the Party correct the overestimation of emissions and consumption which have been reported and that the Party provide detailed information on the methodology and EF used for the calculation of $CO_2$ emissions. | IEF has been revised |
| Stationary combustion: liquid | $CO_2$ | BE | 41. The ERT noted that the $CO_2$ IEF for other fuels for 2007 (70.74 t/TJ) for other (manufacturing industries and construction) is the lowest of the whole time series (70.74- 82.54 t/TJ). In response to questions raised during the review, the Party stated that the energy consumption data reported for 2007 in the Flemish Region were incorrect in the 2010 submission and corrected energy consumption data will be reported in the 2011 submission. The energy consumption data originate from the regional energy balances of the three regions. $CO_2$ emissions were calculated by using default EFs from the Revised 1996 IPCC Guidelines. The ERT recommends that the Party correct this error in its next annual submission. | IEF has been revised |
| Stationary combustion: liquid fuels | all gases | LU | 42. The ERT noted a sharp increase in the AD of liquid fuels for agriculture/forestry/fisheries from 2003 to 2004. In response to questions raised by the ERT during the review, the Party stated that one explanation could be that, during this period, diesel oil became tax exempt in order to lift the heavy burden of energy prices from the agriculture sector. The Party indicated that, in the process of the ongoing revision of the energy balance by STATEC, this particular point might be automatically revised. If not, the Party noted that further investigations need to be carried out in order to explain the increase. The ERT recommends that the Party include the explanation in its next annual submission. | Time series has been revised. |
| Stationary combustion: liquid, solid, gaseous and other fuels | $CO_2$ | AT | 51. As in previous review reports, the ERT noted a decrease in the $CO_2$ IEFs for liquid and other fuels from 1990 to 2008 (decreasing by 2.7 per cent and 13.0 per cent, respectively) reported for the category other (manufacturing industries and construction). Austria provided some information in the NIR and in response to earlier stages of the review process on how fluctuations in the fuel mix (fluctuations in petroleum coke used in cement industries) have an impact on the $CO_2$ IEFs; the Party explained that these IEFs can also be affected by the inclusion of plant-specific EFs since 2005 obtained from EU ETS data (waste reported under other fuels). In addition, Austria stated that the fuel use data used are consistent with the fuel consumption reported to IEA. The ERT reiterates the relevant recommendations made in the previous review report and encourages Austria to provide in its NIR more detailed explanations for these changes in the $CO_2$ IEFs for liquid and other fuels. Additionally, in categories with fluctuations in the mix of the type of fuel used and changes in country-specific EFs which lead to changes in the IEFs, such as in chemical industries, pulp, paper and print, and the category other, the ERT encourages Austria to provide detailed explanations for and supporting data on, for example, thecomposition of other fuels, together with the evolution over time of the IEFs, for as far back as 1990, if applicable, in the NIR of its next annual submission. The ERT recommends that Austria provide further details in its NIR on the impact of the inclusion of plant-specific EFs for the applicable source categories. | Implemented |

| Sector | Gas | Member State | Comment UNFCCC report of the review of the 2010 submission | MS comment |
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| Stationary combustion: liquid, solid, gaseous and other fuels | $CO_2$ | AT | 52. The commercial/institutional category shows very high inter-annual changes (ranging from –25.4 per cent to +58.1 per cent) in the estimated $CO_2$ emissions (mainly for the periods 1991–1992, 1994–1995, 1999–2003 and 2004–2008). The explanation provided by Austria in its response to earlier stages of the review process indicated that this category represents fuel combustion not allocated to any of the other categories (or what Austria terms the residual fuel consumption) and therefore has a high trend uncertainty. The ERT also noted for this category that the $CO_2$ IEFs for liquid fuels show variations between 1990 and 2008: the $CO_2$ IEF for 2008 (73.91 t/TJ) is 2.5 per cent lower than that for 1990 (75.81 t/TJ). The ERT recommends that Austria provide, in its next annual submission, detailed information on the changes in fuel consumption and IEFs and provide further information on the allocation of fuel use for this category versus the allocation of fuel use for other categories in the sector, where a specific allocation exists. | Work is on-going |
| Stationary combustion: other fuels | $CO_2$, $CH_4$ and $N_2O$ | GB | 44. As noted in the NIR, the $CO_2$ EF used for combustion of municipal solid waste (MSW) developed in 1993 has been reviewed and is considered to need improvement, since the composition of the waste has most likely changed over time; however, the choice of a new methodology and the revision of emission estimates were not possible for the 2010 submission. The ERT recommends that the United Kingdom report revised emission estimates in its next annual submission. Emissions from the incineration of MSW in heat generation are currently reported under other sectors, which is not in accordance with the IPCC good practice guidance. The ERT recommends that the United Kingdom reallocate these emissions to the category public electricity and heat production in its next annual submission. In response to a question raised by the ERT, the United Kingdom indicated that it intends to reallocate these emissions in its next annual submission. | Will be implemented in the 2012 submission. |
| Stationary combustion: solid fuels | $CH_4$ | GR | 50. The ERT noted unusual trends in the $CH_4$ IEF for solid fuels in manufacturing industries and construction: after a constant IEF (1 kg/TJ) for the period 1993-2004, in the following years of the time series the IEF shows inter-annual changes of 5-20 per cent. Greece explained that these changes were due to the introduction of alternative fuels, such as scrap tyres and other waste, in cement plants since 2005. The ERT recommends that Greece report scrap tyres and other waste used in cement production as other fuels, separately from solid fuels, in its next annual submission. | Implemented in 2011 NIR section 3.2.4.8 |
| Stationary combustion: solid fuels | $CO_2$ | FI | 39. Finland calculated $CO_2$ emissions from fuel combustion using a country-specific method and cross-checked the results with $CO_2$ emissions calculated from the national energy consumption reported in the national energy balance sheet using a top-down calculation as the reference approach. As already indicated by the Party, the ERT recommends that Finland include the results of the cross-check in its next annual submission. The country-specific method uses detailed AD on fuel consumption and fuel-specific EFs. Finland has a detailed database of EFs and a calculation system. In response to questions raised by the ERT during the review on the use of these country-specific $CO_2$ EFs, Finland indicated that it uses data collected through the EU ETS for the calculations to supplement and verify the inventory data; monitored EU ETS data for $CO_2$ emissions are only available for the inventory years 2005-2008 and allocation of the EU ETS data is not always sufficiently detailed for inventory purposes. The Party indicated that, among others, the issue of how to address time-series consistency for the years prior to the implementation of the EU ETS needs to be resolved before the EU ETS data use in the inventory can be, substantially increased. | Work is ongoing |

| Sector | Gas | Member State | Comment UNFCCC report of the review of the 2010 submission | MS comment |
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| Stationary combustion: solid fuels | $CO_2$ | GR | 42. The ERT noted that the NCVs and carbon EFs for lignite are significantly different for energy industries and for manufacturing industries and construction. In response to a question raised by the ERT during the review, Greece provided detailed information explaining and justifying this difference, including that the lignite is distributed from different mining fields. The ERT recommends that Greece include this information in its next NIR. | Implemented in 2011 NIR section 3.2.4.2. |
| Stationary combustion: solid fuels | $CO_2$ | IT | 38. Italy has reported the reductants (coke) used in iron and steel production under the energy sector; however, the Revised 1996 IPCC Guidelines recommend that this be reported under the industrial processes sector. The ERT recommends that Italy report in its next annual submission the use of reductants in iron and steel production under the industrial processes sector instead of under the energy sector, ensuring that there is no double-counting between the two sectors. | The quantity of carbon stored in steel produced has been accounted for in the carbon balance of the iron and steel production ensuring no double counting occurs. The carbon balance methodology does not imply to separate off input between the energy and industrial sectors. |
| Stationary combustion: solid fuels | $CO_2$ | IT | 39. In response to a question raised by the ERT during the review week on how Italy accounts for the sequestration of carbon in steel, the Party responded that its current method assumes that the carbon is emitted as $CO_2$, which results in an overestimation of around 100,000 Gg $CO_2$. The ERT recommends that, as a part of reallocating the emissions from the use of reductants in iron and steel production to the industrial processes sector, the Party amend its methodology to take account of the quantity of carbon stored in steel produced, in order to avoid a subsequent overestimation of $CO_2$ in the industrial processes sector. | see above (para 38) |
| Stationary combustion: solid, liquid and gaseous fuels | $CO_2$ | LU | 38. The ERT commends Luxembourg's efforts in increasing the transparency of the NIR by including additional data tables and discussions to explain the changes in emission trends within the time series, such as the phasing out of the use of blast furnace gas by power plants to generate electricity and the start-up of a new gas and steam turbine plant. With respect to the use of blast furnace gas, the ERT recommends that Luxembourg reallocate emissions from any iron and steel autoproducers in public electricity and heat production to the iron and steel category in its next annual submission, as recommended in the previous review report, to ensure consistency and comparability. | Implemented |
| Stationary combustion: solid, liquid and gaseous fuels | $CO_2$ | LU | 39. The $CO_2$ EF for natural gas used by Luxembourg to estimate emissions from combustion sources is based on normal conditions (with temperature set to 0 °C). In the NIR, it is not transparent whether that is the standard temperature set by distribution companies in the European Union when measured at metering stations. If metering devices are measuring natural gas volume set to a different standard temperature (greater than 0 °C) than the derived $CO_2$ EF for natural gas needs to be adjusted accordingly, in order to ensure that $CO_2$ emissions are not overestimated. To increase the transparency and accuracy of the emission estimate, the ERT recommends that the Party provide additional discussion in its next NIR, in particular on the applicability of the $CO_2$ EF for natural gas taking into account the temperature-dependent volume at metering stations. | Unclear if action has been taken |
| Stationary combustion: solid, liquid and gaseous fuels | $CO_2$ | LU | 40. Luxembourg reports all emissions from manufacturing industries and construction under other (manufacturing industries and construction). The ERT noted large inter-annual fluctuations in the emissions from gaseous fuels between 1990 and 1991, from liquid fuels between 2004 and 2005 and from solid fuels between 2000 and 2001. Explanations of contributing factors are not included in the NIR. To help increase the transparency of the observed trends and to ensure time-series consistency, the ERT recommends that Luxembourg provide, in its next annual submission, a discussion of energy consumption, in order to support the reported emission trends. | Several revisions and recalcualtions were made, but unclear if additional information is included in the NIR. |

| Sector | Gas | Member State | Comment UNFCCC report of the review of the 2010 submission | MS comment |
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| Stationary combustion: solid, liquid and other fu-els | $CO_2$ | DK | 56. Public electricity and heat production is the main subcategory in the GHG inventory of Denmark. In 2008, $CO_2$ emissions from the combustion of solid fuels in public electricity and heat production amounted to 15,255.49 Gg, or 23.6 per cent of total GHG emissions. The emission series 1990–2005 has been estimated using a constant EF value of 95.00 t/TJ, while for the emission series 2006–2008 Denmark has used plant-specific data reported under the EU ETS for a number of thermal power plants. The NIR reports that, for 2008, these data were available from 17 coal-fired power plant units, which account for 95 per cent of the Danish coal consumption and 48 per cent of the total $CO_2$ emissions from stationary combustion plants. The impact of the use of these plant-specific data reflects in the time series of the $CO_2$ implied emission factor (IEF) as follows: 95.00 t/TJ/GJ (1990–2005), 94.42 t/TJ (2006), 94.26 t/TJ (2007) and 93.96 t/TJ (2008). Previous reviews (2008 and 2009) have recommended that Denmark provide information to confirm that the plantspecific data are in line with the Revised 1996 IPCC Guidelines and the IPCC good practice guidance. | The documentation in NIR has been improved and reference to tiers and stan-dards included. |
| Stationary combustion: solid, liquid and other fu-els | $CO_2$ | DK | 57. The 2010 NIR indicates that the plant-specific data employed in the Danish inventory only include data from plants using higher tier methods, as defined in the corresponding EU decision (European Commission, 2007), which establishes the specific methods for de-termining carbon content, oxidation factor and calorific value and in-cludes rules for measuring, reporting and verification. During the re-view, the inventory team confirmed that: (i) Denmark does not em-ploy the plant information under the EU ETS that has been estimated using tier 1 and tier 2 methods as defined in the corresponding EU decision, which are not necessarily in line with the IPCC good prac-tice guidance; (ii) DEA holds all emission reports submitted under the EU ETS (para. 47 above) and NERI has complete access to this information; and (iii) NERI performs some QA/QC checks on these emission reports, particularly detecting unusual values. The ERT re-commends that Denmark improve the discussion of the use of plant-specific information under the EU ETS by providing a more transpa-rent and self-contained explanation about the scope of tier 3 methods for stationary combustion within this framework in such a way that the reader is not forced to consult the EU decision document5 to un-derstand the implications of the selection of these data. | The documentation in NIR has been improved and reference to tiers and stan-dards included. |
| Stationary combustion: solid, liquid and other fu-els | $CO_2$ | DK | 58. The Danish Energy Statistics 20086 reports net calorific values (NCVs) for electricity-plant coal in the range 24.30-25.80 GJ/t in the period 1990-2008. The time series of these NCVs exhibits significant variability, most likely associated with the different origins of an-nually imported coal and the variability of coal itself. It is well known that, on average, there is an inverse relationship between the $CO_2$ EF and NCV for all fuels. This inverse relationship does not oc-cur for electricity-plant coal between the time series of the $CO_2$ IEF of the Danish inventory and the time series of the NCV reported by DEA. The ERT recommends that, through DEA, Denmark corrobo-rate the accuracy of the reported NCV. After having confirmed the validity of the NCV reported by DEA, the ERT recommends that Denmark: (a) Include a QC check for the data reported under the EU ETS that uses the NCV of the fuel to detect the possible existence of unusual values and bias; (b) Explore the possibility of obtaining a correlation between the carbon content and the NCV of coal reported by the selected facilities that have used tier 3 methods under the EU ETS, taking into account the recent scientific literature (e.g. Fott, 1999; Mazumdar,2000; Mesroghli et al., 2009). | The correspondence be-tween NCV and $CO_2$ emission factor in the ap-plied EU ETS data for coal has been analysed. The analysis and discus-sions with the Danish Energy Agency and power plant owners will continue in 2011. An improved $CO_2$ emission factor time-series (1990-2005) have been implemented. The QC check for outliers per-formed by NERI is now mentioned in NIR. |
| Stationary combustion: solid, liquid and other fu-els | $CO_2$ | DK | 59. If a satisfactory correlation is obtained, the ERT further recom-mends that Denmark use this correlation to generate the time series 1990-2005 of $CO_2$ EFs and recalculate the corresponding emissions. | Implemented (see above) |

| Sector | Gas | Member State | Comment UNFCCC report of the review of the 2010 submission | MS comment |
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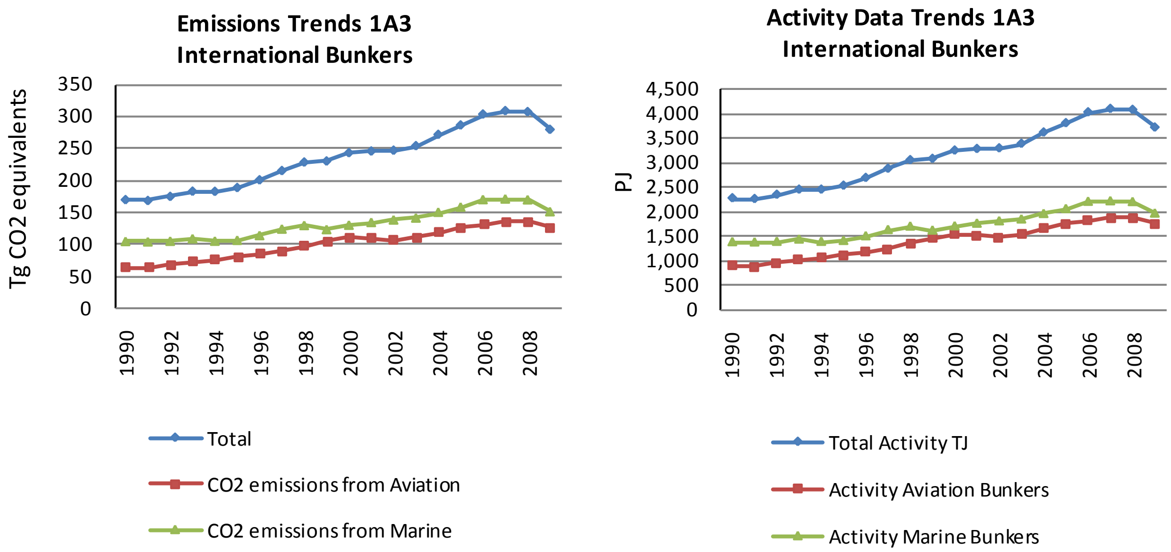
| Stationary combustion: solid, liquid and other fuels | $CO_2$ | DK | 60. Denmark has also used plant-specific data under the EU ETS to estimate $CO_2$ emissions from thermal power plants burning liquid fuels reported under public electricity and heat production. The NIR reports that, for 2008, these data were available from 19 power plant units burning residual fuel oil and for five units burning gas oil. The ERT recommends that Denmark explore the relationship between the $CO_2$ EFs for residual fuel oil and gas oil reported under the EU ETS and the corresponding NCV reported by DEA. The ERT also notes that the recommendations for coal-fired power plants provided in paragraph 59 above apply to liquid fuels. | This will be included in the future discussions with DEA. Improved emission factor time-series for source sector 1A1a based on EU ETS data have been implemented for residual oil. The emission factor for other sectors now refers to IPCC (1996). |
| Stationary combustion: solid, liquid and other fuels | $CO_2$ | DK | 63. The NIR does not discuss the fate of medical and hazardous wastes. During the review, Denmark informed the ERT that these types of waste are also incinerated with energy recovery. To improve transparency, the ERT recommends that Denmark provide background information in the next NIR on the incineration of medical and hazardous wastes for energy purposes. | This information is now provided in the NIR. |
| Stationary combustion: solid, liquid and other fuels | $CO_2$ | DK | 64. The emissions arising from fuels used in cement production are reported under the subcategory other (manufacturing industries and construction). Emissions from other fuels are reported as not occurring ("NO") in the period 1990-2002, while the time series of $CO_2$ IEF values in the period 2003-2008 are as follows: 78.88 t/TJ (2003-2005), 46.97 t/TJ (2006), 66.92 t/TJ (2007) and 93.91 t/TJ kg/GJ (2008). During the review, Denmark explained that a large variety of fuels with different biogenic/fossil shares are combusted in cement production. The ERT recommends that Denmark revise the variability of $CO_2$ EFs, particularly before and after the introduction of plant-specific data under the EU ETS. To improve transparency, the ERT recommends that Denmark include in the NIR an explanation of the different fuels covered under other fuels. | A description of the “Other fuels” will be included in the NIR. |
| | | DE | Review report (In-country review 2010) not yet available | |
| | | ES | Review report (Centralized review 2010) not yet available. | |
| | | FR | Review report (In-country review 2010) not yet available | |
| | | NL | Review report (Centralized review 2010) not yet available. | |
| | | SE | Review report (Centralized review 2010) not yet available. | |

## 3.8 International bunker fuels (EU-15)

International bunker emissions include emissions from Aviation bunkers and Marine bunkers. The emissions of the EU inventory are the sum of the international bunker emissions of the Member States ([28]). Between 1990 and 2009, greenhouse gas emissions from international bunker fuels increased by 64.1 % in the EU-15. $CO_2$ emissions from “Marine bunkers” account for 54 % of total greenhouse gas emissions from international bunkers in 2008, $CO_2$ from “Aviation bunkers” accounts for 44.2 % (Figure 3.92).

**Figure 3.92 International bunker fuels: GHG emission trend and activity data**




### 3.8.1 Aviation bunkers (EU-15)

This source category includes emissions from flights that depart in one country and arrive in a different country (include take-offs and landings for these flight stages).

$CO_2$ emissions from Aviation Bunkers account for 3.4 % of total GHG emissions in 2009 but are not included in the national total GHG emissions (Table 3.110).

The Member States France, Germany, Spain and the United Kingdom contributed more than two thirds to the EU-15 emissions from this source. All Member States increased emissions from Aviation bunkers between 1990 and 2009.

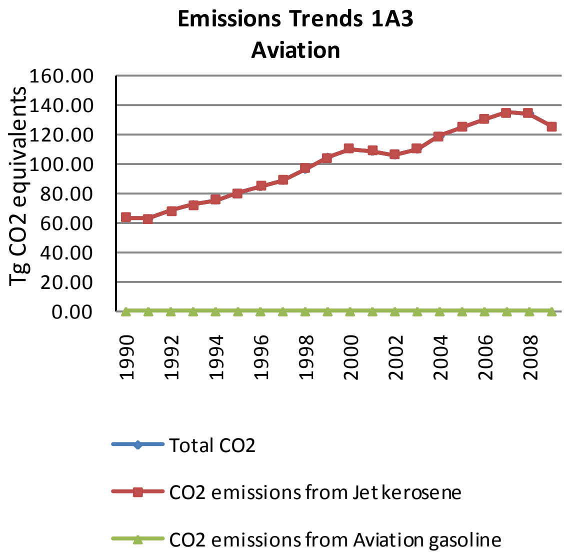
([28]) The definitions in Tables 2.8 and 2.9 of the IPCC good practice guidance are based on activities within ‘one country”. This means domestic aviation is defined for individual countries. The decision tree in Figure 2.8 of the IPCC good practice guidance considers ‘national fuel statistics’ for domestic aviation. As the EC is neither a country nor a nation, the EC’s interpretation of the good practice guidance is that the emission estimate at EC level has to be the sum of Member States estimates for domestic air or marine transport as they are the countries or nations addressed in the definition and decision trees of the IPCC good practice guidance.

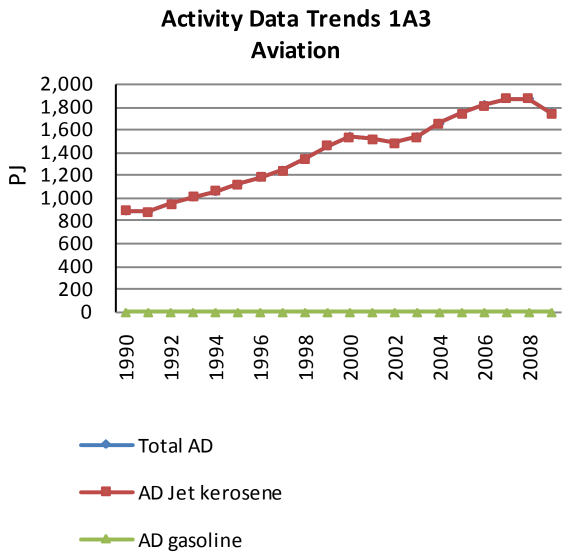
**Table 3.110** **Aviation bunkers: Member States' contributions to $CO_2$**

| Member State | $CO_2$ emissions in Gg | | | Share in EU15 emissions in 2009 | Change 1990-2009 | | Change 2008-2009 | |
|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) |
| Austria | 886 | 2,182 | 1,893 | 1.5% | 1,007 | 114% | -289 | -15% |
| Belgium | 3,095 | 4,301 | 4,404 | 3.5% | 1,308 | 42% | 103 | 2% |
| Denmark | 1,736 | 2,648 | 2,314 | 1.8% | 578 | 33% | -334 | -14% |
| Finland | 1,008 | 1,792 | 1,570 | 1.2% | 562 | 56% | -222 | -14% |
| France | 8,549 | 17,243 | 15,832 | 12.6% | 7,284 | 85% | -1,411 | -9% |
| Germany | 12,022 | 25,646 | 24,959 | 19.8% | 12,937 | 108% | -687 | -3% |
| Greece | 2,448 | 3,040 | 2,615 | 2.1% | 168 | 7% | -425 | -16% |
| Ireland | 1,061 | 2,782 | 2,194 | 1.7% | 1,133 | 107% | -588 | -27% |
| Italy | 4,161 | 10,087 | 8,968 | 7.1% | 4,808 | 116% | -1,119 | -12% |
| Luxembourg | 394 | 1,313 | 1,255 | 1.0% | 861 | 218% | -57 | -5% |
| Netherlands | 4,540 | 11,135 | 10,214 | 8.1% | 5,674 | 125% | -921 | -9% |
| Portugal | 1,453 | 2,590 | 2,425 | 1.9% | 972 | 67% | -165 | -7% |
| Spain | 5,660 | 13,606 | 12,564 | 10.0% | 6,904 | 122% | -1,043 | -8% |
| Sweden | 1,335 | 2,354 | 1,993 | 1.6% | 658 | 49% | -361 | -18% |
| United Kingdom | 15,638 | 34,255 | 32,783 | 26.0% | 17,144 | 110% | -1,472 | -4% |
| **EU-15** | **63,985** | **134,973** | **125,982** | **100.0%** | **61,997** | **97%** | **-8,991** | **-7%** |

$CO_2$ emissions from jet kerosene account for 99,99 % of total emissions from "Aviation bunkers" in 2009 (Figure 3.93**).** All Member States increased emissions from jet kerosene between 1990 and 2009. Member States with the highest increase between 1990 and 2009 in percent were Luxembourg, the Netherlands and Spain. On the other hand, Greece was the country with the lowest increase.

**Figure 3.93** **Aviation bunkers: Trend of $CO_2$ Emissions and Activity Data**

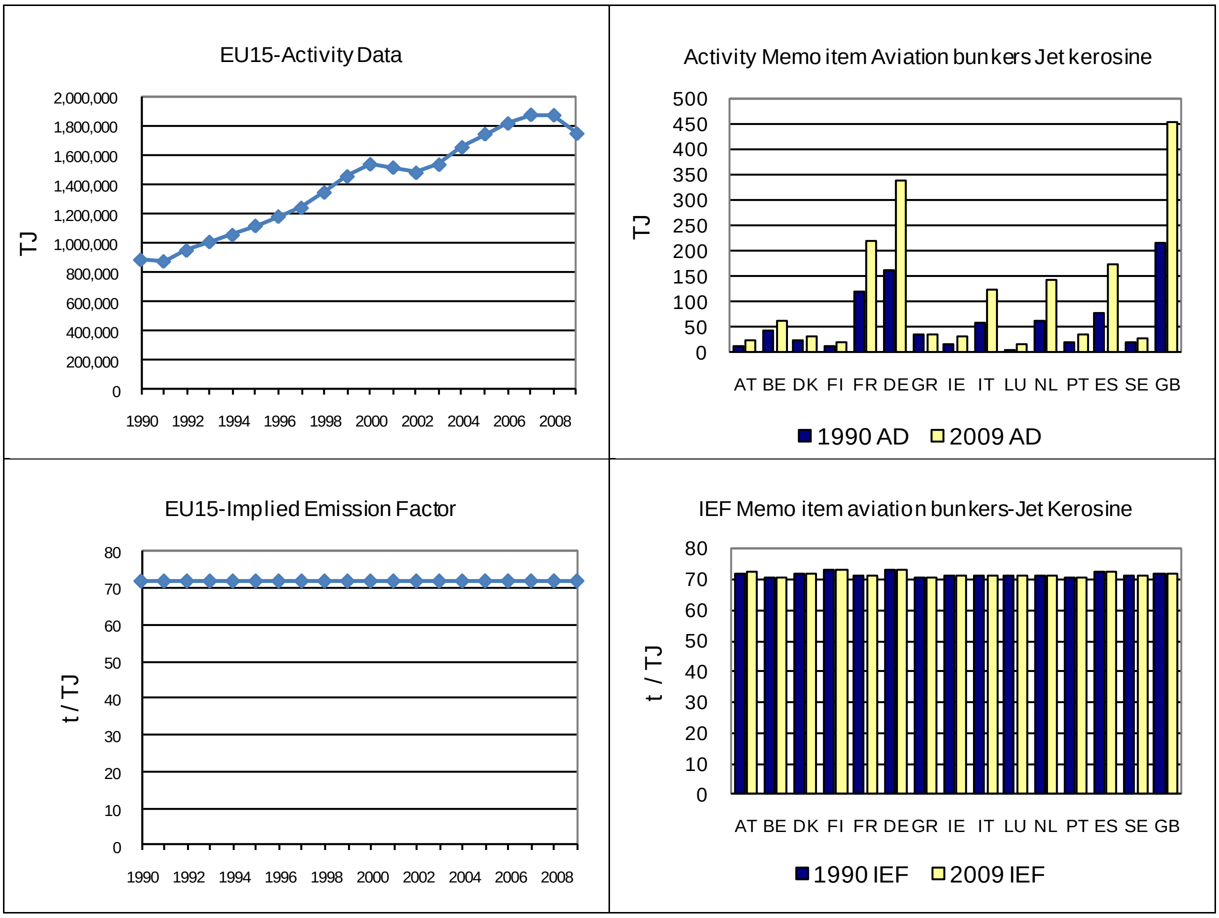


### 3.8.1.1 Aviation Bunkers – Jet Kerosene ($CO_2$)

Figure 3.94 provides an overview of activity data and emission factors for EU-15 and those Member States contributing most to EU-15 emissions. Fuel combustion of EU-15 increased by 97 % between 1990 and 2009. The EU-15 implied emission factor was at 72.02 t/TJ in 2009.

**Figure 3.94 Aviation bunkers, Jet kersoene: Activity Data and Implied Emission Factors for $CO_2$**




## 3.8.2 *Marine bunkers (EU-15)*

This source category includes emissions from fuels used by vessels of all flags that are engaged in international water-borne navigation. The international navigation may take place at sea, on inland lakes and waterways and in coastal waters. Marine bunkers include emissions from journeys that depart in one country and arrive in a different country. Marine bunkers exclude consumption by fishing vessels (see Other Sector - Fishing).

$CO_2$ emissions from “Marine bunkers” account for 4.05 % of total GHG emissions in 2009 and are also not included in the national total GHG emissions. Between 1990 and 2009, $CO_2$ emissions from Marine bunkers increased by 43 % in the EU-15 (Table 3.111).

The Member States Belgium, Spain and the Netherlands contributed most to the emissions from this source (63.9 %) in 2009. Between 1990 and 2009, Denmark and Finland decreased emissions from Marine bunkers; France kept them constant whereas all the other Member States increased them. The Member States with the highest increase in absolute terms again were Belgium, Spain and the Netherlands.

**Table 3.111 Marine bunkers: Member States' contributions to $CO_2$ emissions**

| Member State | $CO_2$ emissions in Gg | | | Share in EU15 emissions in 2009 | Change 1990-2009 | | Change 2008-2009 | |
|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) |
| Austria | 19 | 31 | 31 | 0.02% | 12 | 66% | -1 | -2% |
| Belgium | 13,307 | 30,973 | 22,696 | 15.1% | 9,388 | 71% | -8,277 | -36% |
| Denmark | 3,005 | 2,809 | 1,487 | 1.0% | -1,518 | -51% | -1,323 | -89% |
| Finland | 1,845 | 1,305 | 809 | 0.5% | -1,035 | -56% | -496 | -61% |
| France | 7,890 | 8,115 | 7,897 | 5.2% | 7 | 0% | -217 | -3% |
| Germany | 7,915 | 9,542 | 8,737 | 5.8% | 821 | 10% | -806 | -9% |
| Greece | 8,028 | 9,768 | 8,294 | 5.5% | 266 | 3% | -1,474 | -18% |
| Ireland | 57 | 221 | 303 | 0.2% | 247 | 434% | 83 | 27% |
| Italy | 4,389 | 8,437 | 7,258 | 4.8% | 2,868 | 65% | -1,180 | -16% |
| Luxembourg | 0.1 | 0.1 | 0.1 | 0.0% | 0 | 59% | 0 | -25% |
| Netherlands | 34,357 | 49,470 | 45,766 | 30.4% | 11,408 | 33% | -3,704 | -8% |
| Portugal | 1,383 | 1,952 | 1,778 | 1.2% | 395 | 29% | -174 | -10% |
| Spain | 11,528 | 27,841 | 27,651 | 18.4% | 16,123 | 140% | -190 | -1% |
| Sweden | 2,228 | 6,991 | 7,281 | 4.8% | 5,053 | 227% | 290 | 4% |
| United Kingdom | 9,091 | 11,452 | 10,664 | 7.1% | 1,574 | 17% | -787 | -7% |
| **EU-15** | **105,041** | **168,907** | **150,652** | **100.0%** | **45,610** | **43%** | **-18,255** | **-12%** |

$CO_2$ emissions from residual fuel oil account for 88.3 % of total emissions from "Marine bunkers" in 2009 (Figure 3.95). Between 1990 and 2009, $CO_2$ emissions from residual fuel oil increased by 63.5 % in the EU-15. All Member States, except for Denmark and Finland, increased emissions from residual oil between 1990 and 2009. Member States with the highest increase in percent were Ireland and Sweden.

$CO_2$ emissions from gas/diesel oil account for 11.4 % of total emissions from "Marine bunkers" in 2009. Between 1990 and 2009, $CO_2$ emissions from gas/diesel oil decreased by 25.3 % in the EU-15.

**Figure 3.95 Marine bunkers: Trend of $CO_2$ Emissions and Activity Data**

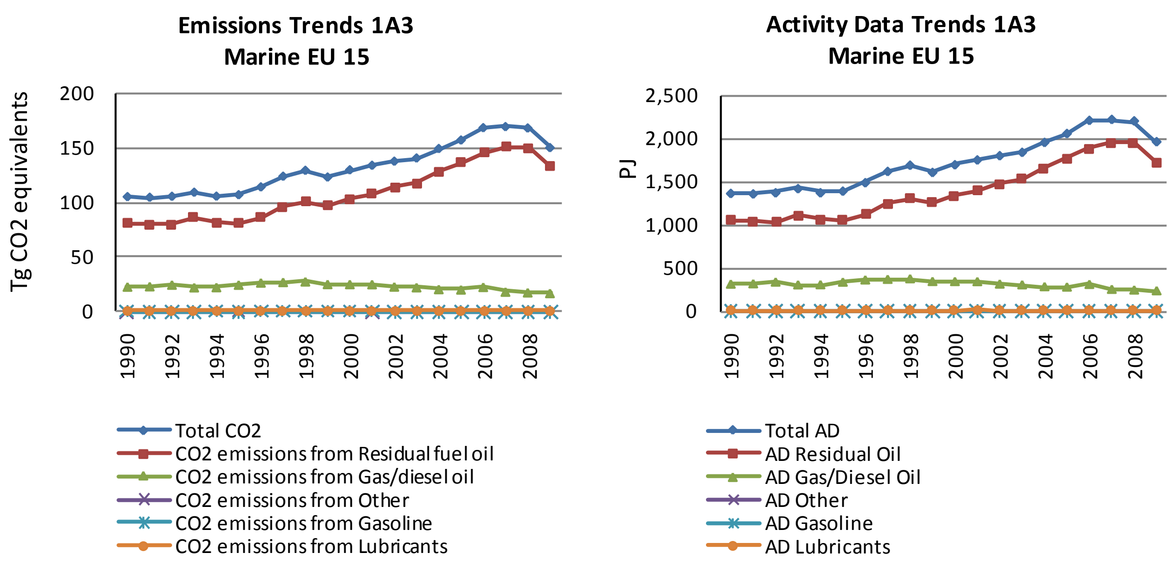
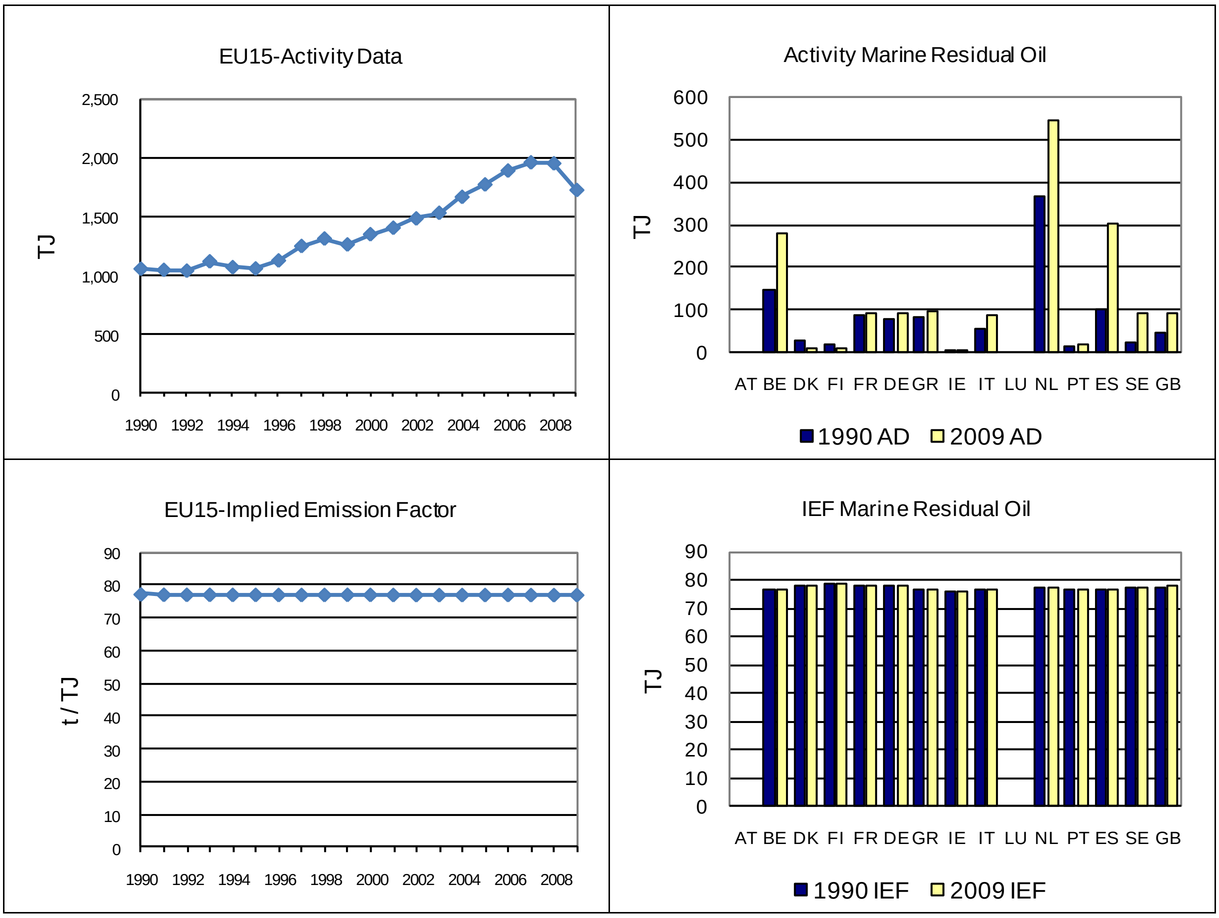



Figure 3.96 and Figure 3.97 provide an overview of activity data and emission factors for residual oil and gas/diesel oil for EU-15 and those Member States contributing most to EU-15 emissions.

### 3.8.3 Marine Bunkers – Residual Oil ($CO_2$)

Combustion of residual oil in the EU-15 increased by 64 % between 1990 and 2009. The EU-15 implied emission factor was at 77.17 t/TJ in 2009.

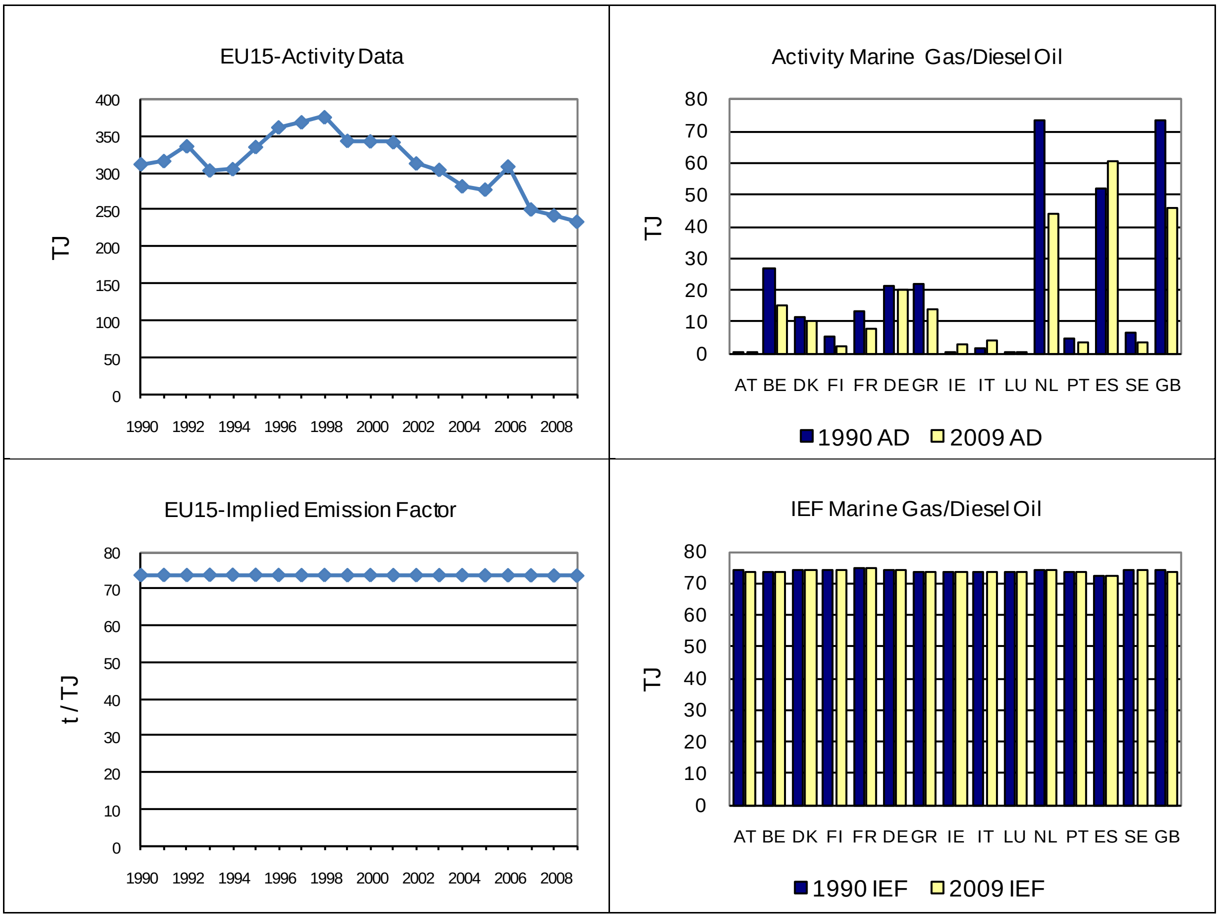
**Figure 3.96 Marine bunkers' – Residual Oil: Activity Data and Implied Emission Factors for $CO_2$**



### 3.8.3.1 Marine Bunkers – Gas/Diesel Oil ($CO_2$)

Combustion of gas/diesel oil in the EU-15 decreased by 25 % between 1990 and 2009. The EU-15 implied emission factor was at 73.6 t/TJ in 2009.

**Figure 3.97 Marine bunkers, Gas/Diesel Oil: Activity Data and Implied Emission Factors for $CO_2$**




## 3.8.4 QA/QC activities

### 3.8.4.1 2007 Study

The European Topic Centre on Air and Climate Change conducted a study in 2007 based on aviation emission estimates from Member States and calculations by the European Organisation for the Safety of Air Navigation (Eurocontrol). The purpose of the study was to compare emissions reported by Member States with modelling results provided by Eurocontrol to assess the quality of the emissions estimates and help identify areas in need for improvement. The calculations by Eurocontrol are based on flight movement data using an independent data set whereas most Member States use fuel sale statistics. The study assessed three questions: (i) how consistent are estimates for total fuel consumption between the two data sets; (ii) how consistent are estimates for the share of domestic aviation between the two data sets; (iii) does the consistency between the two estimates depend on the type of methodology applied by Member States. The main conclusions of the study were:

Comparing country estimates for fuel burn, $CO_2$ emissions and NOx with Eurocontrol calculations is a genuine quality assurance exercise which can help both sides in improving their data. Despite significant uncertainties in the estimates the comparison was able to identify countries for which the differences could not be easily explained and where countries as well as Eurocontrol might need to do further analysis. Especially for the share of domestic aviation Eurocontrol data might be of use to several countries in the future.

The analysis showed that although in theory $CO_2$ estimates from aviation do not depend on the tier chosen, in practice countries applying higher tiers also had more consistent carbon dioxide emission estimates. One of the reasons might be that the application of higher tiers requires detailed statistics in the aviation sector which might also be reflected in the fuel sale estimates.

The use of bottom-up data for the determination of the split between domestic and international aviation could improve the accuracy of inventory estimates. The small country approach is a good and very easy methodology for countries without domestic IFR/GAT aviation; research projects can produce good estimates for the share of domestic emissions. Out of the 29 countries assessed those applying expert judgement or top-down data had the highest discrepancies compared to Eurocontrol.

In general, the European countries tend to overestimate domestic emissions. This is a conservative approach as it increases the emissions included in the emission reduction commitment under the Kyoto Protocol. For the same reason it would be in the interest of the concerned countries to improve their estimates: greenhouse gas emissions from aviation have increased substantially since 1990 and overestimating the domestic share will exacerbate the efforts for reaching the national targets. Applying the share of domestic aviation as calculated by Eurocontrol to total fuel consumption in the EU-15 leads to an overestimation of domestic emissions from aviation by 6.2 Mt $CO_2$ in 2005.

**2011 pilot web-portal**

At the end of 2010 the European Commission signed a framework contract with Eurocontrol regarding 'support to the European Commission in relation to climate change policy and the implementation of the EU ETS'. The support project is organised in different Work Packages corresponding to the different areas identified in the framework contract.

One of these Work Packages (WP) pertains to the improvement of GHG and air pollutant emissions inventories submitted by the 27 Member States and the European Union to the UNFCCC and to the UNECE. The main objective of the WP is to assist EU Member States improve the reporting of annual greenhouse gas (and other air pollutant) emission inventories by e.g. estimating the fuel split domestic/international using real flight data from Eurocontrol. The European Environment Agency and its European Topic Centre on Air Pollution and Climate Change Mitigation will assist DG CLIMA regarding the technical requirements.

For instance, the EEA and its ETC ACM, as agreed in their 2011 implementation plan, will provide content and functional specifications to Eurocontrol for the development of an online inventory-data portal by 30 April 2011. This will include user-testing of the web-portal which shall be established and maintained by Eurocontrol. Eurocontrol will develop a pilot version of the web-portal by 31 July 2011 to be used for evaluation and test purposes only. The EEA and its ETC ACM will provide feedback to Eurocontrol and may suggest further improvements. During the autumn of 2011, the EEA and its ETC will compare Eurocontrol estimates with those from national GHG emission inventories (i.e. fuel split domestic/international). The findings will be presented to WG1 of the Climate Change Committee.

A series of telephone, video conferences and meetings have been organised with Eurocontrol. Preliminary discussions earlier in 2011 have revealed the type of information that can be used for estimating emissions from domestic and international aviation according to UNFCCC/IPCC guidelines.

There exist two sources of flight data in Eurocontrol that may be suitable for the web portal:

1. **AEM model description:**

AEM (Advanced Emission Model) is the model used by Eurocontrol for calculating aircraft emissions based on flight track. This model is ICAO-CAEP stamped.

Emissions and pollutants covered by AEM are: HC; SOx; NOX; CO; $CO_2$; H2O; PM total, non-volatile part and volatile part, PM10, PM2.5, PM0.1 and of fuel Burned.

Below 3,000 ft, the fuel burned calculation is based on the Landing and Take-Off Cycle (LTO) defined by the ICAO Engine Certification specifications. ICAO LTO covers four engine operation modes, which are used in AEM to model the six following phases of operation: Taxi-Out, Taxi-In (Idle), Take-Off, Climb-Out, Approach and Landing (Approach). The ICAO Engine Exhaust Emissions Data Bank includes emission indices and fuel flow for a very large number of aircraft engines. AEM links each aircraft appearing in the input traffic sample to one of the engines in the ICAO Engine Exhaust Emissions Data Bank.

Above 3,000 ft, fuel burned calculations are based on the "Base of Aircraft Data" BADA). This database provides altitude and attitude dependent performance and fuel burned for more than 150 aircraft types. Emission calculations are based on the ICAO Engine Exhaust Emissions Data Bank, but emission factors and fuel flow are adapted to the atmospheric conditions at altitude by using a method initially developed by The Boeing Company (The Boeing Method 2 - BM2) and modified by Eurocontrol (BFFM2). BFFM2 makes it possible to estimate emissions of NOx, HC, CO pollutants. The emissions for the H2O and $CO_2$ pollutants are a direct result of the oxidation process of the carbon and hydrogen contained in the fuel with the oxygen contained in the atmosphere. The SOx emissions depend directly on the sulphur content of the fuel used. All three are directly proportional to the fuel burned. Benzene emissions, as well as VOC, TOG and all pollutants derived from VOC-TOG, are proportional to the HC emissions.

## 2. PAGODA description:

PAGODA is a front-end to an Oracle database called PRISME. It computes fuel burned and emission estimates as defined by the ANCAT 3 method based on distance flown and type of aircraft as available in PRISME. PAGODA provides different level of aggregation and different access views depending on user access rights.

The EU GHG inventory submission in 2012 will reflect some of the results from the ongoing collaboration with Eurocontrol to improve the split of domestic / international fuel use and greenhouse gas emissions.

## 3.9 Feedstocks and non-energy use of fuels

Following a recommendation of the expert review team the EU GHG inventory team analyzed in more detail the fractions of carbon stored as used by the EU and its Member States. The recommendation of the ERT was to use weighted average fractions in order to potentially reduce the differences for apparent consumption between the reference approach and the sectoral approach. Following this exercise the EU inventory team revised the fractions of carbon stored for those fuels where the IPCC default values (used by the EU up to 2008) are far from the weighted averages of the EU Member States (i.e., for natural gas and lubricants). Table 3.112 provides an overview of the fraction of carbon stored by fuel as used in the EU GHG inventory 2010. These values are compared with the IPCC default values and the weighted average values of the EU-15 MS.

**Table 3.112 Fraction of carbon stored from Table 1A(c) used by the EU-15 Member States compared with IPCC default values and the values used in the EU GHG inventory 2010**

| 2008 | Weighted average based on EU-15 MS GHG inventories 2009 | IPCC default (used by the EU before 2009) | Values used in the EU GHG inventory 2010 |
|---|---|---|---|
| Naphtha | 0,76 | 0,75 | 0,75 |
| Lubricants | 0,74 | 0,50 | 0,75 |
| Bitumen | 1,00 | 1,00 | 1,00 |
| Coal Oils and Tars | 0,78 | 0,75 | 0,75 |
| Natural Gas | 0,53 | 0,33 | 0,50 |
| Gas/Diesel Oil | 0,60 | 0,50 | 0,50 |
| LPG | 0,75 | 0,80 | 0,80 |
| Ethane | 0,70 | 0,80 | 0,80 |

Table 3.113 provides an overview on how Member States treat emissions from feedstocks and non-energy use of fuels.

**Table 3.113 Information related to feedstocks and non-energy use from Member States' NIRs**

| MS | Information on feedstocks and non-energy use of fuels | Source |
|---|---|---|
| Austria | Non-energy use of fuels is considered in the national energy balance. Below explanations for the reported non-energy use is provided together with information on where $CO_2$ emissions due to the manufacture, use and disposal of carbon containing products are considered.<br>For fraction of carbon stored the IPCC default values are applied for all fuels except for coke oven coke, of which the amount carbon stored in steel was calculated.<br>**Lubricants**<br>**manufacture:** emissions are assumed to be included in total emissions from category 1 A 1 b petroleum refinery.<br>**use:** emissions from the use of motor oil are included in $CO_2$ emissions from transport. VOC emissions from lubricants used in rolling mills are considered in category 2 C 1. It is assumed that other uses of lubricants do not result in VOC or $CO_2$ emissions due to the low vapour pressure of lubricants.<br>**disposal:** emissions from incineration of lubricants (waste oil) are either included in categories 1 A 1 a and 1 A 2 if waste oil is used as fuels or in category 6 C respectively if energy is not recovered.<br>**Bitumen**<br>**manufacture:** emissions from the production of bitumen are assumed to be included in total emissions of category 1 A 1 b petroleum refinery.<br>**use:** indirect $CO_2$ emissions from the use of bitumen for road paving and roofing that should be reported in categories 2 A 5 and 2 A 6 are included in sector 3 solvent and other product use.<br>**disposal:** $CO_2$ emissions from the disposal from bitumen are assumed to be negligible. Recycling is not considered.<br>**Natural Gas**<br>**manufacture:** emissions from the use of natural gas as a feedstock in ammonia production are accounted for in the industrial processes sector (category 2 B 1).<br>**use/disposal:** not applicable, no $CO_2$ emissions result from the use or disposal of ammonia.<br>**Coke oven coke**<br>**manufacture:** emissions from the production of coke are considered in category 1 A 2 a.<br>**use:** $CO_2$ emissions from coke used in iron and steel industry are reported under 2 C.<br>**disposal:** not applicable.<br>**Other bituminous coal**<br>In (IEA JQ 2008) non energy use is reported for the manufacture of electrodes.<br>**manufacture:** No information about emissions from manufacture of electrodes is currently available.<br>Therefore it is not clear if emissions are not estimated or not applicable.<br>**use:** Emissions from the use of electrodes are considered in category 2 B 4 carbide production<br>and 2 C metal production.<br>**disposal:** not applicable.<br>**Other oil products**<br>**manufacture:** emissions from the production of ethylene and propylene are included in total emissions of category 1 A 1 b petroleum refinery. $CO_2$ emissions from solvent use are considered in sector 3 solvent and other product use.<br>**use:** $CO_2$ emissions from solvent use are considered in sector 3.<br>**disposal:** emissions from the disposal of plastics in landfills are considered in 6 A and from the use of plastic waste as a fuel in 1 A 2; emissions from the incineration of plastic in waste without energy recovery is included in 6 C; emissions from incineration of plastics in waste with energy recovery are considered in 1 A 1 a. | Austria's National Inventory Report 2011, Mar 2011, pp.78-79 |

| MS | Information on feedstocks and non-energy use of fuels | Source |
|---|---|---|
| Belgium | Categories 1A2 and 2B<br><br>The emissions of non-energy use of fuels and related emissions (emissions from recovered fuels from processes) are reported under categories 1A2, 2B1 and 2B5.<br><br>As a result of the in-country review performed by the expert review team of UNFCCC in June 2007, the emissions reported in category 2G during the previous submissions are no longer included in the Belgian emission inventory. In this category 2G the emissions from the non-energy use of fuel were reported, estimated by using the IPCC default emission factors of carbon stored during the use of lubricants and solvents. Following the advise of the expert review team, these emissions of $CO_2$ from the use of solvents and lubricants will only arise when they are burned or destroyed. As a consequence these emissions are excluded out of the Belgian emission inventory during this submission.<br><br>In Flanders, a recalculation of the non-energy use and related $CO_2$ emissions was performed during the 2005 submission, based on the results of a study conducted in 2003 [43]. The default % of carbon stored in the IPCC Guidelines were considered to be inaccurate in the Flemish situation. The default % of carbon stored in the 1996 IPCC guidelines are not well defined: it is not clear what is included or excluded in these default % (f.i. is the waste phase included or not?). Belgium participated in a European network on the $CO_2$-emissions from non-energy use (see website http://www.chem.uu.nl/nws/www/nenergy/) and one of the conclusions of this network is that the new IPCC guidelines need to give more information on this subject.<br><br>To our opinion, the guidelines are also not very clear on the allocation of the resulting emissions: in the CRF table 1.A(d), as part of the reference approach, a country should specify in the documentation box where these emissions are allocated. This problem of allocation should be tackled also.<br><br>Since the petrochemical industry is important in Flanders and Belgium and the emissions from the feed stocks are a key source in the Belgian inventory, the study mentioned above was conducted to get more detailed, country-specific information. A distinction was made between :<br><br>1. The use of recovered fuels from cracking units or other processes where a fuel is used as raw material and where part of this fuel (or transformed product) is recovered for energy purposes. These emissions are reported under category 1A2c 'other fuels'. This is the largest source of $CO_2$ emissions. The involved industry is reporting the $CO_2$ emissions and PJ for these recovered fuels.<br><br>2. $CO_2$ emissions occurring during chemical processes, for example the production of ammonia based on natural gas or the production ethylene oxide where $CO_2$ is formed in a side reaction (reported respectively under 2B1 and 2B5 other). The industry involved is reporting these $CO_2$ emissions directly for these processes.<br><br>3. Waste treatment of final products is not included in the study. This is practically impossible due to import/export of plastic products, etc (it is also not clear if the waste phase is included in the default IPCC carbon stored % or not). The emissions of waste incineration are therefore calculated separately and are reported under the sector of waste (category 6C) or under the sector of energy (category 1A1a), whether or not energy recuperation takes place during the process.<br><br>The result of the study made a recalculation possible for all years. The effect of the recalculation was greater in the more recent years because the petrochemical industry has expanded its activities in the beginning of the nineties (that's one of the reasons this sector is a key source).<br><br>The resulting emissions are reported under different sections. The first and largest part (recovered fuels) of the resulting emissions is reported under 1A2c, under 'other fuels'. This includes other fuels in the chemical sector, a result of recovered fuels in the steam cracking units in petrochemical industry (approx. 2/3) and other recovered fuels from the chemical industry (approx. 1/3). These recovered fuels are reported directly in the yearly surveys carried out by the chemical federation in cooperation with the VITO [1] to establish a yearly Flemish energy balance. The choice was made to allocate these fuels under 'other fuels' and not 'liquid fuels' or 'gaseous fuels', for transparency reasons.<br><br>Another part of the emissions surveyed in the study, are considered to be process emissions and are reported under 2B. These include the $CO_2$-emission during the production of ammonia (2B1) and other process $CO_2$ emissions (2B5) reported by the chemical industry in Flanders (for example production of ethylene oxide, production of acrylic acid from propene, production of cyclohexanone from cyclo-hexane, production of paraxylene/meta-xylene, etc). These $CO_2$ emissions result from the same surveys in the chemical sector in Flanders as those reported under 1A2c. In the survey, more sources of emissions from chemical processes are reported than are described in the IPCC 1996 guidelines. | Belgium´s Greenhouse Gas Inventory 1990-2009, Mar 2011, pp.46-47 |
| Denmark | The Danish national energy statistics includes three fuels used for non-energy purposes; bitumen, white spirit and lubricants. The total consumption for non-energy purposes is relatively low, e.g. 10.6 PJ in 2009. The use of white spirit is included in the inventory in 'Solvent and other product use'. The emissions associated with the use of bitumen and lubricants are included in 'Industrial Processes'. The non-energy use of fuels is included in the reference approach for Climate Convention reporting. Emissions from non-energy use of fuels have been included in other source categories than fuel combustion of the Danish inventory. | Denmark's National Inventory Report 2011<br><br>Mar 2011 p. 138 |

| MS | Information on feedstocks and non-energy use of fuels | Source |
|---|---|---|
| Finland | To calculate the emissions from the non-specified burning of feedstocks there is a separate module in ILMARI. The ILMARI system includes point source (bottom-up) data on feedstock combustion in the petrochemical industry as well as recycled waste oil combustion in different branches of industry, and they are reported in corresponding subcategories of 1.A 2. These specified energy uses of feedstock and lubricants are subtracted from the corresponding total amounts. For the rest of the feedstock 100% of carbon is estimated to be stored in products (mainly plastics). For the rest of lubricants, 33% of carbon is estimated to be stored in products (recycled lubricants) and 67% of carbon released as $CO_2$ either in burning of lubricants in motors or illegal combustion of waste oil in small boilers. These non-specified emissions from burning of feedstocks (which are not included in 1.A 2) are included in category 1.A 5.<br><br>Emissions from natural gas used as feedstock are calculated and reported in sector 2.B 5. | Greenhouse Gas emissions in Finland 1990-2009, Mar 2011<br><br>p. 117 |
| France | Les combustibles fossiles peuvent être consommés pour différents usages tels que la combustion pour des besoins énergétiques ou en tant que matière première, intermédiaire ou agent réducteur. Tous les types de combustibles sont concernés et sont différenciés, en fonction des cas, selon les usages énergétiques et non énergétiques, dans le bilan de l‟énergie. Le cas des combustibles solides, liquides et gazeux sont différenciés ci-dessous :<br><br>En ce qui concerne les *consommations de combustibles solides* (charbon et coke de charbon), le bilan de l‟énergie du SOeS comptabilise tous les usages dans les consommations énergétiques. Quoiqu‟il en soit, les usages énergétiques et non énergétiques sont bien distingués dans l‟inventaire. Les consommations de combustibles solides en tant que réducteurs ou intermédiaires sont considérées dans le code CRF 2C pour les sites sidérurgiques et de production de ferro-alliages.<br><br>Les *produits pétroliers* à usage non énergétique sont essentiellement consommés sur les sites pétrochimiques. Ces usages sont bien connus et font l‟objet d‟une enquête exhaustive de la part du SOeS10. Selon les résultats de cette enquête, environ 12% de la consommation française de produits pétroliers est utilisée non comme source d‟énergie, mais comme matière première pour la chimie organique. Cette enquête définit les quantités des différentes bases pétrolières consommées ainsi que les productions des vapocraqueurs dont une part de produits autoconsommés par le vapocraqueur (fioul lourd et fuel gas) à des fins énergétiques. Les consommations de ces produits à usage énergétique sont bien comptabilisées dans les consommations énergétiques de produits pétroliers dans le bilan de l‟énergie français et les émissions de GES associées sont prises en compte dans la catégorie CRF 1A2.<br><br>Seules des émissions de $CH_4$ sont donc estimées pour les usages non énergétiques des vapocraqueurs et rapportées dans le code CRF 2B5. Les émissions liées à la combustion des huiles moteur pour les 2-temps sont prises en compte dans la catégorie CRF 1A3. Les émissions des huiles récupérées et brûlées dans les procédés type cimenterie sont prises en compte dans la catégorie CRF 1A2 et celles traitées en incinérateurs de déchets spéciaux en CRF 6.<br><br>Enfin, le principal usage non énergétique du *gaz naturel* correspond à la production d‟ammoniac. Les émissions de $CO_2$ associées sont comptabilisées dans le code CRF 2B. | Rapport National D'Inventaire pour la France<br><br>Mar 2011<br><br>p.81-82 |
| Germany | In cooperation with the University Utrecht, the emissions from non-energy use of fuels were assessed within a research project in 2007. The results have been compared to the $CO_2$ reference approach. In the following results of the study are summarized (source: NIR 2007, Annex 2, p. 465-472).<br><br>Germany uses the results of the research project "Estimating $CO_2$ Emissions from the Non- Energy Use of Fossil Fuels in Germany" in order to improve the inventory of non-energy use of fuels. In this research project non-energy use of fossil fuels is calculated with the NEAT-Model (Non-energy Use Emission Accounting Tables) that was developed at Utrecht University (Netherlands). NEAT calculates the non-energy use of fossil fules and the resulting emissons with a mass-balance and a material-flow analysis. These calculations are almost independent from data from the official energy balance but require data from production and external trade and detailed knowledge of the structure of the of the chemical industry. The emissions from the ammonia production are considerably higher with the NEAT model than with the IPCC sectoral approach. This is mainly due to the assumption of rather efficient plants in the NEAT model. The emissions from aluminium production are considerably higher with the NEAT model than with the IPCC sectoral approach. The main reason for this difference is the lower emission factor used in the IPCC sectoral approach. Based on the results of the research project Germany plans further improvements. | Nationaler Inventarbericht zum deutschen Treibhausgasinventar 1990-2009<br><br>Mar 2011<br><br>p. 148 |

| MS | Information on feedstocks and non-energy use of fuels | Source |
|---|---|---|
| Greece | Non-energy use of fuels in Greece refers to the consumption of:<br>• naphtha, natural gas, and lignite (for the period 1990 – 1991) in chemical industry,<br>• petroleum coke in the production of non-ferrous metals,<br>• lubricants in transport (including off-road transportation),<br>• bitumen in construction and<br>• other petroleum products in the industrial and residential sectors<br><br>The calculation of carbon dioxide emissions from non-energy use of fuels is based on the relevant consumption by fuel type and the fraction of the carbon stored by fuel type<br><br>Data on the non-energy consumption of fuels derive from the national energy balance. However,<br><br>plant specific data derived from verified ETS reports and information provided by specific greek<br><br>industries resulted to the improvement of reallocation of non-energy use fuels from the energy to<br><br>the industrial processes sector:<br>• The non-energy use of natural gas for ammonia production has been reallocated in industrial processes sector, by using data from ETS reports and plant specific information. Non-energy use of lignite is accounted in Energy sector and refers only to ammonia production (in one installation for 1990 and 1991) and as a result the fraction of carbon stored is equal to 0. The operation of this installation ended at 1998 while it did not produce ammonia for the period 1992 – 1998.<br>• No data regarding non-energy use in the iron and steel industry are reported in the national energy balance and, as a result, $CO_2$ emissions from the use of fuels as reduction agents, are only reported under the industrial processes sector.<br>• Solid fuels consumption in the ferroalloys production industry is included (in the national energy balance) in the solid fuels consumption of the non-ferrous metals sector. However, by using data from ETS reports and plant specific information, emissions from solid fuels for ferroalloys production are reallocated to the industrial processes sector, as from 2010 submission.<br>• The non-energy use of petroleum coke (see Table 3.9) refers exclusively to the primary aluminium production. Given that the relevant emissions are reported under the industrial processes sector, petroleum coke consumption is not taken into account in the energy sector.<br><br>On the basis of the above-mentioned clarifications, the possibility to double-count or underestimate $CO_2$ emissions from the non-energy use of fuels is minor. | Annual Inventory submission to the EC<br><br>Mar 2011<br><br>pp.80-81 |
| Ireland | Naphtha was previously the only petroleum product to be considered in relation to non-energy fuel-use, where the carbon is not fully released as in combustion. The IPCC default value of 0.50, 0.75 and 1.0 are used for the proportion of carbon stored in lubricants, naphtha and bitumen respectively. Ireland"s only oil refinery is a small hydroskimming refinery where there is no production of other petroleum products normally used for non-energy purposes, such as bitumen, lubricants, plastics and asphalt. The expanded SEAI energy balance sheets now record the import of some of these products, thereby allowing improved completeness in the Reference Approach estimation of $CO_2$ emissions and carbon storage. A significant amount of natural gas feedstock was traditionally used in ammonia production in Ireland but the company closed in 2003 and there is consequently no feedstock use of natural gas since then. | Ireland National Inventory Report 2011<br><br>Mar 2011<br><br>p. 58 |

| MS | Information on feedstocks and non-energy use of fuels | Source |
|---|---|---|
| Italy | Data on petrochemical and other non-energy use of fuels are based on a rather detailed yearly report available by the Ministry of Economic Development (MSE). The report summarizes answers from a detailed questionnaire that all operators in Italy prepare monthly. The data are more detailed than those normally available by international statistics and refer to:<br><br>- input to plants (gross input);<br><br>- quantities of fuels returned to the marked (with possibility to estimate the net input);<br><br>- fuels used internally for combustion;<br><br>- quantities stored in products.<br><br>National energy balances include only the input and output quantities from the petrochemical plants; so the output quantity could be greater than the input quantity, due to internal transformation. Therefore it is possible to have negative values for some products (mainly gasoline, refinery gas, fuel oil).<br><br>The quantities of fuels stored in products, in percentage on net and gross petrochemical input, are estimated with these data. The amount of quantity stored in products for each fuel is calculated as the difference between input (petrochemical input) and output (returns to refinery and internal consumption and losses); these amounts are transformed in carbon stored. Non-energy products quantity amount stored are reported in the BEN and the carbon stored is estimated with emission factors reported in Table 3.35. Fuel quantity reported in TJ in Table 1.A(d) of the CRF are the amount of fuels stored; for this matter the fractions of carbon stored are all equal to 1.<br><br>An attempt was made to estimate the quantities stored in products using IPCC percentage values as reported in table 1-5 and the fuels reported as "petrochemical input" in Table 3.35. The resulting estimate of about 5,940 Gg of products for the year 2008, is almost 50% bigger than the quantities reported, 4,040 Gg.<br><br>At national level this methodology seems the most precise according to the available data. The European Project "Non Energy use-$CO_2$ emissions" ENV4-CT98-0776 has analysed the Italian methodology performing a mass balance between input fuels and output products in a sample year. The results of the project confirm the reliability of the reported data. | Italian Greenhouse Gas Inventory<br><br>1990-2008<br><br>National Inventory Report 2010, April 2010, pp.99-101 |
| Luxembourg | Non-energy use of fuels is considered in the national energy balance. Below explanations for the reported non-energy use is provided together with information on where $CO_2$ emissions due to the manufacture, use and disposal of carbon containing products are considered. For fraction of carbon stored the IPCC default values are applied for all.<br><br>Lubricants<br><br>Manufacturing: manufacturing of lubricants does not occur in Luxembourg.<br><br>Use: Emissions from the use of motor oil (by default 50% of the total quantity of lubricants sold) should be included in $CO_2$ emissions from transport. It is assumed that other uses of lubricants do not result in VOC or $CO_2$ emissions due to the low vapour pressure of lubricants.<br><br>Disposal: incineration of lubricants (waste oil) does not occur in Luxembourg. Waste oil is either recycled or exported.<br><br>Bitumen<br><br>Manufacturing: manufacturing of bitumen does not occur in Luxembourg.<br><br>Use: by default the carbon contained in bitumen is considered to be entirely stored in the product, i.e. asphalt for road paving.<br><br>Disposal: $CO_2$ emissions from the disposal of bitumen are assumed to be negligible. Recycling is not considered.<br><br>Coke oven coke<br><br>Manufacturing: not occurring. All coke used in the iron and steel industry was imported.<br><br>Use: $CO_2$ emissions from coke used in iron and steel industry are reported under 2.C.1 – Iron and Steel Production.<br><br>Disposal: not applicable.<br><br>Other bituminous coal<br><br>Manufacturing: Manufacturing of electrodes from anthracite used in the electric arc furnaces does not occur in Luxembourg.<br><br>Use: Emissions from the use of electrodes in the iron and steel production are considered in category 2.C.1 – iron and steel production.<br><br>Disposal: not applicable.<br><br>Other oil products<br><br>Manufacturing: not occurring. All products such as white spirits, etc. are imported.<br><br>Use: $CO_2$ emissions from solvent use are considered in sector 3.<br><br>Disposal: emissions from the disposal of plastics in landfills are considered in 6.A and emissions from incineration of plastics in waste with energy recovery are considered in 1 A 1 a. | Luxembour g's National Inventory Report 1990-2009<br><br>Apr 2011<br><br>p. 154f |

| MS | Information on feedstocks and non-energy use of fuels | Source |
|---|---|---|
| Netherlands | 46% of the gross national consumption of petroleum products is used in non-energy applications, mainly as feedstock (naphta) in the petrochemical industry and in products in many applications (bitumen, lubricants, etc.). Also a fraction of the gross national consumption of natural gas (6%, mainly in the ammonia production) and coal (2%, mainly in the iron and steel production) is used for non-energy applications and hence not directly oxidised. In many cases, these products will finally be oxidised in waste incinerators or during use (lubricants in two stroke engines). In the Reference Approach these product flows are excluded from the calculation of $CO_2$ emissions.<br>The $CO_2$ emissions reported in category 2G stem from the direct use of specific fuels for non-energy purposes, which results in partially or fully 'oxidation during use (ODU) of the carbon contained in the products – for example, lubricants, waxes and other fuels. With the exception of lubricants and waxes no other fuels are included in this category. Oxidation for mineral turpentine is included in Sector 3 (Indirect $CO_2$ of solvent use).<br>Feedstock/non-energy uses of fuels in the energy statistics are also part of the IPCC Reference Approach for $CO_2$ from fossil fuel use. The fraction of carbon not oxidised during the use of these fuels during product manufacture or other uses is subtracted from total carbon contained in total apparent fuel consumption by fuel type. The fractions stored/oxidised have been calculated as three average values, one for gas, liquid and solid fossil fuels:<br>• 77.7±2% for liquid fuels<br>• 55.5±13% for solid fuels<br>• 38.8±4% for natural gas.<br>These were calculated from all processes for which emissions are calculated in the NA, either by assuming a fraction oxidised, for example ammonia, or by accounting for by-product gases (excluding emissions from blast furnaces and coke ovens). (In Table A.4.4 of the NIR 2005, the calculation of annual oxidation fractions for 1995-2002 are presented and the average values derived from them.) It shows indeed that the factors show significant interannual variation, in particular for solid fuels. The use of one average oxidation factor per fuel type for all years, whereas in the derivation of the annual oxidation figures differences up to a few per cent points can be observed, are one reason for differences between the RA and the corrected NA. In the Netherlands about 10 to 25% of all carbon in the apparent consumption of fossil fuels is stored. | Greenhouse Gas Emissions in the Netherlands<br>National Inventory report 2011<br>1990-2009 pp.48, 88, 211-212 |
| Portugal | Emissions of greenhouse gas emissions from feedstock use are only clearly accounted in the inventory in the following situations:<br>- emission of $CO_2$ resulting from use of feedstock sub-products as energy sources. That is the case of emissions from consumption of fuel gas in refinery and petrochemical industry;<br>- emission of $CO_2$ liberated as sub-product in production processes such as ammonia production;<br>- emission of NMVOC from fossil fuel origin, and occurring from solvent use and evaporation. Although in this case it is not possible to establish which part results from feedstock consumption in Portugal in the energy balance;<br>However, some potential emissions are not estimated or are only partly estimated. Those that are estimated in the reference approach but not in sectoral approach are:<br>- emissions from mineral oil use as lubricants;<br>- emissions from wear of bitumen in roads.<br>It is evident that more efforts should be made to estimate other emissions from feedstock use, although it is expected that reporting guidelines should give more clear guidance in the future. | Portuguese National Inventory Report on Greenhouse Gases 1990-2009<br>Ma 2011<br>p.3-187 |
| Spain | The consumption of fuel for non-energy use is accounted for in the energy balance. The quantities of each fuel type are included in the reference approach. For each fuel type a split into two parts is given: a) the part that stays in the product and b) the part that is set free and causes the corresponding $CO_2$ emissions. | Inventario de emissiones de gases de efecto invernadero de Espana años 1990-2006, March 2008,p. 1.23 |

| MS | Information on feedstocks and non-energy use of fuels | Source |
|---|---|---|
| Sweden | Activity data on feedstocks and non-energy use of fuels is collected from the quar-terly fuel statistics. As also noted in Annex 2 section 1.1.1, in the survey form for the quarterly fuel statistics, respondents are among many other things asked to specify whether fuels are used as raw materials or for energy purposes. This facili-tates the use of data for CRF table 1Ad, non-energy use of fuels.<br><br>Data on carbon from coke, bound in produced ferroalloys is collected directly from the only ferroalloy producer and is added to the remaining data on carbon from coke. Estimates of carbon stored are derived by multiplying given energy amount with emission factors for $CO_2$ (as given in Annex 2 section 1.2 and Appen-dix 1) multiplied by 12/44 (the weight of one atom of carbon is by definition 12/44 the weight of one molecule of $CO_2$).<br><br>$CO_2$ emissions derived from non-energy use of fuels and reported under CRF 1B and CRF 2 (e.g. flaring of gases and iron and steel process emissions) are added under CRF 1Ad and linked to the CRF 1Ab as carbon stored (see Annex 4). | National Inventory<br><br>Report 2011 Sweden<br><br>Mar 2011<br><br>p. 81-82 |
| United Kingdom | Following the review of stored carbon, the procedure adopted is to assume that emissions from the non-energy use of fu-els are zero (i.e. the carbon is assumed to be sequestered as products), except for cases where emissions could be identi-fied and included in the inventory:<br><br>• Catalytic crackers – regeneration of catalysts;<br>• Ammonia production;<br>• Aluminium production – consumption of anodes;<br>• Combustion of waste lubricants and waste solvents;<br>• Burning of lubricants during use in engines;<br>• Use of waste products from chemical production as fuels;<br>• Emissions of carbon due to use and/or disposal of chemical products;<br>• Incineration of fossil carbon in products disposed of as waste.<br><br>In addition, an estimate is made of lubricants burnt in vehicle engines. Carbon emissions from these sources are calcu-lated using a carbon factor derived from analysis of eight samples of waste oil (Passant, 2004). In 2005, the combustion of lubricating oils within engines was reviewed. Analysis by UK experts in transport emissions and oil combustion have lead to a revision to the assumptions regarding re-use or combustion of lubricating oils from vehicle and industrial ma-chinery.<br><br>The fate of the unrecovered oil has now been allocated across several IPCC source sectors including road, rail, marine, off-road and air transport. Emissions from these sources are reported under 1A3b, 1A3d & 1A4c. Some of the unrecov-ered oil is now allocated to non-oxidising fates such as coating on products, leaks and disposal to landfill.<br><br>Emissions can occur from products from the chemical industry. Sources of emissions include burning of waste products and final products (e.g. flaring and use of wastes as fuels, or burning of candles, firelighters and other products etc.) or degradation of products after disposal resulting in $CO_2$ emissions (including breakdown of consumer products such as detergents etc.).<br><br>After considering the magnitude of the sources in relation to the national totals, the uncertainty associated with emis-sions, and the likely reporting requirements in the 2006 IPCC Guidelines, emissions of carbon from the following sources were included in the 2004 GHG inventory (2006 NIR) and subsequent NIRs:<br><br>• Petroleum waxes;<br>• Carbon emitted during energy recovery - chemical industry;<br>• Carbon in products - soaps, shampoos, detergents etc; and<br>• Carbon in products – pesticides. | UK Greenhouse Gas Inventory, 1990 to 2009<br><br>Mar 2011<br><br>Annex 3, pp. 478-480 |

# 4 INDUSTRIAL PROCESSES (CRF SECTOR 2)

This chapter starts with an overview on emission trends in CRF Sector 2 Industrial processes. Then for each EU-15 key source overview tables are presented including the Member States (MS)' contributions to the key source in terms of level and trend, and information on methodologies and emission factors. The quantitative uncertainty estimates are summarised in a separate section. Finally, the chapter includes a section on recalculations and on sector-specific QA/QC activities. In addition, overviews of Member States' responses to UNFCCC review findings for industrial processes source categories are provided.

## 4.1 Overview of sector (EU-15)

CRF Sector 2 Industrial Processes is the third largest sector contributing 7 % to total EU-15 GHG emissions in 2009. The most important GHGs from this sector are $CO_2$ (4.1 % of total GHG emissions), HFCs (1.8 %) and $N_2O$ (0.6 %). The emissions from this sector decreased by 29 % from 353 Tg in 1990 to 250 Tg in 2009 (Figure 4.1). In 2009, the emissions decreased by 13.8 % compared to 2008, as a consequence of the economic recession. Cement production dominates the trend until 1997. Factors for declining emissions in the early 1990s were low economic activity and cement imports from Eastern European countries. Between 1997 and 1999 the trend is dominated by reduction measures in the adipic acid production in Germany, France and the UK. In addition, between 1998 and 1999 large reductions were achieved in the UK due to reduction measures in hydrochlorofluorocarbons (HCFC) production. The large decrease in 2009 was driven by reductions in cement production and iron and steel production.

The key sources in this sector are:

- 2 A 1 Cement Production: ($CO_2$)
- 2 A 2 Lime Production: ($CO_2$)
- 2 A 3 Limestone and Dolomite Use: ($CO_2$)
- 2 B 1 Ammonia Production: ($CO_2$)
- 2 B 2 Nitric Acid Production: ($N_2O$)
- 2 B 3 Adipic Acid Production: ($N_2O$)
- 2 B 5 Other: ($CO_2$)
- 2 C 1 Iron and Steel Production: ($CO_2$)
- 2 C 3 Aluminium production: (PFC)
- 2 E 1 By-product Emissions: (HFC)
- 2 E 1 By-product Emissions: ($SF_6$)
- 2 E 2 Fugitive Emissions: (HFC)
- 2 F 1 Refrigeration and Air Conditioning Equipment : (HFC)
- 2 F 3 Fire Extinguishers: (HFC)
- 2 F 4 Aerosols/ Metered Dose Inhalers: (HFC)

**Figure 4.1** **CRF Sector 2 Industrial Processes: EU-15 GHG emissions for 1990–2009 in $CO_2$ equivalents (Tg)**

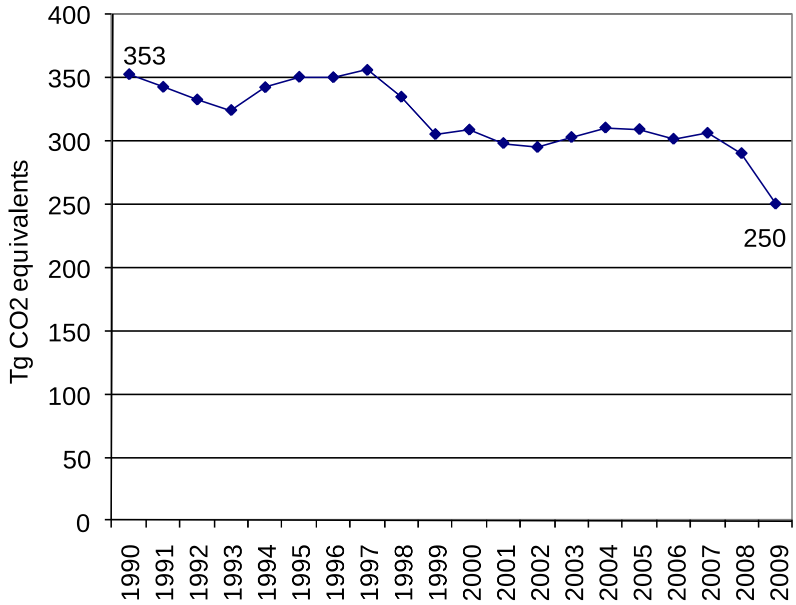
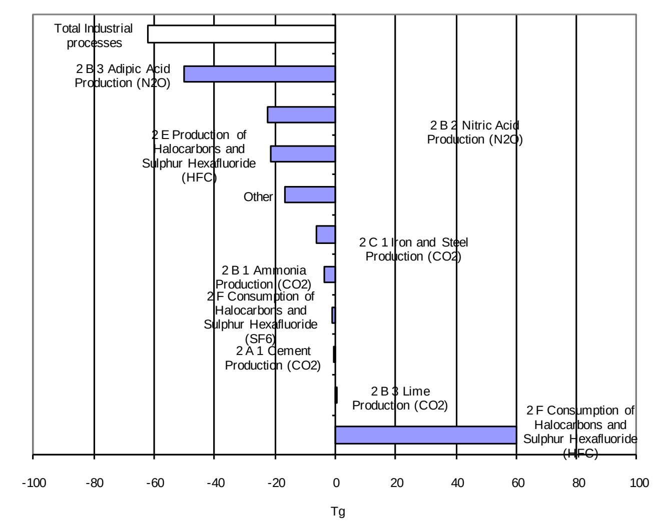
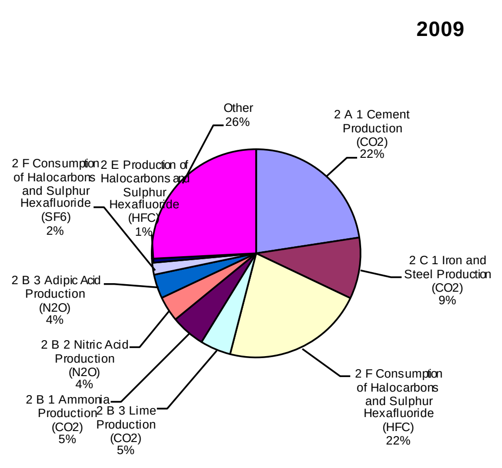



Figure 4.2shows that large emission reductions occurred in adipic acid production ($N_2O$) mainly due to reduction measures in Germany, France, the UK and Italy, and in production of halocarbons and $SF_6$ (HFCs). Additional $N_2O$ emission reductions were achieved in nitric acid production. Large HFC emission increases can be observed from consumption of halocarbons and $SF_6$. Figure 4.2 shows that the three largest key sources account for about two thirds of total process-related GHG emissions in the EU-15.

**Figure 4.2** **CRF Sector 2 Industrial processes: Absolute change of GHG emissions by large key source categories 1990–2009 in $CO_2$ equivalents (Tg) and share of largest key source categories in 2009**



## 4.2 Source categories (EU 15)

### *4.2.1 Mineral products (CRF Source Category 2A) (EU-15)*

The source category 2A Mineral Products includes three key sources: $CO_2$ from 2A1 Cement Production, $CO_2$ from 2A2 Lime Production and $CO_2$ from 2A3 Limestone and Dolomite Use. In source category 2A1 Cement Production by-product $CO_2$ emissions in cement production are reported that occur during the production of clinker, an intermediate component in the cement manufacturing process. Source category 2A2 Lime Production accounts for $CO_2$ emitted through the calcination of the calcium carbonate in limestone or dolomite for lime production. Source category 2A3 Limestone and Dolomite Use covers a number of industrial applications generating $CO_2$ through the heating of limestone or dolomite, such as in metallurgy (iron and steel), glass manufacture, agriculture, construction or environmental pollution control.

Table 4.1 summarizes Member States' emissions from Mineral Products in 1990 and 2009. $CO_2$ emissions from Mineral Products decreased by 19 %, especially since 2007 mainly driven by the decrease in cement production. Only four EU-15 Member States increased their $CO_2$ emissions during 1990 and 2009 (Ireland, the Netherlands, Portugal and Sweden); Ireland had largest emission increases in absolute terms and France largest absolute emission reductions in the period 1990-2009.

**Table 4.1 2A Mineral Products: Member States total GHG and $CO_2$ emissions**

| Member State | GHG emissions in 1990 (Gg $CO_2$ equivalents) | GHG emissions in 2009 (Gg $CO_2$ equivalents) | $CO_2$ emissions in 1990 (Gg) | CO2 emissions in 2009 (Gg) |
|---|---|---|---|---|
| Austria | 3,274 | 2,918 | 3,274 | 2,918 |
| Belgium | 5,330 | 4,584 | 5,330 | 4,584 |
| Denmark | 1,069 | 881 | 1,069 | 881 |
| Finland | 1,254 | 876 | 1,254 | 876 |
| France | 16,394 | 11,512 | 16,394 | 11,512 |
| Germany | 22,928 | 18,075 | 22,928 | 18,075 |
| Greece | 6,676 | 5,315 | 6,676 | 5,315 |
| Ireland | 1,117 | 1,485 | 1,117 | 1,485 |
| Italy | 21,265 | 17,498 | 21,265 | 17,498 |
| Luxembourg | 623 | 440 | 623 | 440 |
| Netherlands | 923 | 1,042 | 923 | 1,042 |
| Portugal | 3,475 | 3,841 | 3,475 | 3,839 |
| Spain | 15,404 | 14,675 | 15,404 | 14,675 |
| Sweden | 1,722 | 1,836 | 1,722 | 1,836 |
| United Kingdom | 10,175 | 5,806 | 10,151 | 5,800 |
| **EU-15** | **111,629** | **90,785** | **111,605** | **90,777** |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

#### 4.2.1.1 2A1-Cement Production

$CO_2$ emissions from Cement Production account for 1.7 % of total EU-15 GHG emissions in 2009. In 2009, $CO_2$ emissions from Cement Production were 18 % below 1990 levels in the EU-15 (Table 4.2).

**Figure 4.3** **2A1 Cement Production: EU-15 $CO_2$ emissions**

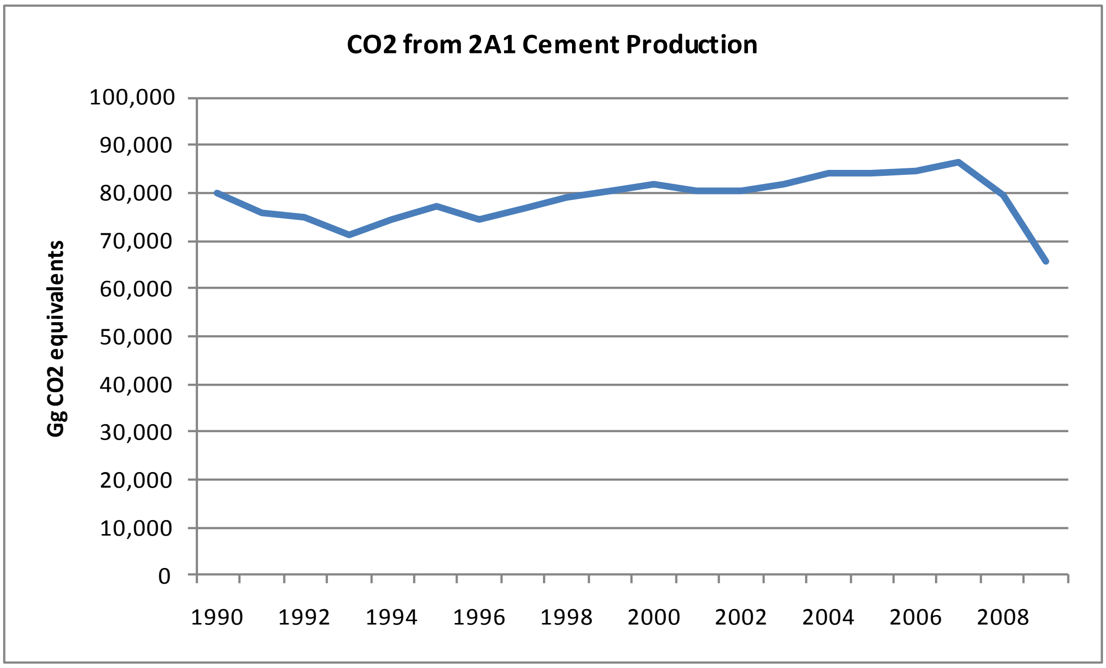



Figure 4.3 provides information on emission trends of the key source $CO_2$ from 2A1 Cement Production by Member State. In 2009, Italy and Germany are the largest emitters accounting for 39.3 % of EU-15 emissions, followed by Spain (17.4 %). $CO_2$ emissions in Italy peaked in 1995 due to a high increase of clinker production in 1995 after an economic recession in 1993-1994. The United Kingdom, France and Germany had large reductions in absolute terms between 1990 and 2009. $CO_2$ emissions in the United Kingdom decreased considerably during 2007 and 2008 due to a drop of cement production in that period. This decrease proceeded in 2009 due to the recent economic downturn. The decrease in clinker production of -21 % as a consequence of the impact of the economic recession was also the reason for the reduction of emissions in Spain. Emissions of $CO_2$ in Germany from pertinent raw materials are tied directly to the quantities of cement that are produced. Thus the reduction of German $CO_2$ emissions is also due to the reduced production of clinker production. Italy, having the highest share in EU-15 emissions, also had a strong reduction in $CO_2$ emissions during 2008 and 2009 due to the decrease in clinker production of about 19 %. In the country, the effects of the global recession period have led to two plants closedown at national level.

Only one EU-15 MS had increases in emissions (the Netherlands) during 2008 and 2009. This is due to a change in carbon input to the kiln. The Netherlands, for estimating $CO_2$ emissions from this source category, considers monthly estimates of carbonate content of the process input. A process emission factor and emissions are calculated from i) the calcination of the carbonate input of the raw material, marl, ii) the calcination of the carbonate input of sewage sludge and iii) the burning of organic carbon in the raw material on a monthly basis.

**Table 4.2 2A1 Cement production: Member States' contributions to $CO_2$ emissions**

| Member State | CO2 emissions in Gg | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg CO2 equivalents) | (%) | (Gg CO2 equivalents) | (%) | | |
| Austria | 2,033 | 2,133 | 1,799 | 2.7% | -334 | -16% | -235 | -12% | CS | CS |
| Belgium | 2,824 | 3,033 | 2,795 | 4.3% | -237 | -8% | -29 | -1% | T2 | PS |
| Denmark | 882 | 1,155 | 764 | 1.2% | -390 | -34% | -118 | -13% | CS | PS |
| Finland | 734 | 638 | 382 | 0.6% | -256 | -40% | -352 | -48% | T2 | CS |
| France | 10,937 | 8,879 | 7,679 | 11.7% | -1,200 | -14% | -3,258 | -30% | CR | PS |
| Germany | 15,146 | 13,444 | 12,313 | 18.8% | -1,131 | -8% | -2,833 | -19% | T2 | CS |
| Greece | 5,641 | 6,054 | 4,582 | 7.0% | -1,472 | -24% | -1,059 | -19% | CS | PS |
| Ireland | 884 | 2,107 | 1,327 | 2.0% | -780 | -37% | 443 | 50% | T2 | PS |
| Italy | 16,084 | 16,127 | 13,454 | 20.5% | -2,673 | -17% | -2,630 | -16% | T2 | CS,PS |
| Luxembourg | 570 | 404 | 378 | 0.6% | -26 | -6% | -192 | -34% | T2 | CS,PS |
| Netherlands | 416 | 399 | 416 | 0.6% | 17 | 4% | 0 | 0% | CS | PS |
| Portugal | 3,176 | 4,012 | 3,223 | 4.9% | -789 | -20% | 46 | 1% | T2 | D |
| Spain | 12,279 | 14,389 | 11,402 | 17.4% | -2,988 | -21% | -877 | -7% | T2 | CS |
| Sweden | 1,272 | 1,425 | 1,289 | 2.0% | -136 | -10% | 17 | 1% | T2 | PS |
| United Kingdom | 7,295 | 5,203 | 3,720 | 5.7% | -1,482 | -28% | -3,575 | -49% | T2 | CS |
| **EU-15** | **80,174** | **79,401** | **65,523** | **100.0%** | **-13,878** | **-17%** | **-14,651** | **-18%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

Table 4.3 shows information on methods applied, activity data, emission factors for $CO_2$ emissions from 2A1 Cement Production for 1990 and 2009. In response to the recommendations by the ERT, Denmark used clinker production data as activity data for its 2010 greenhouse gas (GHG) inventory submission, thus harmonization across Member States was achieved (FCCC/ARR/2009/EC, para 49).

The implied emission factors per tonne of clinker produced vary slightly from 0.50 t $CO_2$/t of clinker produced for Finland to 0.56 t $CO_2$/t of clinker produced for Sweden; except for Portugal, all MS use country-specific and plant-specific emission factors. The EU-15 implied emission factor (IEF) (excluding UK, as the MS indicated with its inventory submission 2010 that emission factors and activity data for the production of cement are commercially sensitive and therefore confidential) is 0.53 t $CO_2$/t of clinker produced. The table also suggests that 100 % of EU-15 emissions are estimated with higher Tier methods.

A noticeable decrease of IEF during 1990 and 2009 in the inventories 2011 could only be found for Denmark, whereas no significant increase or decrease of IEFs during that time could be found. Explanations for the development of the implied emission factors are given in the following overview:

***Implied Emission Factor, Denmark***

The EF decreased primarily during 1990 and 1996 (-18 %) which is due to the ratio white/grey cement and the ratio rapid cement (GKL-clinker)/basis cement (FHK-clinker)/low alkali cement (SKL-RKL-clinker). The ratio white/grey cement is known from 1990-1997 with maximum in 1990 and thereafter decreasing.

Due to a question raised during the Centralized review in 2010, table 4.3 was corrected for Belgium and Luxembourg, as these MS use a Tier 2 methodology to estimate $CO_2$ emissions from cement production instead of Tier 3.

**Table 4.3** **2A1 Cement Production: Information on methods applied and emission factors for $CO_2$ emissions**

| Member State | Method applied | Emission factor | 1990 | | | | 2009 | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Activity data | | Implied emission factor (t/t) | $CO_2$ emissions (Gg) | Activity data | | Implied emission factor (t/t) | $CO_2$ emissions (Gg) |
| | | | Description | (kt) | | | Description | (kt) | | |
| Austria | CS | CS | Clinker production | 3694 | 0.55 | 2033 | Clinker production | 3428 | 0.52 | 1799 |
| Belgium | T2 | PS | Clinker production | 5292 | 0.53 | 2824 | Clinker production | 5132 | 0.54 | 2795 |
| Denmark | CS | PS | Clinker production | 1406 | 0.63 | 882 | Clinker production | 1493 | 0.51 | 764 |
| Finland | T2 | CS | Clinker production | 1470 | 0.50 | 734 | Clinker production | 764 | 0.50 | 382 |
| France | CR | PS | Clinker production | 20854 | 0.52 | 10937 | Clinker production | 14568 | 0.53 | 7679 |
| Germany | T2 | CS | Clinker production | 28577 | 0.53 | 15146 | Clinker production | 23232 | 0.53 | 12313 |
| Greece | CS | PS | Clinker production | 10645 | 0.53 | 5641 | Clinker production | 8649 | 0.53 | 4582 |
| Ireland | T2 | PS | Clinker production | 1610 | 0.55 | 884 | Clinker production | 2438 | 0.54 | 1327 |
| Italy | T2 | CS,PS | Clinker production | 29786 | 0.54 | 16084 | Clinker production | 25259 | 0.53 | 13454 |
| Luxembourg | T2 | CS,PS | Clinker production | 1048 | 0.54 | 570 | Clinker production | 708 | 0.53 | 378 |
| Netherlands | CS | PS | Clinker production | 770 | 0.54 | 416 | Clinker production | 800 | 0.52 | 416 |
| Portugal | T2 | D | Clinker production | 6128 | 0.52 | 3176 | Clinker production | 6164 | 0.52 | 3223 |
| Spain | T2 | CS | Clinker production | 23212 | 0.53 | 12279 | Clinker production | 21595 | 0.53 | 11402 |
| Sweden | T2 | PS | Clinker production | 2348 | 0.54 | 1272 | Clinker production | 2305 | 0.56 | 1289 |
| UK | T2 | CS | Clinker production | C | C | 7295 | Clinker production | C | C | 3720 |
| **EU15** | | | **EU15 w/o UK (91%)** | **136,839** | **0.53** | **72,878** | **EU15 w/o UK (94%)** | **116,537** | **0.53** | **61,802** |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

Table 4.4 summarizes the methodological information provided by EU-15 Member States in their national inventory reports for cement production. A number of Member States use data collected from plants under the EU emission trading scheme.

**Table 4.4 2A1 Cement Production: Summary of methodological information provided by Member States**

| Cement Production | |
|---|---|
| **Member State** | **Methodology comment** |
| **Austria** | Emissions were estimated using a country specific method similar to the IPCC Tier 2 methodology. AD (clinker production) as well as emission were taken from studies from the Austrian cement production industry covering the years 1988 to 2003. The determination of the emission data took place by inspection of every single plant, recording and evaluation of plant specific records and also plant specific measurements and analysis carried out by independent scientific institutes. Activity data and emissions for 2004 were reported directly by the Association of the Austrian Cement Industry as well as activity data for 2005-2009. For 2005-2009 verified CO2 emissions, reported under the ETS, were used for the inventory. These data cover the whole cement industry in Austria. The methodology for these emission calculations is the same like in the years before. CO2 emissions from the raw meal calcination (decarbonising) were calculated from the raw meal composition determined at every Austrian plant, considering also the MgCO3 content of the raw meal. [NIR 2011]. |
| **Belgium** | The AD is the clinker production collected directly from individual plants following the Tier 2 method. An average EF by plant has been estimated in 2002 and is applied on the all time-series 1990-2001. Since 2002, the EF varies each year and was calculated directly by the plant. Since 2004, plant data's include information on the CaO content of the clinker and non-carbonate sources of CaO. The CO2 EF is estimated as described for Tier 2 method. [NIR 2011] |
| **Denmark** | The CO2 emission from the production of cement has been estimated by the company. The emission factor has been estimated from the loss of ignition determined for the different kinds of clinkers produced, combined with the volumes of grey and white cements produced. Determination of loss of ignition takes into account all the potential raw materials leading to release of CO2 and omits the Ca-sources leading to generation of CaO in cement clinker without CO2 release. From the year 2005 the CO2 emission determined by the company for EU-ETS is used in the inventory. [NIR 2011] |
| **Finland** | Emissions were calculated using Tier 2 methodology from the good practice guidance. The amount of clinker produced annually is used as AD. Data for the years 1990-2006 are received directly from the company and for years 2007-2009 from EU ETS data. EFs used in the calculation of emissions from cement production are plant-specific provided by the industry for the whole time series (except for plant 3 where the mean of the two other plant is applied). [NIR 2011] |
| **France** | Methodology based on national statistics (clinker statistics) from cement association and national EFs from industry. Since 2004 detailed plant-specific data with plant-specific EF and emissions reported under the EU-ETS are used. In France from 33 cement plants, there are 3 plants producing a special type of cement with a specific higher EF. Since 2008, annual data considering all three sources (calcination of carbonates in the raw materials used to produce the clinker, the partial calcination of cement kiln dust or bypass dust, the non-carbonate carbon in raw materials) is used. [NIR 2011] |
| **Germany** | Methodology based on AD from associations of industries (clinker production) and a CS EF (which is also obtained from associations of industries based on PS data). [NIR 2011] |
| **Greece** | For the years 2005-2009 detailed data have been accessed via the verified EU ETS reports of the plants. These data refer to the quantities of carbonate raw material (CaCO3, MgCO3) used for the production of clinker. In the recent years (2008 – 2009) the plants report also emissions from non-carbonate carbon (organic carbon). Emissions prior to 2005 in the past were calculated using the Tier 2 methodology, based on clinker production. Following the change of the methodology to Tier 3, and acc to the IPCC GPG, the overlap method has been used in order to ensure the consistency of the time-series. [NIR 2011] |
| **Ireland** | In 2004, plant-specific information relating to CO2 emissions in 2002 and 2003 was obtained by the EPA for all cement plants for the development of Ireland's First National Allocation Plan. The reported process CO2 emissions for each plant in 2002 and 2003 were calculated using the Tier 2 method. As the EU ETS subsequently became operational, plant specific CO2 emissions and corresponding clinker production data are also available for all cement plants for the years 2004 through 2009 and these data are used directly to report emissions for category 2.A.1 in Ireland. [NIR 2011] |
| **Italy** | CO2 emissions from cement production are estimated by the IPCC Tier 2 approach. Activity data comprise data on clinker production provided by ISTAT (ISTAT, several years). Emission factors are estimated on the basis of information provided by the Italian Cement Association (AITEC, several years) and by cement facilities in the framework of the European pollutant emission register (EPER, now E-PRTR) and the European emissions trading scheme. [NIR 2011] |
| **Luxembourg** | In Luxembourg, one clinker production plant is operating. During the production of clinker, limestone, which is mainly calcium carbonate (CaCO3), is calcined to produce lime (CaO) and CO2 as a by-product. Activity data, i.e. clinker production, is obtained annually from the plant operator. For the estimation of CO2 emissions, the Tier 2 method of 2000 IPCC-GPG using clinker production data is applied. [NIR 2011] |
| **Netherlands** | For cement clinker production the environmental reports (MJVs) of the single Dutch company are used. Because of changes in raw material composition it is not possible to estimate reliable CO2 process emissions by calculating the clinker production(as AD) by a default EF. For that reason the company has chosen to base the calculation of CO2 emissions on the carbonate content of the process input. [NIR 2011] |
| **Portugal** | EU-ETS method A from Annex VII of Decision 2007/589/EC is used for the period 2005-2009. Calculation is based on the carbonate content of process inputs (including fly-ash or blast furnace slag) with cement kiln dust (CKD) and bypass dust deducted from raw material consumption (Tier 3). For the period 1990-2004, emissions were estimated based on clinker production time series. Data on consumption of raw materials, was obtained for the period 2005-2009 from EU-ETS. Clinker production for all the years from 1990 to 2009, was received directly from each industrial plant, and the correspondent time series may be observed in next figure. Total clinker production for 1990-2009 as reported in the National Statistical Database from INE is fully consistent with the sum of the information received from each individual plant. [NIR 2011] |
| **Spain** | The estimation of CO2 emissions for this activity has been performed by using the Tier 2 IPCC and by applying an emission factor per quantity of clinker produced. Clinker production data and the applied EF are obtained from associations of cement manufacturing sector (OFICEMEN). The EF was derived from data on ton of clinker produced for the period 2005-2009 as provided by OFICEMEN. [NIR 2011] |
| **Sweden** | Emissions have been estimated based on ETS data as well as direct information from the company based on clinker production. A cement kiln dust (CKD) correction factor is used. For CO2 estimates for 1990-2004, the cement company uses the GHG protocol made on initiative by the WRI for the WBCSD. Since 2005, data on clinker production has been acquired through the ETS. [NIR 2011] |
| **UK** | The methodology used for estimating CO2 emissions from calcination is to use data provided by the British Cement Association (2010), which in turn is based on data generated by UK cement clinker producers for the purposes of reporting to the EU Emission Trading Scheme. The data are available for 2005 to 2009 only, and so the value for 2005 has been applied to earlier years as well. Previously, estimates had been based on the IPCC Tier 2 approach (IPCC, 2000), yielding an emission factor of 137.6 t C/kt clinker. The revised emission factors are about 10% higher than this figure and the reasons for this disparity are that the previous emission factor:<br>• Slightly underestimated the CaO content of clinker produced; and<br>• Failed to take account of CO2 emitted from dolomite (i.e. the method assumed a zero MgO content, which was not correct). [NIR 2011] |

*Source: NIR 2011.*

According to the analysis presented in Table 4.4 all MS estimate emissions with higher tier methods. Table 4.5 summarizes the recommendations from the 2010 UNFCCC inventory reviews in relation to the category 2A1 Cement Production. The overview shows that reports from the centralized and in-country reviews are still lacking for five Member States until now (France, Germany, the Netherlands, Spain and Sweden). Findings for Belgium, Denmark, Greece, Ireland, Portugal and the UK listed so far have been resolved.

**Table 4.5** **2A1 Cement Production: Findings of the 2010 UNFCCC inventory reviews in relation to $CO_2$ emissions and responses in 2011 inventory submissions**

| Member State | Review findings and responses related to 2A1 Cement Production | |
|---|---|---|
| | **Comment UNFCCC report of the review of the 2010 submission** | **Status in 2011 submission** |
| **Austria** | No recommendation for improvement of this source category in Review Report. (FCCC/ARR/2010/AUT) | No follow-up necessary |
| **Belgium** | The ERT noted from the NIR that the EF for cement production is calculated on the basis of calcium oxide (CaO) only. The response provided by Belgium to a question on this issue raised by the ERT during the review did not give a clear indication of whether magnesium oxide (MgO) content is incorporated in the EF used. The ERT recommends that Belgium revisit this issue and provide clear details on the estimation of its CO2 EFs for cement in its next annual submission. (FCCC/ARR/2010/BEL, para 49) | Information on the inclusion of MgO in the EF is given. Since 2004, plant data had included information on the CaO and MgO content of the clinker and non-carbonate sources of CaO. [NIR 2011, p.83] |
| **Denmark** | On the basis of the information provided in the EU ETS reports, the ERT recommends that Denmark derive a country-specific EF that could be used throughout the whole time series. In order to allow comparability among Parties, it is essential that AD for clinker production be investigated more deeply, and that the Party provide information on the calcium oxide content of the clinker. The ERT also recommends that a qualitative explanation be included in the NIR regarding the changing nature of the raw materials or the products, wherever decreasing trends are found in the IEF. (FCCC/ARR/2010/DNK, para 77) | The EF varies as a consequence of variation in product mix. Therefore, it makes no sense to use one national EF during the time period. In the NIR the possibilities for getting more precise clinker data back in time has been described. The inventory team has established a dialogue with the cement factory in order to improve the data for the recent years as well as establishing a qualitative explanation on the decreasing trend in IEF during the last 5 years. [NIR 2011, p.578] |
| **Finland** | No recommendation for improvement of this source category in Review Report. (FCCC/ARR/2010/FIN) | No follow-up necessary |
| **France** | Review report (In-country review 2010) not yet available. | |
| **Germany** | Review report (In-country review 2010) not yet available. | |
| **Greece** | The ERT commends Greece for its clear and transparent description of this category, except for the determination of the EF for the period 1990–-2004, on which the ERT recommends that Greece include more information in the NIR, such as that provided during the review week. (FCCC/ARR/2010/GRC, para 56) | Done, the respective information has been Included in Section 4.2 of NIR 2011. [NIR 2011, p.312] |
| **Ireland** | Estimates include the consideration of the cement kiln dust (CKD) factor. However, the Party does not report information on the calcium oxide (CaO) and magnesium oxide (MgO) contents of the clinker that are used to derive the country-specific estimates. The ERT therefore recommends, in accordance with the IPCC good practice guidance, that Ireland include information on the CaO and MgO content of the clinker in its next annual submission. (FCCC/ARR/2010/IRL, para 67) | The timing of Ireland's draft ARR 2010 did not allow sufficient time for this recommendation to be implemented in submission 2011. Additional information on AD and EFs for the Industrial Processes sector is provide in an Annex in NIR 2011.The inventory agency will provide additional information on CaO and MgO content in clinker for reporting in Submission 2012. (Chapter 4, section 4.7. Annex E, Tables E.1 to E.4.) [NIR 2011, p.272] |
| **Italy** | No recommendation for improvement of this source category in Review Report. (FCCC/ARR/2010/ITA) | No follow-up necessary |
| **Luxembourg** | No recommendation for improvement of this source category in Review Report. (FCCC/ARR/2010/LUX) | No follow-up necessary |
| **Netherlands** | Review report (Centralized review 2010) not yet available. | |
| **Portugal** | Data on clinker production for the period 1990–2008 were received by the Party directly from each industrial plant. Portugal used the tier 2 methodology to estimate emissions from this key category. However, the Party used the default EF (0.507 t CO2/t clinker) based on the default CaO fraction in clinker (64.6 per cent). During the review, the ERT was informed that Portugal will implement new estimates based on the EU ETS methodology (kiln input-based methodology) in its 2011 submission. The ERT welcomes this planned improvement and recommends that Portugal report its emission estimates accordingly in its next annual submission. (FCCC/ARR/2010/PRT, p.53) | We are now using ETS data and methodology with plant specific values. [NIR 2011, p.9-3] |
| **Spain** | Review report (Centralized review 2010) not yet available. | |
| **Sweden** | Review report (Centralized review 2010) not yet available. | |
| **UK** | According to the United Kingdom's tier 2 key category analysis, cement production is not a key category. However, excluding uncertainties, this category is by far the most significant category within the industrial processes sector. The ERT recommends therefore, based on this quantitative and qualitative criterion, that the United Kingdom consider this category as key. (FCCC/ARR/2010/GBR, para 56) | In the 2011 submission cement production is considered as a key source. [NIR 2011] |
| | The ERT recommends that the United Kingdom include, in its next annual submission, the summary information on the components of the EFs provided during the review week as well as additional information to better explain the inter-annual variation in the IEF, the choices made for the year(s) to backcast the EF to maintain time-series consistency and the extent and type of category-specific QC performed, such as the information provided during the review week. (FCCC/ARR/2010/GBR, para 57) | Not yet adressed. [NIR 2011] |
| | In its 2010 submission, the United Kingdom did not provide AD for cement production, but used the notation key "C" (confidential). The United Kingdom explained that providing these data would disclose the production of one plant in Northern Ireland. The total production of all 13 other plants is publicly available and cement production was reported in the Party's previous annual submissions. Since this lack of AD reduces the transparency and comparability of the Party's IEF (level and trend), the ERT encourages the United Kingdom to find a way to provide the missing AD, for example by providing an estimated national total. (FCCC/ARR/2010/GBR, para 58) | Not yet adressed. [NIR 2011] |

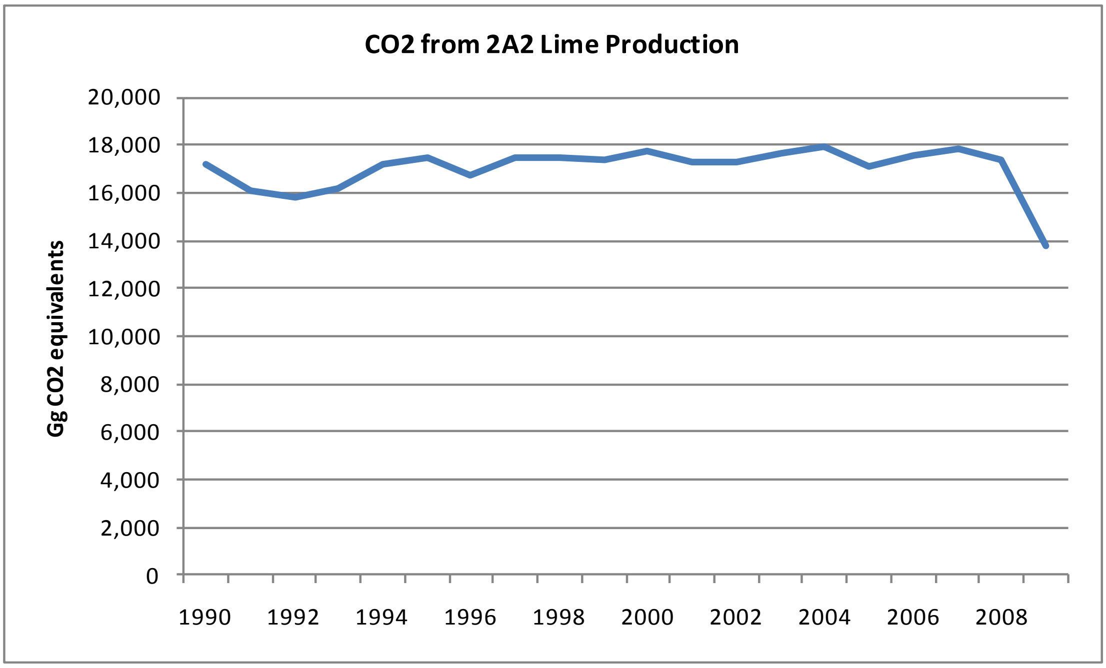
*Source: NIR 2011, UNFCCC inventory review reports, as published at UNFCCC: http://unfccc.int/national_reports/annex_i_ghg_inventories/inventory_review_reports/items/5687.php*

#### 4.2.1.2 2A2 Lime Production

$CO_2$ emissions from 2A2 Lime Production account for 0.37 % of total GHG emissions in 2009. Between 1990 and 2009, $CO_2$ emissions from this source decreased by 20 % in the EU-15. Germany and France are the largest emitters accounting for 47 % of EU-15 emissions, followed by Italy (12 %).The decrease of $CO_2$ emissions in the early nineties was dominated by emission reductions in Germany, Belgium, France and the UK due to a decreased production of lime and dolomite.

The emissions in the EU-15 increased by 6 % during 1993 and 1994. This increase was caused by a raised production rate of lime in Germany and France in that period (Figure 4.4). Since 2007, for the second consecutive year $CO_2$ emissions decreased significantly due to a reduced production rate that was mostly driven by economic reasons. In the UK, limestone and dolomite consumption data are derived from the British Geological Survey, 2009, but have not been available in time for inclusion in the inventory. Therefore, it has been the practice to assume that limestone calcinations are the same in the latest year (in this case, 2009) as in the previous year. All EU-15 MS show reductions in emissions of more than 10 %, driven by the decline in the production of lime.

**Figure 4.4 2A2 Lime Production: EU-15 $CO_2$ emissions**




Germany was responsible for 33 % of the emissions from this source in 2009. The decrease of emissions in the early nineties was dominated by the drop in German lime production due to the sector's restructuring following German reunification, as well as of economic factors and development of competing and substitute products. Compared to last year's inventory report, where six MS increased their emissions during 1990 and 2009, this year only four MS increased their emissions during 1990 and 2009 (Portugal, Sweden, Austria, Spain). Finland and Italy had been able to reduce their $CO_2$ emissions below 1990 levels.

**Table 4.6 2A2 Lime Production: Member States' contributions to $CO_2$ emissions**

| Member State | CO2 emissions in Gg | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg CO2 equivalents) | (%) | (Gg CO2 equivalents) | (%) | | |
| Austria | 396 | 621 | 507 | 3.7% | -114 | -18% | 111 | 28% | CS | CS |
| Belgium | 2,097 | 2,054 | 1,399 | 10.2% | -655 | -32% | -698 | -33% | T3 | PS |
| Denmark | 116 | 66 | 43 | 0.3% | -22 | -34% | -72 | -63% | CS | D |
| Finland | 383 | 439 | 361 | 2.6% | -78 | -18% | -21 | -6% | T2 | CS |
| France | 2,545 | 2,444 | 1,990 | 14.4% | -454 | -19% | -555 | -22% | CR | PS |
| Germany | 6,176 | 5,702 | 4,539 | 32.9% | -1,162 | -20% | -1,637 | -27% | T2 | D |
| Greece | 432 | 342 | 289 | 2.1% | -53 | -16% | -143 | -33% | CS | PS |
| Ireland | 214 | 188 | 156 | 1.1% | -31 | -17% | -58 | -27% | T2 | PS |
| Italy | 2,042 | 2,276 | 1,689 | 12.3% | -587 | -26% | -353 | -17% | T1 | CS,PS |
| Luxembourg | NO | NO | NO | - | - | - | - | - | NA | NA |
| Netherlands | IE | IE | IE | - | - | - | - | - | NA | NA |
| Portugal | 183 | 407 | 361 | 2.6% | -46 | -11% | 178 | 97% | D | D |
| Spain | 1,123 | 1,659 | 1,431 | 10.4% | -228 | -14% | 308 | 27% | D | D,PS |
| Sweden | 295 | 534 | 390 | 2.8% | -144 | -27% | 96 | 32% | D | D |
| United Kingdom | 1,192 | 627 | 627 | 4.5% | 0 | 0% | -565 | -47% | T2 | CS |
| **EU-15** | **17,194** | **17,358** | **13,784** | **100.0%** | **-3,573** | **-21%** | **-3,409** | **-20%** | | |

*Emissions of the Netherlands are included in 2D2 Food industries.*
*Abbreviations explained in the Chapter 'Units and abbreviations'.*

Table 4.7 shows information on methods applied, activity data, emission factors for $CO_2$ emissions from 2A2 Lime Production for 1990 to 2009. The table shows that all EU-15 MS use lime production as activity data for calculating $CO_2$ emissions, except for the UK that uses limestone consumption.

The EU-15 IEF (excluding the UK) in 2009 is 0.75 t $CO_2$/t of lime produced. The implied emission factors per tonne of lime produced vary between 0.65 for Italy and 0.80 for Portugal (excluding the UK). The table also suggests that 72 % of the EU-15 emissions are estimated using higher tier methodologies (country-specific, CORINAIR, Tier 2 and Tier 3).

An increase of IEFs during 1990 and 2009 in the inventories 2011 could be only found for Portugal, whereas the IEF decreased in all other EU-15 MS; for Belgium, Finland and Germany only very slight changes could be observed. Italy's IEF decreased most during 1990 and 2009 (-18 %), followed by Greece (-14 %) and Ireland (-10 %). Explanations for the development of the implied emission factors are given in the following overview:

***Implied Emission Factor Lime production, Portugal***

The IEF increased continuously during 1990 and 2009 (+9 %) due to different expression of activity data and emissions: Whilst the activity data is expressed in tons of lime produced, the emissions are related both to lime production and to the use of lime in paper pulp.

***Implied Emission Factor Lime production, Italy***

The consistent trend of IEF was interrupted in 2004, as the IEF decreased by 11 % during 2004 and 2005. This break is caused by the use of data based on times series supplied in the framework of the ETS. An average emission factor that was supplied for the years 2000 to 2004 have been derived also for previous years. By contrast data deriving from the ETS submission for the first allocation plan was used for the years 2005 onwards.

***Implied Emission Factor Lime production, Greece***

The IEF decreased especially from 2005 onwards, interrupting a rather constant trend until that year (-0.65 % 1990-2005). This is due to the fact, that for years 2005-2009, the calculation of $CO_2$ emissions from lime production is based on the collection of plant-specific data on the type(s) and quantity(ies) of carbonate(s) consumed to produce lime, as well as the respective emission factor(s) of the carbonates consumed.

***Implied Emission Factor Lime production, Ireland***

The variations of IEF (0.753 t $CO_2$/t in 1992 to 0.877 t $CO_2$/t in 1997, reaching the second highest IEF among EU-15 MS in 1997) is caused by reporting of different activity data by the lime manufacturers in the past as the activity data is partly referred to limestone raw material on the one hand and partly to lime production data on the other. For recent years no significant variations of IEF could be found; the implied emission factor for aggregated lime production was 0.76 t $CO_2$/t lime in 2009, which is very similar to that for the other years for which ETS data is available.

Neither 1996 IPCC Guidelines for Greenhouse Gas inventories nor IPCC Good Practice Guidance (2000) clearly define a lower or higher tier method. Draft 2006 IPCC Guidelines define three tiers, an output-based approach that uses default values (Tier 1), an output-based approach that estimates emissions from CaO and CaO·MgO production and country-specific information for correction factors (Tier 2) and an input-based carbonate approach (Tier 3), the latter requiring plant-specific data. Lime production is covered under the EU emissions trading scheme and monitoring guidelines under the EU ETS (Commission Decision of 29/01/2004 establishing guidelines for the monitoring and reporting of greenhouse gas emissions pursuant to Directive 2003/87/EC of the European Parliament and of the Council) allow methods equivalent to either Tier 2 or Tier 3 above. The use of plant-specific data reported and verified under the EU ETS by Member States therefore can be considered as equivalent to Tier 2 or Tier 3 as defined in draft 2006 IPCC Guidelines.

**Table 4.7 2A2 Lime Production: Information on methods applied, activity data, emission factors for $CO_2$ emissions**

| Member State | Method applied | Emission factor | 1990 | | | | 2009 | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Activity data | | Implied emission factor (t/t) | $CO_2$ emissions (Gg) | Activity data | | Implied emission factor (t/t) | $CO_2$ emissions (Gg) |
| | | | Description | (kt) | | | Description | (kt) | | |
| Austria | CS | CS | Lime Production | 513 | 0.77 | 396 | Lime Production | 695 | 0.73 | 507 |
| Belgium | T3 | PS | Lime production | 2661 | 0.79 | 2097 | Lime production | 1782 | 0.79 | 1399 |
| Denmark | CS | D | Lime production | 156 | 0.74 | 116 | Lime production | 59 | 0.73 | 43 |
| Finland | T2 | CS | Lime Production | 519 | 0.74 | 383 | Lime Production | 490 | 0.74 | 361 |
| France | CR | PS | Lime Production | 3319 | 0.77 | 2545 | Lime Production | 2701 | 0.74 | 1990 |
| Germany | T2 | D | Lime Production | 7772 | 0.79 | 6176 | Lime Production | 5728 | 0.79 | 4539 |
| Greece | CS | PS | Lime Production | 491 | 0.88 | 432 | Lime Production | 381 | 0.76 | 289 |
| Ireland | T2 | PS | Lime Production | 255 | 0.84 | 214 | Lime Production | 205 | 0.76 | 156 |
| Italy | T1 | CS,PS | Lime Production | 2583 | 0.79 | 2042 | Lime Production | 2608 | 0.65 | 1689 |
| Portugal | D | D | Lime Production | 251 | 0.73 | 183 | Lime Production | 452 | 0.80 | 361 |
| Spain | D | D,PS | Lime Production | 1475 | 0.76 | 1123 | Lime Production | 1899 | 0.75 | 1431 |
| Sweden | D | D | Lime Production | 389 | 0.76 | 295 | Lime Production | 519 | 0.75 | 390 |
| UK | T2 | CS | Limestone consumption | 2708 | 0.44 | 1192 | Limestone consumption | 1424 | 0.44 | 627 |
| **EU15** | | | **EU15 w/o UK** | **20,384** | **0.79** | **16,002** | **EU15 w/o UK** | **17,519** | **0.75** | **13,158** |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

Table 4.8 provides a more detailed overview on methods used in EU-15 Member States and the coverage of this source category. Austria, Finland, Ireland, Italy and Portugal included an explicit reference to the use of plant-specific data under the EU ETS. Some Member States include lime production and use in some industries such as sugar or pulp and paper resulting in different EFs.

**Table 4.8 2A2 Lime Production: Summary of methodological information provided by Member States**

| Lime Production | |
|---|---|
| **Member State** | **Methodology comment** |
| **Austria** | Emissions were estimated using a country specific method based on detailed production data. Activity data and emission values were reported by the Association of the Stone & Ceramic Industry. For 2005-2009 verified $CO_2$ emissions reported under the ETS were used for the inventory. These data cover the whole lime producing industry in Austria. The methodology for this emission calculation is the same like in the years before. The reported $CO_2$ emission data is based on data of each lime production plant in Austria, considering the CaO and MgO content either from limestone or lime at the different plants and calculating $CO_2$ emissions from the stoichiometric ratios (using IPCC default emis- |

| Lime Production | |
|---|---|
| **Member State** | **Methodology comment** |
| | sion factors). [NIR 2011] |
| **Belgium** | From 1990 to 2002, these emissions of lime production were estimated by using default emission factors in three different plants and a plant-specific emission factor in the three others plants. This plant-specific emission factor was coming from analyses performed in 2002. Since 2003, all the emission factors are plant-speficic (except for the dolomite lime in 2003 and 2004). The activity data are the lime and dolomite lime production and are collected directly from individual plants. The emission factors are also collected directly from individual plants. A part of the lime production is coming from the kraft pulping process: the $CO_2$ liberated during the conversion of calcium carbonate to calcium oxide in the lime kiln in the kraft pulping process contains carbon which originates in wood. This $CO_2$ is not included in the net emissions. [NIR 2011] |
| **Denmark** | The $CO_2$ emission from the production of burnt lime (quicklime) as well as hydrated lime (slaked lime) has been estimated from the annual production figures, registered by Statistics Denmark, and emission factors. The EFs applied are 0.785 kg $CO_2$/kg CaO as recommended by IPCC (IPCC (1996), vol. 3, p. 2.8) and 0.541 kg $CO_2$/kg hydrated lime (calculated from company information on composition of hydrated lime (Faxe Kalk, 2003)). [NIR 2011] |
| **Finland** | Emissions from lime production are calculated by multiplying emission factors with lime output. Activity data are collected mainly directly from the industry but industrial statistics have also been used for earlier years. Emissions from 2005 onwards have been calculated using production data reported to the EU ETS data, although the total amount of produced lime has been checked from industrial statistics. There are two emission factors used in Finland to calculate emissions of lime production. The first emission factor is based on the actual CaO and MgO contents of lime derived from measurements by a company that has five plants in Finland. It is a calculated mean value from emission and production data for the years 1998-2002. This emission factor has been used for the whole time series for those five plants. The second emission factor has been specified by a company founded in 2003 and it is also based on the actual CaO and MgO contents in lime.<br><br>AD for the years 1990−1997 is partly collected from the industry and partly taken from industrial statistics and companies' reports. AD for years 1998-2003 was received directly from lime producing companies. For the year 2004 part of the AD was collected from industrial statistics and VAHTI database due to refusal of disclose of a company. Since the year 2005 the AD was received from the Energy Market<br><br>Authority which grants the emission permits to companies for the EU Emission Trading Scheme. [NIR 2011] |
| **France** | Higher tier methodology considering three types of lime. AD from industrial associations are used until 2005 (plant-specific data were available for a subset of plants), since 2004 plant-specific AD for all installations are available. Stochiometric EF for lime, and CS EF for hydraulic lime used based on national data. Average EFs for the three lime types are used until 1995 which were gradually replaced by plant-specific EF. To take into account impurities corrections have been undertaken to be in accordance with the methodology applied in the EU ETS. [NIR 2011] |
| **Germany** | Default- EF based on stochiometric relationships. The approach conforms to the specifications in IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC 2000, Chapter 3.1.2). AD for lime and dolomite-lime production are collected by the German Lime Association (BVK) and provided annually in aggregated form. [NIR 2011] |
| **Greece** | For years 2005 – 2009, the calculation of carbon dioxide emissions from lime production is based on the collection of plant-specific data on the type (s) and quantity(ies) of carbonate(s) consumed to produce lime, as well as the respective emission factor(s) of the carbonates consumed. The lime production of Greece refers to high-calcium and hydraulic lime. Both values are provided by the NSSG for the years 1993-2008, whereas for the years 1990-1993 the missing data have been calculated using the trend extrapolation method as described in the IPCC GPG. Hydraulic lime data for 2008 and 2009 are provided directly by the sole plant producing it in Greece.Lime production in the national statistics is reported as non hydrated lime, hydrated lime and hydraulic lime. The hydrated lime production data are converted to non hydrated lime using the correction for the proportion of hydrated lime as described in the IPCC GPG, using a water content of 28%. [NIR 2011] |
| **Irland** | Statistical data on lime production in Ireland are obtained annually from the lime manufacturers. Lime producers provided their own estimates of $CO_2$ emissions from lime manufacture for the development of NAP1. These were calculated in accordance with the methods providing detailed information on emission estimates and activity data. The $CO_2$ estimates for lime production in 2009 have been obtained from the ETS returns to the Climate Change Unit of the EPA as for other recent years covered by the scheme and these have been used to confirm the estimates for previous years of the time-series. [NIR 2011] |
| **Italy** | $CO_2$ emissions from lime have been estimated on the basis of production activity data supplied by ISTAT (ISTAT, several years) adding the amount of lime produced and used in the sugar and iron and steel production sectors; emission factors have been estimated on the basis of detailed information supplied by plants in the framework of the European emission trading scheme and checked with the industrial association (CAGEMA, 2005). [NIR 2011] |
| **Luxembourg** | Not occuring. [NIR 2011] |
| **Netherlands** | Lime production are not estimated. [NIR 2011] |
| **Portugal** | EU-ETS method A from Annex VIII of Decision 2007/589/EC is used for the period 2005-2009. Calculation is based on the amount of calcium carbonate and magnesium carbonate in the raw materials consumed. For the period 1990-2004, emissions were estimated based on lime production time series. Data on consumption of raw materials, was obtained for the period 2005-2009 from EU-ETS. Lime production for the period 1990-2009, was obtained from National Statistics (INE) IAPI industrial survey. Lime production in the iron and steel industry was available from information received from the industry for the period 1991-1994. For the remaining years 1990 and 1995-2001 annual lime production, which data was unavailable, was forecasted using energy consumption as surrogate indicator. After |

| Lime Production | |
|---|---|
| **Member State** | **Methodology comment** |
| | year 2002 production of lime in this unit was interrupted and the production line dismantled. All lime produced in the iron and steel plant was high calcium lime. [NIR 2011] |
| **Spain** | Higher tier methodology considering different types of lime. AD are obtained from lime producer association ANCADE. In the 2011 emissions from lime consumption in integrated steel plants are included in this category for the years 1990-1992. Emission factors are derived from stochiometric relations and the degree of purity. The purity degrees are derived from plant-specific data and if such data was not available for individual plants, it was derived from WBSCD/WRI "The GHG Protocol: a corporate accounting and reporting standard." [NIR 2011] |
| **Sweden** | The emissions of $CO_2$ from the production of lime are based on activity data on produced amounts of quicklime and hydraulic lime and dolomitic lime. Activity data on used amounts of limestone for production of lime for sugar production are obtained directly from the sugar producing company. All other activity data are collected from the Swedish Lime Association and The Swedish Lime Industry, and represents the total production of lime in conventional lime mills, and limestone used for the production of lime within the pulp and paper industry. All emission factors used are as presented in the 2006 IPCC Guidelines and the purity of the limestone is set to 95% for the production of lime in conventional lime mills and within the pulp and paper industry. For determining activity data and emissions of $CO_2$ within the sugar industry, the amounts of limestone for the production of quicklime are used. The quantities are obtained directly from the sugar producing company for the years 1999 – 2009. For years prior to 1999 no data on used amounts of limestone are available. |
| | For those years the amounts of limestone used for production of quicklime are estimated using the quantity of coke used for lime production 1990 – 1998, together with the average ratio coke/limestone for the years 1999 to 2002. According to the company the used limestone consists to 97% of CaCO3. The source category also includes AD based on the amount of make-up lime within the pulp and paper industry. In order to improve the reporting of activity data and associated $CO_2$ emissions, detailed data from the Swedish Lime Association and The Swedish Lime Industry have been used in submission 2010. Detailed data on the quantities of lime used as make-up lime in the pulp and paper industry, and quantities of limestone a nd dolomite used for production of make-up lime, have been obtained from the Swedish Lime Association and The Swedish Lime Industry for the years 1995 – 2009. [NIR 2011] |
| **United Kingdom** | The UK bases estimation of lime production on limestone and dolomite consumption data, which are readily available (British Geological Survey, 2009). The use of consumption data rather than production data is simpler and probably more reliable since it is not necessary to consider the different types of lime produced. An emission factor of 120 t carbon/kt limestone was used, based on the stoichiometry of the chemical reaction and assuming pure limestone. For dolomite, an emission factor of 130t carbon/kt dolomite would have been appropriate; however dolomite calcination data are not given separately by the British Geological Survey, but included in the limestone data. The use of the limestone factor for this dolomite calcination will cause a small under-estimate of emissions. Dolomite calcination is believed to be a small proportion of the total hence the underestimate is unlikely to be significant. The limestone calcination data exclude limestone calcined in the chemical industry since a large proportion of this is used in the Solvay process, which does not release $CO_2$. The calcination of limestone in the sugar industry is also excluded for the same reason. [NIR 2011] |

*Source: NIR 2011.*

Table 4.9 summarizes the recommendations from the 2010 UNFCCC inventory reviews in relation to the category 2A2 Lime Production. The overview shows that only one finding have been included in the review reports that are available by now (ten out of fifteen) and that Portugal already solved the issue.

**Table 4.9** **2A2 Lime Production: Findings of the 2010 UNFCCC inventory reviews in relation to $CO_2$ emissions and responses in 2011 inventory submissions**

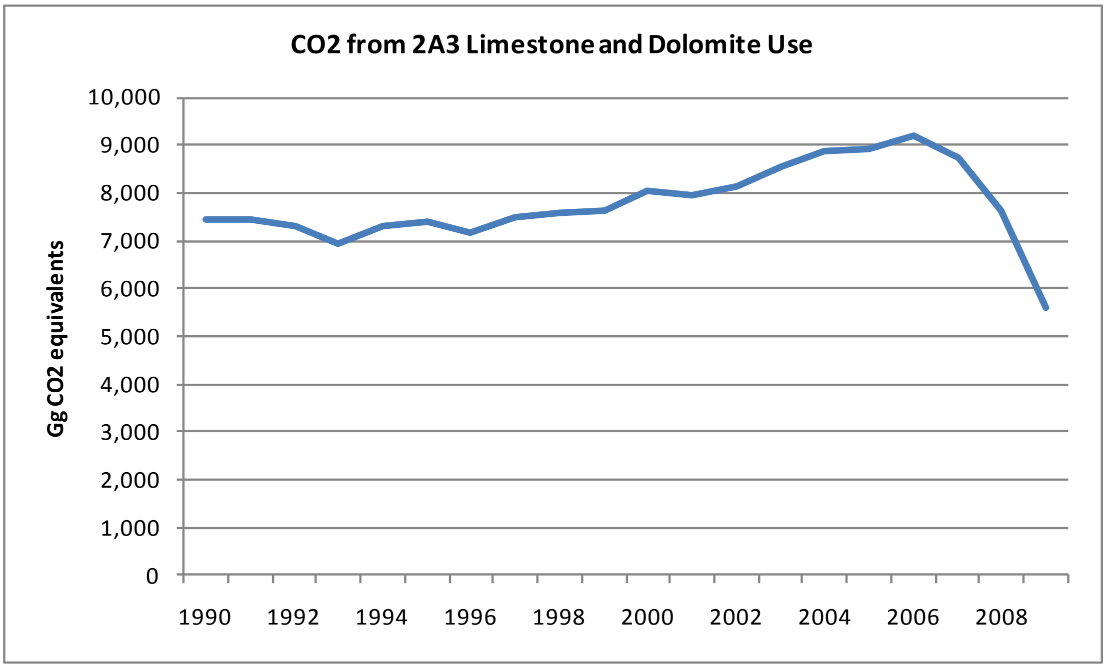
| Member State | Review findings and responses related to 2A2 Lime Production | |
|---|---|---|
| | **Comment UNFCCC report of the review of the 2010 submission** | **Status in 2011 submission** |
| **Austria** | No recommendation for improvement of this source category in Review Report. (FCCC/ARR/2010/AUT) | No follow-up necessary |
| **Belgium** | No recommendation for improvement of this source category in Review Report. (FCCC/ARR/2010/BEL) | No follow-up necessary |
| **Denmark** | No recommendation for improvement of this source category in Review Report. (FCCC/ARR/2010/DNK) | No follow-up necessary |
| **Finland** | No recommendation for improvement of this source category in Review Report. (FCCC/ARR/2010/FIN) | No follow-up necessary |
| **France** | Review report (In-country review 2010) not yet available. | |
| **Germany** | Review report (In-country review 2010) not yet available. | |
| **Greece** | No recommendation for improvement of this source category in Review Report. (FCCC/ARR/2010/GRC) | No follow-up necessary |
| **Ireland** | No recommendation for improvement of this source category in Review Report. (FCCC/ARR/2010/IRL) | No follow-up necessary |
| **Italy** | No recommendation for improvement of this source category in Review Report. (FCCC/ARR/2010/ITA) | No follow-up necessary |
| **Luxembourg** | No recommendation for improvement of this source category in Review Report. (FCCC/ARR/2010/LUX) | No follow-up necessary |
| **Netherlands** | Review report (Centralized review 2010) not yet available. | |
| **Portugal** | Portugal has made considerable efforts to improve the AD used for emission estimates for lime production for the years 2001–2007, based on surveys by INE. However, AD for 2008 were estimated again using a simple linear forecast. The ERT recommends that Portugal make efforts to continue using the statistical data for the most recent year or obtain plant-specific data and report its emission estimates accordingly in its next annual submission. (FCCC/ARR/2010/PRT, para 54) | Start using AD from EU-ETS on CRF category 2A2 (Lime Production) on the period 2005-2009. [NIR 2011, p.9-7] |
| **Spain** | Review report (Centralized review 2010) not yet available. | |
| **Sweden** | Review report (Centralized review 2010) not yet available. | |
| **UK** | No recommendation for improvement of this source category in Review Report. (FCCC/ARR/2010/GBR) | No follow-up necessary |

*Source: NIR 2011, UNFCCC inventory review reports, as published at UNFCCC: http://unfccc.int/national_reports/annex_i_ghg_inventories/inventory_review_reports/items/5687.php*

### 4.2.1.3 2A3 Limestone and Dolomite Use

$CO_2$ emissions from 2A3 Limestone and Dolomite Use account for 0.15 % of total GHG emissions in 2009. Between 1990 and 2006, $CO_2$ emissions from this source increased by 24 % in the EU-15 and decreased by 37 % until 2009 (Figure 4.5). In 2009, Italy was responsible for 30 %, the UK for 21 % and Spain for 13 % of the emissions from this source. Emissions from this source category increased in seven MS during 1990 and 2009 (Austria, Denmark, Finland, Ireland, the Netherlands, Portugal and Sweden), whereas in five Member States emissions decreased during that time period. In absolute terms, the decrease in emissions was larger than the increase, with the largest absolute reduction in Italy.

**Figure 4.5** **2A3 Limestone and Dolomite Use: EU-15 $CO_2$ emissions**




The increase of $CO_2$ emissions by 6 % in 1993-1994 was dominated by the increase of emissions in the Netherlands, the UK, Spain and Finland. The increase of emissions was mainly due to changes of activity (Netherlands, the UK). Reverse emissions trends and thus offsetting the increases of emissions to some extent could be found for Italy and Greece for that period.

$CO_2$ emissions decreased by 27 % in EU-15 during 2008-2009. Italy (the country's share in EU change of emissions 2008-2009 was 34 %) and Spain (the country's share in EU change of emissions 2008-2009 was 28 %) were the main contributors to this reduction. The decrease of $CO_2$ emissions in Spain in that time is mainly due to decrease of brick and tiles production as a consequence of the impact of the economic recession. Additionally, there was a decrease in the carbonates content in the clay used for brick and tiles manufacturing. For Italy, the emissions reduction is related to a decrease in carbonates input to brick, tiles, ceramics, pulp and paper production at country level equal to 30 % during 2008 and 2009.

**Table 4.10 2A3 Limestone and Dolomite Use: Member States' contributions to $CO_2$ emissions**

| Member State | CO2 emissions in Gg | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg CO2 equivalents) | (%) | (Gg CO2 equivalents) | (%) | | |
| Austria | 203 | 281 | 222 | 4.0% | -59 | -21% | 19 | 9% | D | CS,D |
| Belgium | IE | IE | IE | - | - | - | - | - | T3 | CR,CS |
| Denmark | 14 | 39 | 38 | 0.7% | -1 | -2% | 24 | 177% | T1,CS | D,CS |
| Finland | 88 | 146 | 114 | 2.0% | -32 | -22% | 26 | 30% | T2 | CS |
| France | 1,338 | 902 | 718 | 12.8% | -184 | -20% | -620 | -46% | CR | PS |
| Germany | IE | IE | IE | - | - | - | - | - | NA | NA |
| Greece | 583 | 545 | 431 | 7.7% | -114 | -21% | -152 | -26% | CS,T1 | CS,D |
| Ireland | 0 | 3 | 2 | 0.0% | -1 | -43% | 1 | 920% | T2 | PS |
| Italy | 2,540 | 2,352 | 1,651 | 29.5% | -701 | -30% | -889 | -35% | T1 | D,CS,PS |
| Luxembourg | IE | IE | IE | - | - | - | - | - | NA | NA |
| Netherlands | 232 | 271 | 269 | 4.8% | -1 | -1% | 37 | 16% | CS | D |
| Portugal | 33 | 155 | 124 | 2.2% | -31 | -20% | 91 | 272% | D | D |
| Spain | 1,005 | 1,310 | 732 | 13.1% | -578 | -44% | -273 | -27% | D | D,PS |
| Sweden | 90 | 130 | 102 | 1.8% | -28 | -22% | 11 | 12% | CS | D |
| United Kingdom | 1,317 | 1,510 | 1,195 | 21.3% | -315 | -21% | -123 | -9% | T2 | CS,D |
| **EU-15** | **7,444** | **7,644** | **5,598** | **100.0%** | **-2,046** | **-27%** | **-1,847** | **-25%** | | |

*Belgium reports emissions in the source category 2A7.*
*Germany reports emissions in the source categories where limestone and dolomite is used (1A1a, 2A1, 2A2, 2A4, 2A7, 2C1).*
*Luxembourg reports emissions in the source category 2A1 and 2A7.*
*Abbreviations explained in the Chapter 'Units and abbreviations'.*

Table 4.11 provides information on methods applied, activity data, emission factors for $CO_2$ emissions from 2A3 Limestone and Dolomite Use for 1990 to 2009. The table shows that almost all MS use limestone and dolomite consumption as activity data for calculating $CO_2$ emissions. In 2009 the EU-15 IEF is 0.26 t $CO_2$/t of lime produced. The implied emission factors per tonne of lime produced vary between 0.06 t $CO_2$/t for France and 0.61 t $CO_2$/t for the UK. In contrast to the description in the last years' EU inventory report, France, for the estimation of $CO_2$ emissions from 2A3, includes the use of limestone in the process of agglomeration of ore steel. If limestone is being used to manufacture lime, the emissions are included in the category 2A2; if it is used directly in processes such as cement or glass emissions are recorded in the consumer sectors, respectively. Neither 1996 IPCC Guidelines for Greenhouse Gas inventories nor IPCC Good Practice Guidance (2000) clearly define a lower or higher tier method. The use of plant-specific data reported and verified under the EU ETS by Member States can be considered as equivalent to a Tier 2 or Tier 3 method. Table 4.121 suggests that 36 % of the EU-15 emissions are estimated using higher tier methodologies;

**Table 4.11** **2A3 Limestone and Dolomite Use: Information on methods applied, activity data, emission factors for $CO_2$ emissions**

| Member State | Method applied | Emission factor | 1990 | | | | 2009 | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Activity data | | Implied emission factor (t/t) | $CO_2$ emissions (Gg) | Activity data | | Implied emission factor (t/t) | $CO_2$ emissions (Gg) |
| | | | Description | (kt) | | | Description | (kt) | | |
| Austria | D | CS,D | Limestone and Dolomite Use | 462 | 0.44 | 203 | Limestone and Dolomite Use | 514 | 0.43 | 222 |
| Belgium | T3 | CR,CS | Limestone and Dolomite Use | IE | IE | IE | Limestone and Dolomite Use | IE | IE | IE |
| Denmark | T1,CS | D,CS | Limestone and Dolomite Use | 42 | 0.33 | 14 | Limestone and Dolomite Use | 94 | 0.40 | 38 |
| Finland | T2 | CS | Limestone and Dolomite Use | 206 | 0.43 | 88 | Limestone and Dolomite Use | 271 | 0.42 | 114 |
| France | CR | PS | Limestone and Dolomite Use | 22062 | 0.06 | 1338 | Limestone and Dolomite Use | 11251 | 0.06 | 718 |
| Germany | NA | NA | Limestone and Dolomite Use | IE | IE | IE | Limestone and Dolomite Use | IE | IE | IE |
| Greece | CS,T1 | CS,D | Limestone Consumption | 1249 | 0.47 | 583 | Limestone Consumption | 948 | 0.45 | 431 |
| Ireland | T2 | PS | Limestone Consumption | 0.3 | 0.44 | 0.2 | Limestone Consumption | 4 | 0.43 | 2 |
| Italy | T1 | D,CS,PS | Carbonates input to brick, tiles, ceramic production | 5773 | 0.44 | 2540 | Carbonates input to brick, tiles, ceramic | 3752 | 0.44 | 1651 |
| Netherlands | CS | D | Limestone and Dolomite Use | 498 | 0.47 | 232 | Limestone and Dolomite Use | 581 | 0.46 | 269 |
| Portugal | D | D | Limestone consumption | 74 | 0.45 | 33 | Limestone consumption | 271 | 0.46 | 124 |
| Spain | D | D,PS | Limestone and Dolomite Use | 2285 | 0.44 | 1005 | Limestone and Dolomite Use | 1694 | 0.43 | 732 |
| Sweden | CS | D | Limestone and Dolomite Use | 194 | 0.47 | 90 | Limestone and Dolomite Use | 223 | 0.46 | 102 |
| UK | T2 | CS,D | Limestone and Dolomite Use | 3109 | 0.42 | 1317 | Limestone and Dolomite Use | 1961 | 0.61 | 1195 |
| **EU15** | | | **EU15** | **35,954** | **0.21** | **7,444** | **EU15** | **21,565** | **0.26** | **5,598** |

*Belgium reports emissions in the source category 2A7.*
*Germany reports emissions in the source categories where limestone and dolomite is used (1A1a, 2A1, 2A2, 2A4, 2A7, 2C1).*
*Abbreviations explained in the Chapter 'Units and abbreviations'.*

A considerable increase of IEFs during 1990 and 2009 in the inventories 2011 could be observed for Denmark and the UK, whereas no significant increase or decrease of the IEF (> 0.02 t/t) occurred during for any other MS that time period. Explanations for the development of the implied emission factors are given in the following overview:

### *Implied Emission Factor Limestone and Dolomite Use, the Netherlands*

Compared to last year's inventory, the Dutch IEF now corresponds to the IPCC default EF (0.44 t/t). Because more detailed information on activity data for the sources Limestone use for flue gas desulphurisation (FGD), soda ash use and Glass production came available, the emissions of these sources changed for a number of years, resulting in a changed IEF. In response to a recommendation from the EU Centralized Review in 2010, explanations on the methods, AD and EFs used for estimating $CO_2$ emissions from limestone and dolomite use in the Netherlands are provided in the following:

- Limestone from southern Limburg is used in the Dutch cement industry, as well as for producing lime-based fertilisers, fillers, animal fodder lime, flue gas desulphurisation lime, and lime for the brick industry, while Winterwijk limestone (dolomite) is used to produce agricultural lime and acts as a filler for asphalt in the road-construction sector (DWW, the agency for road and hydraulic engineering, 2005). Usage is known for only a few applications, e.g. limestone use for cement, iron and steel, agriculture and flue-gas desulphurisation.

- The $CO_2$ process emissions from flue-gas desulphurisation installations (FGDIs) at coal-fired power plants are determined (through lack of a more accurate method), via the gypsum production from FGDIs, based on the gypsum production and the stoichiometric relationship between limestone, FGD-gypsum production and $CO_2$. The gypsum production (calcium-sulphate, CaSO4) is based on annual reports by the Fly-ash Association. FGD-gypsum consists primarily of calcium-sulphate, with small amounts of metaloxides, such as magnesium-, sodium-, potassium- and aluminium-oxides, and also includes around 8 % water (less than 10 % own moisture) (Fly-Ash Association, 2005).

***Implied Emission Factor Limestone and Dolomite Use, France***

The comparable low IEF (2009) is due to the fact that the French IEF is related to sinter production. In France, source category 2A3 includes $CO_2$ emissions from the decarbonization in the production of enamel, the use of carbon for desulfurization on some industrial sites, the use of limestone to neutralize acidic effluents and the use as a raw material in the agglomeration of ore, thus the global IEF for 2A3 is presently a mixture based on consumption of lime on the one hand, and sinter production on the other. Emissions associated with the use of limestone in sinter production however represent the largest part of 2A3 emissions, and the overall IEF for 2A3 is extremely close to the related specific IEF based on sinter production.

To answer to a recommendation raised during the EU Centralized Review in 2010, additional information explanations of the methods, activity data and emission factor used for estimating $CO_2$ emissions from limestone and dolomite use in France is provided in the following:

- Concerning the production of enamel, domestic production has been known since 2004 and is assumed to be identical for the period 1990-2003. Emissions are derived from annual statements since 1999. An average factor is applied to the period 1990-1998.
- Regarding emissions from desulfurization, the amounts of carbon products used are known through annual statements for recent years and were extrapolated from the emissions for some intermediate years or correspond to the known average emissions for years where no information was available. Emissions are known since 1999. Before that date, an emission factor of 440 kg $CO_2$ / t limestone has been used.
- On the neutralization of acidic effluent, the amount of limestone used are known through annual statements for recent years and were extrapolated from the emissions for some intermediate years or correspond to the known average emissions for years where no information was available. Emissions are known since 1997. Before that date, an emission factor of 418 kg $CO_2$ / t product has been used.
- The quantity of limestone used as a raw material in the agglomeration of ore is precisely known since 2000 through the French association of Steel (FFA, Fédération Française de l’Acier) and direct contact with the only operator not included in the FFA. Before that date, the amounts used are extrapolated from the production of agglomerates which is known and emissions are calculated from the stoichiometric ratio of limestone.

***Implied Emission Factor Limestone and Dolomite Use, Denmark***

The increase of the IEF is caused by the consideration of different activity data: The activity data comprises the consumption of carbonates for production of mineral wool, consumption of CaCO3 for wet flue gas cleaning at waste incineration plants and combined heat and power plants. Activity data for production of mineral wool is not known due to confidentiality. EU-ETS data for some years (1998-2002) combined with energy consumption has been used for extrapolation of the $CO_2$ emission from 1990-1997 and interpolation from 2003-2005. For wet flue gas cleaning at combined heat and power plants the produced amount of gypsum has been used as activity data and the actual $CO_2$ emission has been calculated from stoichiometric relations. From 2006 onwards EU-ETS data combined with environmental reports from the individual plants has been used. The activity data now used is the amount of CaCO3. For wet flue gas cleaning at waste incineration plants produced amount of gypsum has been used as activity data.

***Implied Emission Factor Limestone and Dolomite Use, UK***

The comparable high IEF (2009) is due to the inclusion of $CO_2$ emissions from gypsum produced in the flue gas desulphurisation process. The activity data does not reflect this particular process, and therefore the IEF is higher than might otherwise be expected. The increase of the IEF is caused by including $CO_2$ emissions from gypsum produced in the flue gas desulphurisation process but excluding its activity rate.

$CO_2$ emissions occur when limestone and/or dolomite is used in wet flue gas desulphurization (FGD) of flue gases in power generation. With its report of the review of the initial report of the European Union, the ERT recommends that the EU encourage member States which do not mention this category in their NIR to report where this category is included (FCCC/IRR/2007/EC, para 68). In response to the recommendation by the ERT, Table 4.11 provides an overview about the reporting of this category; only for Finland no explicit reference to limestone used in wet flue gas desulphurization (FGD) could not be found in the NIR.

Table 4.13 provides a more detailed overview on methods used in EU-15 Member States and the coverage of this source category. Austria, Denmark, Finland, Greece, Ireland, Italy, Portugal and Sweden report using plant-specific data reported and verified under the EU ETS.

**Table 4.12 2A3 Limestone and Dolomite Use: Information of wet flue gas desulphurization provided by Member States**

| Limestone and dolomite use | | |
|---|---|---|
| **Member State** | **FGD included** | **Further information on wet flue gas desulphurization** |
| **Austria** | 2.A.3 | In this category CO2 emissions from decarbonising of limestone in the iron and steel industry, limestone use for desulphurization and in chemical industry are considered. Activity data for limestone used for desulphurization were taken from a national report on desulphurization technologies in Austria. The time series was constructed with the help of plant specific SO2 emission declarations from the annual steam boiler database. [NIR 2011] |
| **Belgium** | | CO2 capture from flue gases and subsequent CO2 storage is not applicable in Belgium for the time being. [NIR 2011] |
| **Denmark** | 2.A.3 | The CO2 emission from consumption of limestone for flue gas cleaning has been estimated from statistics on generation of gypsum (wet flue gas cleaning processes) and the stoichiometric relations between gypsum and release of CO2. Statistics on the generation of gypsum from power plants are compiled by Energinet.dk (2008). However, for 2006 - 2009 information on consumption of CaCO3 at the relevant power plants has been compiled (from environmental reports) and used in the calculation of CO2- emission from flue gas cleaning. [NIR 2011] |
| **Finland** | | No information available. [NIR 2011] |
| **France** | 2.A.3 | The category limestone and dolomite use includes several sub-sectors, of which one is the the use of carbon for desulfurization on some industrial sites (2 urban heating sites and 4 district heating power plants). The amounts of carbon products used are known through annual statements for recent years and were extrapolated from the emissions for some intermediate years or correspond to the known average emissions for years where no information was available. Emissions are known since 1999. Before that date, an emission factor of 440 kg CO2 / t limestone has been used. [NIR 2011] |
| **Germany** | 1.A.1.a | Limestone is used for the refining of sugar as well as for wet flue gas cleaning at power plants and waste incineration plants. CO2 emissions from flue-gas desulphurisation are included in 1.A.1.a Limestone use in flue-gas desulphurisation in public power stations. In the inventory, these CO2 emissions were assigned to emissions from use of solid fuels, because such use is the reason for operation of the flue-gas desulphurisation systems and for the systems' CO2 emissions. For the calculating the volume of gypsum in years 2008 and 2009 the volume of gypsum was used as preliminary input value. [NIR 2011] |
| **Greece** | 2.A.3 | The operation of flue gas desulphurization systems in Greece started in 2000. The estimation of emissions is based on data collected during the formulation of the NAP for the period 2005 – 2007. For years 2005-2009 data from verified installation ETS reports were used. The emission factor used (0.44 t CO2 / t limestone) derives from the stoichiometry of the reaction. [NIR 2011] |
| **Ireland** | 2.A.3 | The CO2 emissions reported under this category refer to those emissions associated with the use of limestone (CaCO3) for flue gas desulphurisation and limestone used in the manufacture of bricks and tiles. Limestone has been used to capture the sulphur emitted from peat burning in one electricity generating station since 2001 and in a second such plant since 2007. The CO2 emissions estimates are taken from ETS returns. They are estimated on the basis of limestone quantity used by the companies and an emission factor of 0.44 t CO2/t limestone, which is the stoichiometric ratio of CO2 to CaCO3. [NIR 2011] |
| **Italy** | 2.A.3 | CO2 emissions from limestone and dolomite use are related to the use of limestone and dolomite in bricks, tiles and ceramic production, paper production and also in the treatment of flue gases from power plants. CO2 emissions deriving from the treatment of flue gases have been accounted for the whole time series in the present submission.Detailed production activity data and emission factors have been supplied in the framework of the European emissions trading scheme and relevant data are annually provided by the Italian bricks and tiles industrial association and by the Italian ceramic industrial associations. [NIR 2011] |
| **Luxembourg** | | CO2 capture from flue gases and CO2 storage is not occurring in Luxembourg. [NIR 2011] |
| **Netherlands** | 2.A.3 | The CO2 emissions from this source category are based on consumption figures for limestone use – derived from plaster production figures – for flue gas desulphurisation (FGD) with a wet process by coal-fired power plants and for apparent dolomite consumption (mostly used for road construction). [NIR 2011] |
| **Portugal** | 1.A.1.a | CO2 emissions from wet flue gas desulfurization are estimated for large point sources in the sector of public electricity and heat production. Since there is no CRF category specific for desulfurization, total CO2 emissions from this abatement system were included together with combustion emissions. [NIR 2011] |
| **Spain** | 2.A.3 | Emissions from desulfurization are estimated based on specific questionnaires on the consumption of limestone for the desulphurization process that are sent to power stations in which such a technique for reducing emissions is used. [NIR 2011] |
| **Sweden** | 2.A.3 | Activity data and CO2 emissions from the use of limestone and dolomite within facilities producing glass and mineral wool, iron pellets and chemical products, and also use of limestone and dolomite for flue gas purification in energy producing facilities are reported in CRF 2A3. The calculations are made by applying the IPCC Guidelines default emission factors for limestone and dolomite. [NIR 2011] |
| **UK** | 2.A.3 | Limestone is also used in flue-gas desulphurisation (FGD) plant used to abate SO2 emissions from combustion processes. The limestone reacts with the SO2 present in flue gases, being converted to gypsum, with CO2 being evolved. Emissions are calculated using emission factors of 120 t carbon/kt limestone and 130 t carbon/kt dolomite, in the case of glass processes involving calcination, and 69 t carbon/kt gypsum produced in the case of FGD processes. Gypsum produced in FGD plant is available from the British Geological Survey (2009), with the exception of two of the five plant in 2009. In these cases, the production of gypsum in 2009 is assumed to be the same as in 2008. [NIR 2011] |

*Source: NIR 2011.*

**Table 4.13** **2A3 Limestone and Dolomite Use: Summary of methodological information provided by Member States**

| Limestone and Dolomite Use | |
|---|---|
| **Member State** | **Methodology comment** |
| **Austria** | Emissions were estimated using the methodology and the IPCC default EF for the years 1990-2004. AD for limestone used in blast furnaces for the years 1998 to 2002 was reported directly by the plant operator of the two integrated iron and steel production sites that operate blast furnaces. For the years before and after AD was estimated using the average ratio of limestone used per ton of pig iron produced of the years 1998-2002. For 2005-2009 verified $CO_2$ emissions and activity data, reported under the ETS, were used for the inventory. These data cover limestone use in the iron and steel and chemical industry. The use of limestone in chemical industry is included in the inventory since 2005. AD for limestone used for desulphurization were taken from a national report on desulphurization technologies in Austria.<br>For calculation of $CO_2$ emissions the IPCC default emission factors of 440 kg $CO_2$/t limestone and 477 kg $CO_2$/t dolomite were used. Since 2005 ETS background data provided more detailed information on the actual carbon content of the limestone and dolomite used. Therefore, the IEFs since 2005 are slightly different to the IPCC default values. [NIR 2011] |
| **Belgium** | Also in the iron and steel sector (category 2C), more specifically during the sinter production, limestone and dolomite is used. The emissions are not allocated to the sector 2A3 'mineral products/limestone and dolomite use' but are allocated to this sector 2C. [NIR 2011] |
| **Denmark** | The $CO_2$ emission from the production of bricks and tiles has been estimated from information on annual production registered by Statistics Denmark, corrected for amount of yellow bricks and tiles. This amount is unknown and, therefore, is assumed to be 50 %. The content of CaCO3 and a number of other factors determine the colour of bricks and tiles and, in the present estimate, the average content of CaCO3 in clay has been assumed to be 18 %. The emission factor lime (0.44 kg $CO_2$ pr kg CaCO3) has been used to calculate the emission factor for yellow bricks: 0.079 tonne $CO_2$ pr tonne yellow bricks. For 2006-2009 emission factors have been derived from $CO_2$ emissions reported by the brickworks to EU-ETS (confidential reports from approximately 20 brickworks) and production statistics (Statistics Denmark, 2010). The $CO_2$ emission from the production of container glass/glass wool has been estimated from production statistics published in environmental reports from the producers (Rexam Glass Holmegaard, 2007; Ardagh Glass Holmegaard, 2010; Saint-Gobain Isover, 2010) and emission factors based on release of $CO_2$ from specific raw materials (stoichiometric determination). [NIR 2011] |
| **Finland** | Emissions from limestone and dolomite use are calculated by multiplying emission factors with activity data. Activity data are collected mainly directly from the industry but industrial statistics have also been used to calculate emissions at the beginning of the time series. Emission factors are based on the IPCC's default factors. The consumption of limestone and dolomite has been used as AD when calculating emissions from lime stone and dolomite use. Activity data for 2009 are collected directly from individual companies and the EU-ETS data. Most of the data for the earlier years have been received from individual companies and a small part has been estimated using industrial statistics. [NIR 2011] |
| **France** | Emissions from lime use in iron and steel production are reported under 2A3. National production data from the plant is given by the operator since 2004. The EF is derived from stochiometric relationship. [NIR 2011] |
| **Germany** | Limestone consumption is reported in the sectors that use limestone and in 2A7 Other. [NIR 2011] |
| **Greece** | Estimate includes limestone use in steel, aluminium, ceramics production and SO2 scrubbing. AD and plant-specific EF from operators under EU ETS are used. [NIR 2011] |
| **Irland** | The $CO_2$ emissions reported under this category refer to those emissions associated with the use of limestone for flue gas desulphurisation, and since 2006, limestone used by a single tile manufacturer. The $CO_2$ emissions estimates are taken from ETS returns. They are estimated on the basis of limestone quantity used by the companies and an emission factor of 0.44 t $CO_2$/t limestone, which is the stoichiometric ratio of $CO_2$ to CaCO3. [NIR 2011] |
| **Italy** | $CO_2$ emissions from limestone and dolomite use are related to the use of limestone and dolomite in bricks, tiles and ceramic production, paper production and also in the treatment of flue gases from power plants. $CO_2$ emissions from paper production were accounted for, in the previous submission, only from 2000 to 2008, while in the present submission they are accounted for the whole time series as requested by the 2010 review report. $CO_2$ emissions deriving from the treatment of flue gases have been accounted for the whole time series in the present submission. In the CRFs the total amount of limestone and dolomite used in these processes is reported, as activity data, and it has been estimated on the basis of the average content of CaCO3 in the different products. Detailed production activity data and emission factors have been supplied in the framework of the European emissions trading scheme and relevant data are annually provided by the Italian bricks and tiles industrial association and by the Italian ceramic industrial associations (ANDIL, 2000; ANDIL, several years; ASSOPIASTRELLE, several years; ASSOPIASTRELLE, 2004). [NIR 2011] |
| **Luxembourg** | Limestone consumption reported under 2.A.1 and 2.A.7. [NIR 2011] |
| **Netherlands** | Limestone and dolomite use: environmental reports are used for emission data. AD on plaster production for use in desulphurising installation for power plants are based on the environmental reports of the coal-fired power plants. Data on the consumption of limestone and dolomite are based on statistical information obtained from Statistics Netherlands. Limestone EF = 0.440 t/t (IPCC default) Dolomite use EF= 0.477 t/t (IPCC default). [NIR 2011] |
| **Portugal** | $CO_2$ emissions are estimated from the quantification of carbon in original raw materials, and making a mass balance for the quantities of $CO_2$ that are liberated in the conversion process. Carbon content of materials consumed in Portugal was set from molecular stoichiometry. The consumption of sodium carbonate in the paper and pulp industry was |

| Limestone and Dolomite Use | |
|---|---|
| **Member State** | **Methodology comment** |
| | determined from the statistical information from INE from 1990 to 2000 and thereafter forecasted. Fertilizer production data was also available from INE database from 1990 to 2009. The ceramic industry, more particularly the brick and tile industry and the pavement industry, consumes limestone, dolomite and the carbonates of sodium and barium, and all these substances were considered to result in decarbonisation. For this industry sector, although the consumption of carbonate bearing materials is not known for the whole period, a consumption factor was developed based on the information received under the European Emission Trading Scheme (EU-ETS), and production of construction ceramics and pavement ceramics, which is available from INE's industry surveys IAIT and IAPI, was used to obtain the full time series. [NIR 2011] |
| **Spain** | Includes emissions from dolomite and lime use in bricks and tiles production and from flue gas desulphurization in power plants. AD for bricks and tiles are based on data from the industrial association (HISPALYT) and from plant-specific data from power plants. Data on desulphurization are derived from questionnaires directly send by the power plants. Lime use in iron and steel industry is included in 2C1. An EF based on the stechiometric relation was used for bricks and tiles production. Plant-specific parameters for the EF are available for the emissions from desulphurization in power plants. Lime and dolomite use in iron and steel industry is included in source category 2C1 and emissions from glass production under 2A7. [NIR 2011] |
| **Sweden** | Activity data and $CO_2$ emissions from the use of limestone and dolomite within facilities producing glass and mineral wool, iron pellets and chemical products, and also use of limestone and dolomite for flue gas purification in energy producing facilities are reported in CRF 2A3. The calculations are made by applying the IPCC Guidelines default emission factors for limestone and dolomite. Data on the use of limestone and dolomite have been acquired from environ-mental reports, the ETS and through direct contacts with the companies. [NIR 2011] |
| **United Kingdom** | Emissions are calculated using emission factors of 120 t carbon/kt limestone and 130 t carbon/kt dolomite, in the case of glass processes involving calcination, and 69 t carbon/kt gypsum produced in the case of FGD processes. These factors are based on the assumption that all of the carbon dioxide is released to atmosphere. The British Geological Survey (BGS) has previously been the source of data on the consumption of limestone and dolomite by the glass industry. However, the data available for the last ten years are very incomplete and show surprising year on year variations that do not fit well with estimates of glass production. An alternative approach has therefore been adopted this year. This is based on a detailed survey of raw material usage, carried out in 2006 (GTS, 2008), and this yields estimates of dolomite and limestone use by sector. These data are extrapolated to other years between 1999 and 2008. Data on the usage of limestone and dolomite for steel production are available from the Iron & Steel Statistics Bureau (2009). Gypsum produced in FGD plant is available from the BGS (2009), with the exception of two of the five plant in 2009. In these cases, the production of gypsum in 2009.is assumed to be the same as in 2008. [NIR 2011] |

*Source: NIR 2011.*

Table 4.14 summarizes the recommendations from the 2010 UNFCCC inventory reviews in relation to the category 2A3 Limestone and Dolimite Use. The overview shows no findings have been included in the review reports that are available by now (ten out of fifteen).

**Table 4.14** **2A3 Limestone and Dolomite Use: Findings of the 20010 UNFCCC inventory reviews in relation to $CO_2$ emissions and responses in 2011 inventory submissions**

| Member State | Review findings and responses related to 2A3 Limestone and Dolomite Use | |
|---|---|---|
| | **Comment UNFCCC report of the review of the 2010 submission** | **Status in 2011 submission** |
| **Austria** | Review report (Centralized review 2010) not yet available. | |
| **Belgium** | No recommendation for improvement of this source category in Review Report. (FCCC/ARR/2010/BEL) | No follow-up necessary |
| **Denmark** | No recommendation for improvement of this source category in Review Report. (FCCC/ARR/2010/DNK) | No follow-up necessary |
| **Finland** | No recommendation for improvement of this source category in Review Report. (FCCC/ARR/2010/FIN) | No follow-up necessary |
| **France** | Review report (In-country review 2010) not yet available. | |
| **Germany** | Review report (In-country review 2010) not yet available. | |
| **Greece** | No recommendation for improvement of this source category in Review Report. (FCCC/ARR/2010/GRC) | No follow-up necessary |
| **Ireland** | No recommendation for improvement of this source category in Review Report. (FCCC/ARR/2010/IRL) | No follow-up necessary |
| **Italy** | No recommendation for improvement of this source category in Review Report. (FCCC/ARR/2010/ITA) | No follow-up necessary |
| **Luxembourg** | No recommendation for improvement of this source category in Review Report. (FCCC/ARR/2010/LUX) | No follow-up necessary |
| **Netherlands** | Review report (Centralized review 2010) not yet available. | |
| **Portugal** | No recommendation for improvement of this source category in Review Report. (FCCC/ARR/2010/PRT) | No follow-up necessary |
| **Spain** | Review report (Centralized review 2010) not yet available. | |
| **Sweden** | Review report (Centralized review 2010) not yet available. | |
| **UK** | No recommendation for improvement of this source category in Review Report. (FCCC/ARR/2010/GBR) | No follow-up necessary |

*Source: NIR 2011, UNFCCC inventory review reports, as published at UNFCCC:*
http://unfccc.int/national_reports/annex_i_ghg_inventories/inventory_review_reports/items/5687.php

#### 4.2.1.4 2A7 Other Mineral Products

Table 4.15 provides an overview about the emission sources reported in the category 2A7 Other Mineral Products in 2009 as well as total emissions in this category. The most frequent source reported under Other Mineral Products is glass production (14 Member States), followed by bricks and tiles production. Some Member States included emissions from brick and tile production and glass production under 2A3 Limestone and Dolomite Use. This was the case for Ireland. In response to the recommendation by the ERT (FCCC/ARR/2009/IRL, para 50), Ireland reported emissions from the glass production in a separate sub-category under 2.A.7 for the first time in the 2008 national inventory, and thus increased the completeness of its inventory., In the case of limestone and dolomite use within the production of glass, Sweden reallocated $CO_2$ emissions from 2A3 to 2A7.1 due to recommendations from the EC Internal review in 2009. The only MS that reports $CO_2$ emissions from glass production under 2A3 and 2A4 is the UK, but this MS announced that the reallocation of emissions from glass production to source category 2A7 will be made in the 2012 inventory submission.

Germany is the largest contributor to this category with 23 %, followed by Spain (19 %) in 2009.

**Table 4.15 2A7 Other Mineral Products: Emission sources reported for the year 2009**

| Member State | 2.A.7 Other Mineral Products | $CO_2$ emissions [Gg] | $CH_4$ emissions [Gg] | $N_2O$ emissions [Gg] | Total emissions [Gg CO2 equivalents] | Share in EU-15 total |
|---|---|---|---|---|---|---|
| Austria | Glass production, sinter production, bricks and tiles (decarbonizing) | 378 | NA | NA | 378 | 9% |
| Belgium | Glass Production, ceramics | 390 | NA,NO | NA,NO | 390 | 9% |
| Denmark | Glass Production, Yellow bricks. Expanded clay | 34 | IE,NA | IE,NA | 34 | 1% |
| Finland | Glass production | 9 | NO | NO | 9 | 0% |
| France | Glass Production, Brick and Tile Production | 658 | NA | NA | 658 | 15% |
| Germany | Glass Production, Ceramics, Bricks and Tiles (decarbonizing) | 998 | NO | NO | 998 | 23% |
| Greece | Glass Production | 13 | NA,NO | NA,NO | 13 | 0% |
| Ireland | Glas production, Bricks and Tiles (decarbonizing) | 1 | NO | NO | 1 | 0% |
| Italy | Glass production | 530 | NA | NA | 530 | 12% |
| Luxembourg | Glass production | 62 | NO | NO | 62 | 1% |
| Netherlands | Glass production | 228 | NO | NO | 228 | 5% |
| Portugal | Glass Production | 127 | NO | NO | 127 | 3% |
| Spain | Glass production, Magnesite production, Porous Tiles, Non-porous Tiles | 824 | NA | NA | 824 | 19% |
| Sweden | Glass production, Light expanded clay aggregate, Glass and mineral wool production | 53 | NA | NA | 53 | 1% |
| UK | Fletton Brick Production | 74 | 0 | NE | 79 | 2% |
| **EU-15 Total** | | **4,377** | **0** | **0** | **4,383** | **100%** |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

Table 4.16 provides information on the contribution of Member States to EU recalculations in $CO_2$ from 2A Mineral products for 1990 and 2008 and main explanations for the largest recalculations in absolute terms.

**Table 4.16** **2A Mineral products: Contribution of MS to EU recalculations in $CO_2$ for 1990 and 2008 (difference between latest submission and previous submission in Gg of $CO_2$ equivalents and percent)**

| | 1990 | | 2008 | | Main explanations |
|---|---|---|---|---|---|
| | Gg CO2 equiv. | Percent | Gg CO2 equiv. | Percent | |
| Austria | 0 | 0.0 | 0 | 0.0 | |
| Belgium | -7 | -0.1 | 0 | 0.0 | |
| Denmark | 0 | 0.0 | 0 | 0.0 | |
| Finland | 0 | 0.0 | 21 | 1.7 | |
| France | 16 | 0.1 | 61 | 0.5 | |
| Germany | 421 | 1.9 | 301 | 1.5 | - Inclusion of all lime producing plants<br>- recalculations of sod ash production |
| Greece | 297 | 4.7 | 182 | 2.7 | |
| Ireland | 0 | 0.0 | 0 | 0.0 | |
| Italy | 165 | 0.8 | 146 | 0.7 | |
| Luxembourg | 0 | 0.0 | 0 | 0.0 | |
| Netherlands | 0 | 0.0 | -3 | -0.2 | |
| Portugal | 90 | 2.7 | 95 | 2.1 | |
| Spain | -255 | -1.6 | -356 | -1.9 | - Cement Production: Effect of rounding on the EF applied with respect to the previous inventory edition.<br>- Lime Production: Updating of quicklime production in a plant, using ETS data.<br>- Limestone and Dolomite Use: Revision of the EF for the dolomite used as desulphuration technique in a power plant; Revision of dolomite consumption as desulphuration tecnique in a power plant, that was omitted in the previous inventory edition.<br>- Glass Production: Revision of the carbon content for the coal used as reducing agent in a flat glass manufacturing plant.<br>- Porous Tiles production have been reviewed in accordance with new information furnished by the Spanish Association of Ceramic Wall and Flooring Tile Manufacturers (ASCER).<br>- Non-Porous Tiles production have been reviewed in accordance with new information furnished by the Spanish Association of Ceramic Wall and Flooring Tile Manufacturers (ASCER). |
| Sweden | 0 | 0.0 | 0 | 0.0 | |
| UK | 32 | 0.3 | -320 | -4.0 | - Method for glass production revised to use time series from British Glass<br>- Revised activity data used for soda ash use for glass production. Revised data for FGD from the British Geological Survey. Limestone and dolomite use for 2008 now used (not available in time for 2010 submission) |
| **EU-15** | **759** | **0.7** | **127** | **0.1** | |

## *4.2.2 Chemical industry (CRF Source Category 2B) (EU-15)*

Chemical industry includes the following key categories: $CO_2$ from 2B1 Ammonia Production, $N_2O$ from 2B2 Nitric Acid Production and from 2B3 Adipic Acid Production and $CO_2$ and $N_2O$ from 2B5 Other Chemical Industry.

Source category 2B1 Ammonia Production covers $CO_2$ emissions that occur during the production of ammonia, a chemical used as a feedstock for the production of several chemicals. In most instances, anhydrous ammonia is produced by catalytic steam reforming of natural gas (mostly $CH_4$) or other fossil fuels. $CO_2$ at plants using this process is released primarily during regeneration of the $CO_2$ scrubbing solution, with additional but relatively minor emissions resulting from condensate stripping. Source category 2B2 Nitric Acid Production accounts for $N_2O$ emitted as a by-product of the high temperature catalytic oxidation of ammonia (NH3) in the production of nitric acid. Adipic Acid Production (2B3) also emits $N_2O$ as a by-product when a cyclohexanone/cyclohexanol mixture is oxidized by nitric acid.

Table 4.17 summarises information on Member States' emissions from chemical industry in 1990 and 2009 for total GHG, $CO_2$ and $N_2O$. Between 1990 and 2009, $CO_2$ emission from 2B Chemical Industry decreased by 4 %. The absolute increase in $CO_2$ emissions was largest in Germany and Belgium; the absolute reductions were largest in Italy, France and Ireland. Between 1990 and 2009, $N_2O$ emission from 2B Chemical Industry decreased by 76 %. The absolute decreases in $N_2O$ emissions were largest in UK, France and Germany.

**Table 4.17 2B Chemical Industry: Member States' contributions total GHG and $CO_2$ and $N_2O$ emissions**

| Member State | GHG emissions in 1990 (Gg $CO_2$ equivalents) | GHG emissions in 2009 (Gg $CO_2$ equivalents) | CO2 emissions in 1990 (Gg) | CO2 emissions in 2009 (Gg) | $N_2O$ emissions in 1990 (Gg CO2 equivalents) | CO2 emissions in 2009 (Gg CO2 equivalents) |
|---|---|---|---|---|---|---|
| Austria | 1,512 | 728 | 585 | 545 | 912 | 165 |
| Belgium | 4,588 | 3,888 | 645 | 1,859 | 3,943 | 2,028 |
| Denmark | 1,044 | 2 | 1 | 2 | 1,043 | NA,NO |
| Finland | 1,781 | 1,478 | 125 | 685 | 1,656 | 793 |
| France | 28,273 | 6,366 | 3,567 | 2,398 | 24,552 | 3,909 |
| Germany | 35,496 | 27,490 | 13,076 | 15,611 | 22,420 | 11,879 |
| Greece | 1,350 | 555 | 240 | 188 | 1,109 | 367 |
| Ireland | 2,026 | NO | 990 | NO | 1,035 | NO |
| Italy | 9,982 | 2,313 | 3,254 | 1,178 | 6,676 | 1,130 |
| Luxembourg | NO | NO | NO | NO | NO | NO |
| Netherlands | 11,095 | 4,793 | 3,744 | 3,508 | 7,096 | 1,050 |
| Portugal | 1,208 | 228 | 633 | 92 | 567 | 126 |
| Spain | 3,637 | 1,529 | 796 | 593 | 2,800 | 895 |
| Sweden | 961 | 375 | 118 | 58 | 835 | 312 |
| United Kingdom | 27,695 | 3,969 | 2,885 | 2,715 | 24,641 | 1,178 |
| **EU-15** | **130,647** | **53,714** | **30,660** | **29,430** | **99,286** | **23,833** |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

Table 4.18 provides information on the contribution of Member States to EU recalculations in $CO_2$ from 2B Chemical industry for 1990 and 2008 and main explanations for the largest recalculations in absolute terms.

**Table 4.18 2B Chemical Industry: Contribution of MS to EU recalculations in $CO_2$ for 1990 and 2008 (difference between latest submission and previous submission in Gg of $CO_2$ equivalents and percent)**

| | 1990 | | 2008 | | Main explanations |
|---|---|---|---|---|---|
| | Gg CO2 equiv. | Percent | Gg CO2 equiv. | Percent | |
| Austria | 0 | 0.0 | 6 | 1.0 | |
| Belgium | 0 | 0.0 | -62 | -3.1 | |
| Denmark | 0 | 0.0 | 0 | 0.0 | |
| Finland | 0 | 0.0 | 0 | 0.0 | |
| France | -1 | 0.0 | -9 | -0.4 | |
| Germany | 1,471 | 12.7 | 2,080 | 14.4 | - For the CO2-Emissions from methanol production the default emission factor of the IPCC GL 2006 is used, because the old emissions could not be explained.<br>- Inclusion of CO2 recovery from amonia production |
| Greece | 240 | 0.0 | -14 | 0.0 | |
| Ireland | 0 | 0.0 | 0 | 0.0 | |
| Italy | 0 | 0.0 | 0 | 0.0 | |
| Luxembourg | NE | 0.0 | NE | 0.0 | |
| Netherlands | 0 | 0.0 | 23 | 0.7 | |
| Portugal | -2 | -0.3 | -48 | -6.3 | |
| Spain | 6 | 0.7 | 69 | 13.1 | |
| Sweden | 49 | 71.3 | 48 | 90.4 | |
| UK | 0 | 0.0 | 18 | 0.6 | |
| **EU-15** | **1,764** | **6.1** | **2,111** | **7.2** | |

Table 4.19 provides information on the contribution of Member States to EU recalculations in $N_2O$ from 2B Chemical Industry for 1990 and 2008 and main explanations for the largest recalculations in absolute terms.

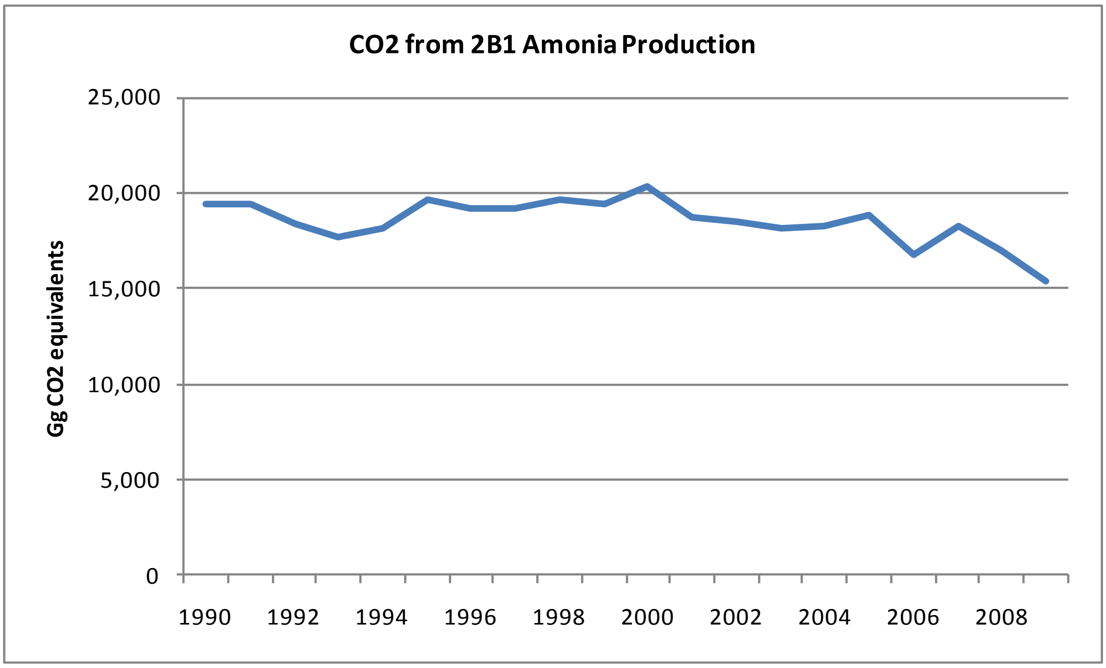
Table 4.19 2B-Chemical Industry: Contribution of MS to EU recalculations in $N_2O$ for 1990 and 2008 (difference between latest submission and previous submission in Gg of $CO_2$ equivalents and percent)

| | 1990 | | 2008 | | Main explanations |
|---|---|---|---|---|---|
| | Gg CO2 equiv. | Percent | Gg CO2 equiv. | Percent | |
| Austria | 0 | 0.0 | 0 | 0.0 | |
| Belgium | 9 | 0.2 | 19 | 1.0 | |
| Denmark | 0 | 0.0 | 0 | 0.0 | |
| Finland | 0 | 0.0 | 18 | 1.2 | |
| France | -31 | -0.1 | 0 | 0.0 | |
| Germany | 0 | 0.0 | 1,363 | 16.3 | Correction of emission factor |
| Greece | 0 | 0.0 | 55 | 14.9 | |
| Ireland | 0 | 0.0 | 0 | 0.0 | |
| Italy | 0 | 0.0 | 0 | 0.0 | |
| Luxembourg | 0 | 0.0 | 0 | 0.0 | |
| Netherlands | 0 | 0.0 | 0 | 0.0 | |
| Portugal | 0 | 0.0 | -71 | -15.4 | |
| Spain | 0 | 0.0 | 0 | 0.0 | |
| Sweden | 4 | 0.4 | 0 | 0.0 | |
| UK | 0 | 0.0 | 0 | 0.0 | |
| **EU-15** | **-18** | **0.0** | **1,383** | **5.9** | |

#### 4.2.2.1 2B1 Ammonia Production

$CO_2$ emissions from 2B1 Ammonia Production account for 0.4 % of total EU-15 GHG emissions in 2009. Between 1990 and 2009, $CO_2$ emissions from this source decreased by 21 % (Figure 4.6). Germany, the Netherlands and France are responsible for 77 % of these emissions in the EU-15. Italy, Ireland and France had large reductions in absolute terms between 1990 and 2009. The reasons for these reductions were a change to low emitting technology in France and production decreases in the other two countries. The largest growth in emissions had Germany, followed by Belgium.

Figure 4.6 2B1 Ammonia Production: EU-15 $CO_2$ emissions



The raise of $CO_2$ emissions by 10 % in 1993-1995 was dominated by the increase of emissions in Belgium, Germany, Portugal and the Netherlands, whereas Italy showed a reverse trend in $CO_2$ emissions. The emissions in Belgium increased noticeably from 1993 to 1994 because new production installations became available in the Flemish region. For Germany, production decreased during 1991-1993 due to changes in Eastern Germany, whereas in 1995 the market had stabilized again. The contribution to the EU-15 emission change 1993-1994 was dominated by activity data rather than implied emission factors.

The decrease in EU-15 $CO_2$ emissions by 10 % in 2006, which was followed by an again increase of emissions by 9 % was mainly caused by France and the UK. For last-mentioned MS, data for 1997 onwards is based on operator reported data and reflect actual trends in emissions. National statistics in France show a drop in production for 2006.

The largest reduction in $CO_2$ emissions in 2008-2009 could be observed for Portugal, as the only fertilizer industrial plant manufacturing ammonia has stopped its activity in 2009; the ammonia production has been relocated to India. $CO_2$ emissions in Germany (country's share in change of EU-15 emissions in 2009 is 35 %), the UK (country's share: 19 %) and Italy (country's share: 11 %) decreased considerably in absolute terms during 2008 and 2009. These reductions were mainly due to a drop in ammonia production that could be observed for nearly all Member States, but with highest rates among EU-15 MS for the UK (-28 %), Italy (-21 %) and Germany (-8 %) . Despite the decrease in the French production rate, France increased its $CO_2$ emissions from Ammonia production during 2008 and 2009, which was caused by a non-optimal process caused by a drop of production due to the economic crisis.

Germany – representing the highest share of $CO_2$ emissions from Ammonia Production – with its 2010 GHG inventory submission estimated these emissions based on plant-specific information (Tier 3 approach) and thus improved the accuracy of estimates for this category, as recommended by the ERT (FCCC/ARR/2009/EC, para 50).

**Table 4.20 2B1 Ammonia Production: Member States' contributions to $CO_2$ emissions**

| Member State | CO2 emissions in Gg | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg CO2 equivalents) | (%) | (Gg CO2 equivalents) | (%) | | |
| Austria | 517 | 533 | 486 | 3.2% | -47 | -9% | -31 | -6% | CS,T2 | CS |
| Belgium | 420 | 1,004 | 845 | 5.5% | -159 | -16% | 424 | 101% | T3 | D,PS |
| Denmark | NO | NO | NO | - | - | - | - | - | NA | NA |
| Finland | 44 | NO | NO | - | - | - | -44 | -100% | NA | NA |
| France | 3,033 | 1,920 | 2,155 | 14.0% | 235 | 12% | -878 | -29% | CR | PS |
| Germany | 5,745 | 7,417 | 6,845 | 44.5% | -572 | -8% | 1,100 | 19% | T3 | PS |
| Greece | 240 | 230 | 188 | 1.2% | -43 | -19% | -53 | - | T1a | CS |
| Ireland | 990 | NO | NO | - | - | - | -990 | -100% | NA | NA |
| Italy | 2,765 | 882 | 695 | 4.5% | -187 | -21% | -2,070 | -75% | T2 | CS,PS |
| Luxembourg | NO | NO | NO | - | - | - | - | - | NA | NA |
| Netherlands | 3,096 | 2,850 | 2,857 | 18.6% | 7 | 0% | -239 | -8% | T1b | CS |
| Portugal | 569 | 574 | NO | - | -574 | -100% | -569 | -100% | T2 | PS |
| Spain | 709 | 505 | 510 | 3.3% | 5 | 1% | -199 | -28% | D | PS |
| Sweden | NO | NO | NO | - | - | - | - | - | NA | NA |
| United Kingdom | 1,322 | 1,108 | 801 | 5.2% | -307 | -28% | -520 | -39% | T1 | CS |
| **EU-15** | **19,450** | **17,022** | **15,381** | **100.0%** | **-1,641** | **-10%** | **-4,068** | **-21%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

Table 4.20 shows information on methods applied, activity data, emission factors for $CO_2$ emissions from 2B1 Ammonia Production for 1990 to 2009. The table shows that all MS (except for Ireland and the UK) report Ammonia Production as activity data. The implied emission factors per tonne of ammonia produced for 2009 vary between 1.08 t $CO_2$/t ammonia for Austria and 2.49 t $CO_2$/t ammonia for Germany (excluding the UK). In 2009 the EU-15 IEF (excluding the Netherlands, Portugal and the UK) is 1.98 t $CO_2$/t of ammonia produced. The table also suggests that about 72 % of EU-15 emissions are estimated with higher Tier methods.

**Table 4.21 2B1 Ammonia Production: Information on methods applied, activity data, emission factors for $CO_2$ emissions**

| | | | 1990 | | | | 2009 | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Member State | Method applied | Emission factor | Activity data: Description | Activity data (kt) | Implied emission factor (t/t) | $CO_2$ emissions (Gg) | Activity data: Description | Activity data (kt) | Implied emission factor (t/t) | $CO_2$ emissions (Gg) |
| Austria | CS,T2 | CS | Ammonia Production | 461 | 1.12 | 517 | Ammonia Production | 449 | 1.08 | 486 |
| Belgium | T3 | D,PS | Ammonia Production | 360 | 1.17 | 420 | Ammonia Production | 684 | 1.23 | 845 |
| Finland | NA | NA | Ammonia Production | 28 | 1.55 | 44 | Ammonia Production | NO | NO | NO |
| France | CR | PS | Ammonia Production | 1928 | 1.57 | 3033 | Ammonia Production | 1184 | 1.82 | 2155 |
| Germany | T3 | PS | Ammonia Production | 2705 | 2.12 | 5745 | Ammonia Production | 2747 | 2.49 | 6845 |
| Greece | T1a | CS | Ammonia Production | 313 | 0.77 | 240 | Ammonia Production | 103 | 1.82 | 188 |
| Ireland | NA | NA | Natural Gas Feedstocks | 430 | 2.30 | 990 | Natural Gas Feedstocks | NO | NO | NO |
| Italy | T2 | CS,PS | Ammonia Production | 1455 | 1.90 | 2765 | Ammonia Production | 354 | 1.96 | 695 |
| Netherlands | T1b | CS | Ammonia Production | C | C | 3096 | Ammonia Production | C | C | 2857 |
| Portugal | T2 | PS | Ammonia Production | C | C | 569 | Ammonia Production | C | NO | NO |
| Spain | D | PS | Ammonia Production | 573 | 1.24 | 709 | Ammonia Production | 409 | 1.25 | 510 |
| UK | T1 | CS | Natural gas consumption PJ net | 45 | 29.53 | 1322 | Natural gas consumption PJ net | 26 | 30.85 | 801 |
| **EU15** | | | **EU15 w/o IE, NL, PT and UK (69%)** | **7823** | **1.72** | **13473** | **EU15 w/o NL, PT and UK (76%)** | **5931** | **1.98** | **11723** |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

The implied emission factor for 2009 was lower than in 1990 only for Austria, whereas the IEF increased for all other MS during that period. Explanations for the development of the implied emission factors and for outliers in IEFs are given in the following overview:

***Implied Emission Factor Ammonia Production, Austria***

Emissions are calculated by natural gas non-energy use from the energy balance. The split in energy and non-energy use made by the operator might not always be consistent. In 1992 a high factor of natural gas/ammonia produced (0.5 t/t) was used, whereas in 2002 this factor was lower (0.41 t/t). The reason for the comparably low EF is i) the relatively low EF for $CO_2$ from natural gas (55.4 t/TJ) consistent with the energy sector, and ii) carbon bound in melamine that is not reported as $CO_2$.

***Implied Emission Factor Ammonia Production, France***

The IEF increased by 14% during 2008 and 2009 due to a non-optimal process which is caused by a drop of production.

***Implied Emission Factor Ammonia Production, Germany***

The growth of German IEF during 1992 and 1993 of 14% contributed most to the overall increase of the IEF during 1990 and 2009 (17%). The underlying reason is a gap in the emissions reported to the UBA from 1990 to 1992. Since its resubmission in 2010 and to correspond to recommendations from the In Country Review in 2010, Germany adds the $CO_2$ captured for other uses to total $CO_2$ emissions from 2B1. Thus the IEF results in 2.49 t $CO_2$/t NH3.

***Implied Emission Factor Ammonia Production, Greece***

The Greek IEF increased especially during the years 1990-1993 and 1998-2001 which is due to the different fuels used in the two plants operating in Greece. The first plant has been operating since 1990, with an interruption between 1994-1997 using natural gas provided by the Public Gas Company SA (DEPA) since 1998. During 1990-1993 natural gas has been provided by the Kavala Oil Corporation. Imported natural gas was introduced to the Greek energy system by DEPA in 1996. Until 1996 natural gas consumption in Greece corresponded to small amounts of domestic natural gas explored by the company Kavala Oil. The second plant has been operating since 1990 up to 1999 with intervals. This plant used lignite as feedstock until 1991, and liquid fuels until its closure.

During the Centralized Review of the Greek inventory in 2010, Greece recalculated and resubmitted all its estimates of $CO_2$ emissions from ammonia production reported under the industrial processes sector and the part that was allocated to the energy sector. The MS also used, for calculating its resubmitted estimates, updated AD compiled in consultation with external data providers, in order to have more accurate data on the natural gas used as feedstock for ammonia production. Thus, to correspond to recommendations raised during the EU Centralized Review in 2010, time-series consistency for ammonia production was improved.

***Implied Emission Factor Ammonia Production, UK***

The comparable high IEF (2009) could be explained by the activity data which is natural gas consumption in PJ for this source.

Table 4.21 provides a more detailed overview of the methodologies and data sources used by Member States for this source category as reported in the NIR 2011.

**Table 4.22 2B1 Ammonia Production: Summary of methodological information provided by Member States**

| Ammonia Production | |
|---|---|
| **Member State** | **Methodology comment** |
| **Austria** | AD since 1990 and CH4 emission data from 1994 onwards were reported directly by the only ammonia producer in Austria and thus represent plant specific data. The composition of the synthesis gas is measured regularly at the only ammonia producer in Austria. CO2 emissions are calculated from the natural gas input with a standard emission factor (55.4 t/TJ). In this methodology it is assumed that all natural gas is transformed to CO2 and emitted at once. But, according to information from the producer, there are also CH4 emissions during start-ups of the ammonia production. Therefore this CH4 has to be subtracted from total CO2 to avoid double counting. Furthermore, CO2 and CH4 emissions from urea production are reported, that both derive directly from ammonia. These emissions are reported under urea production – where they occur – and are also subtracted from total CO2 emissions from ammonia production to avoid double counting of emissions. Account was taken for the carbon bound in the melamine production. [NIR 2011] |
| **Belgium** | In Flanders the emissions of CO2 originating from the production of ammonia are obtained as a result of the yearly surveys carried out by the chemical federation in cooperation with the Vito. The estimation of the emissions is based on the consumption of natural gas. The part of the CO2 (recovery part) is already taken into account.<br>In the Walloon region, the amount of natural gas used in the process is given directly by the plant. The CO2 process emissions are calculated based on this amount of natural gas. 100% per cent of the carbon content of the natural gas is presumed to be emitted and the default IPCC emission factor for CO2 for natural gas (55,8 kton CO2/PJ) is used. [NIR 2011] |
| **Denmark** | Not occuring. [NIR 2011] |
| **Finland** | The tier 1 IPCC methodology was applied. CO2 emissions from ammonia production are calculated by multiplying the amount of produced ammonia with the emission factor. Activity data have been received directly from the company and the emission factor is the default factor from the IPCC.All ammonia currently used in Finland is imported. In 1990-1992 small amounts (4 - 30 Gg per year) were produced using mainly peat and heavy oil as feedstock for the needed hydrogen. From 1993 on there has been no ammonia production in Finland [NIR 2011] |
| **France** | Emission data obtained directly from plants, CS EF calculated on this basis.[NIR 2011] |
| **Germany** | Tier 3 methodology has been applied since the 2011 submission. Companies report all information to Industrieverband Agrar (IVA) where data is aggregated and forwarded to UBA. [NIR 2011] |
| **Greece** | CO2 emissions have been estimated using Tier 1a methodoloy. AD concerning fuel consumption for the years 1998-2009 have been provided by the plant using natural gas and by DEPA. Ammonia production for the whole time-series has been made available by the El Stat, and for the years 1998-2009 by the one plant still operating in Greece. [NIR 2011] |
| **Ireland** | Carbon dioxide emissions from ammonia production are estimated from the natural gas feedstocks to the plant as indicated in the national energy balance provided by SEI. In accordance with the 1996 IPCC guidelines, it is assumed that no feedstock carbon is sequestered in urea and the emission factor is 54.94 kg CO2/TJ, the value for indigenous natural gas, which equates to 2.3 tonne CO2/tonne natural gas. [NIR 2010] Ammonia production was closed in 2003.[NIR 2011] |
| **Italy** | Ammonia production data are published in the international industrial statistical yearbooks (UN, several years), national statistical yearbooks (ISTAT, several years) and from 2002 they have been checked with information reported in the national EPER/E-PRTR registry. Recovered CO2 has been investigated with the cooperation of the operators and the resulting information has been used to revise the whole CO2 emission time series and the emission factors in this submission. The analysis has allowed to understand that CO2 emissions recovered from ammonia production are used to produce urea and technical gases. According to IPCC Guidelines this CO2 recovered should be accounted for emission and included in the estimate. Differently from the previous submissions the resulting average CO2 emission factors are found to be higher than the IPCC defaults.For the years 2002-2007, the average emission factors result also from data reported by the plants in the national EPER/E-PRTR and they account for the recovered CO2 data too. As for 2008 the average emission factor is 1.86 t CO2/t ammonia production, whilst for 2009 the implied emission factor is 1.96 t CO2/t ammonia<br>production.[NIR 2011] |
| **Luxembourg** | Not occuring.[NIR 2011] |
| **Netherlands** | Ammonia production: activity data on use of natural gas are obtained from Statistics Netherlands (CBS). Although ammonia and urea production data are considered confidential, international statistics such as UN, IFA and USGS do report production data for the Netherlands. A country-specific CO2 emission factor is used. This emission factor is based on a 17% fraction of the carbon in the gas-feedstock not being oxidised during the ammonia manufacture and was calculated from the carbon contained in the urea produced. [NIR 2011] |
| **Portugal** | In 2008 only one fertilizer industrial plant manufactures ammonia in Portugal, using Vacuum Residual Fuel Oil (VRF) as source of hydrogen (feedstock). Total production of ammonia in Portugal is available from the only existing facility for the period 1990-2008. In 2009, this plant has stopped activity and the ammonia production has been relocated to India. The quantity of VRF that was used was set from data collected at the only industrial plant in Portugal for a limited number of years – 1990 till 1994 – and a strong linear relation between feedstock consumption and ammonia production could be established from available data [NIR 2011] |
| **Spain** | Production data and country-specific EF from some plants and IPCC default factors and production statistics for the other plants. In 2009 only two plants were producing ammnia. Plant specific data (production of ammonia, consumption of natural gas and refinery gas, CO2 produced, directly emitted, sold) is available. Emission factors are in the range 1.009-1.294 kg CO2/tonne ammonia when using natural gas and in the range 1.420-1.430 kg CO2/tonne ammonia when using naphtha / gas refinery are used. [NIR 2011] |
| **Sweden** | There is an annual production of about 5 Gg of ammonia in Sweden, according to UN statistics . This ammonia is however not intentionally produced, but is a by-product in one chemical industry producing various chelates and chelating agents, such as EDTA, DTPA and NTA . Emissions from this industry are included in CRF code 2B5 Other. Ammonia production, 2B1, is thus reported as NO in the CRF-tables. [NIR 2011] |
| **UK** | Emissions of CO2 from feedstock use of natural gas were calculated by combining reported data on CO2 produced, emitted and sold by the various ammonia processes. Where data were not available, they have been calculated from other data such as plant capacity or natural gas consumption. A correction has to be made for CO2 produced at one site where some of this CO2 is subsequently 'recovered' through sequestration in methanol. the default carbon emission factor for natural gas was used to convert between carbon and natural gas. [NIR 2011] |

*Source: NIR 2011.*

Table 4.23 summarizes the recommendations from the 2010 UNFCCC inventory reviews in relation to the category 2B1 Ammonia Production. The overview shows that only very few findings have been reported of which most recommendations were implemented. For EU-15 MS only ten review reports have been available for the compilation of this report.

**Table 4.23 2B1 Ammonia Production: Findings of the 2010 UNFCCC inventory reviews in relation to $CO_2$ emissions and responses in 2011 inventory submissions**

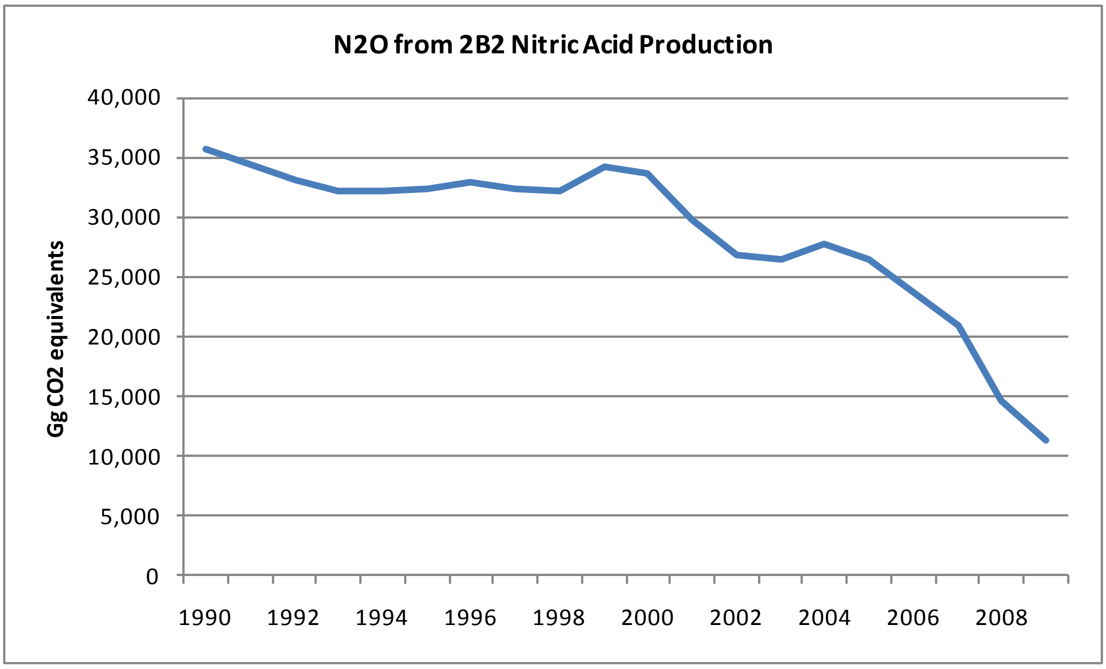
| Member State | Review findings and responses in relation to 2B1 Ammonia Production | |
|---|---|---|
| | **Comment UNFCCC report of the review of the 2010 submission** | **Status in 2011 submission** |
| **Austria** | No recommendation for improvement of this source category in Review Report. (FCCC/ARR/2010/AUT) | No follow-up necessary |
| **Belgium** | In the NIR, Belgium mentions issues of confidentiality on ammonia production, while at the same time it provides AD and EFs for ammonia production in the CRF tables. The ERT recommends that Belgium reconsider this inconsistency between the NIR and the CRF tables and report clearly what exactly is confidential about its data in its next annual submission. (FCCC/ARR/2010/BEL, para 50) | This inconsistency has been solved. Activity data on ammonia production is no longer mentioned to be confidential in the NIR. [NIR 2011, p.88] |
| | Belgium uses an oxidation factor of 99.5 per cent in calculating CO2 emissions from ammonia production, in the process involving catalytic steam reforming of natural gas. In its response to a question raised by the ERT, Belgium indicated that the methodology used is plant specific. The ERT recommends that Belgium provide clearer details on the methodology, including a justification for the oxidation factor applied, in its next annual submission. (FCCC/ARR/2010/BEL, para 51) | Not yet adressed. [NIR 2011] |
| **Denmark** | No recommendation for improvement of this source category in Review Report. (FCCC/ARR/2010/DNK) | No follow-up necessary |
| **Finland** | No recommendation for improvement of this source category in Review Report. (FCCC/ARR/2010/FIN) | No follow-up necessary |
| **France** | Review report (In-country review 2010) not yet available. | |
| **Germany** | Review report (In-country review 2010) not yet available. | |
| **Greece** | The natural gas used as feedstock is the AD used to estimate emissions from ammonia production, which complies with the tier 1a method from the Revised 1996 IPCC Guidelines. However, there is no direct information in the NIR on the EF applied by the Party. During the review, Greece recalculated and resubmitted all its estimates of CO2 emissions from ammonia production reported under the industrial processes sector and the part that was allocated to the energy sector, removing the storage factor of 33 per cent in accordance with the IPCC good practice guidance. The Party also used, for calculating its resubmitted estimates, updated AD compiled in consultation with external data providers, in order to have more accurate data on the natural gas used as feedstock for ammonia production.<br>The ERT noted some inconsistencies in the reported values for 2008 and recommends that Greece recheck the values for non-energy use of natural gas reported in CRF table 1.A(d) and for ammonia and/or hydrogen production and include the relevant background information in the NIR of its next annual submission. (FCCC/ARR/2010/GRC, para 57) | Done. The consistency with the energy sector has been re-checked. Inconsistent values have been corrected in the reported emissions of the energy sector of the 2011 submission. [NIR 2011, p.312] |
| **Ireland** | No recommendation for improvement of this source category in Review Report. (FCCC/ARR/2010/IRL) | No follow-up necessary |
| **Italy** | No recommendation for improvement of this source category in Review Report. (FCCC/ARR/2010/ITA) | No follow-up necessary |
| **Luxembourg** | No recommendation for improvement of this source category in Review Report. (FCCC/ARR/2010/LUX) | No follow-up necessary |
| **Netherlands** | Review report (Centralized review 2010) not yet available. | |
| **Portugal** | There is only one industrial plant for ammonia production in Portugal. Therefore, the AD and EFs are reported as confidential for this category. CO2 emissions were estimated from feedstock consumption (vacuum residual fuel oil) for the period 1990–1994 and an average feedstock/ammonia production ratio for the period 1994–2007. However, AD for 2008 were estimated using a simple linear forecast. During the review, the ERT was informed that Portugal plans to obtain AD directly from the plant. The ERT welcomes this planned improvement and recommends that Portugal report its emission estimates accordingly in its next annual submission. (FCCC/ARR/2010/PRT, para 55) | AD revision for the period 1990-2009 based on data from the only facility in Portugal. AD update (CRF 2B2 and 2B5) for the years2008 and 2009 based on INE (IAPI) surveys. [NIR 2011, p.9-7] |
| **Spain** | Review report (Centralized review 2010) not yet available. | |
| **Sweden** | Review report (Centralized review 2010) not yet available. | |
| **UK** | No recommendation for improvement of this source category in Review Report. (FCCC/ARR/2010/GBR) | No follow-up necessary |

*Source: NIR 2011, UNFCCC inventory review reports, as published at UNFCCC: http://unfccc.int/national_reports/annex_i_ghg_inventories/inventory_review_reports/items/5687.php*

### 4.2.2.2 2B2 Nitric Acid Production

$N_2O$ emissions from 2B2 Nitric acid production account for 0.3 % of total EU-15 GHG emissions in 2009. Between 1990 and 2009, $N_2O$ emissions from this source decreased by 68 % (Table 4.23). Germany (29.1%) and France (17.5%) account for 47.6 % of EU-15 emissions. All Member States had reductions from this source between 1990 and 2009. The Netherlands and France had the greatest reductions in absolute terms, due to the implementation of technical measures at all Dutch nitric acid plants in the third quarter of 2007 and due to the improvement of the process and catalyst efficiency in France. Production stopped in Denmark (middle of 2004) and Ireland (in 2002 due to the liquidation of Irish Fertilizer Industries).

**Figure 4.7 2B2 Nitric acid production: EU-15 $N_2O$ emissions**




The decrease in $N_2O$ emissions by 12 % in 2000-2001 and further 10 % 2001-2002 was dominated by the drop in emissions in France, UK and the Netherlands. The decrease of $N_2O$ emissions of minus 11 % during 2006 and 2007 was dominated by Belgium (contributing with 27 % to the EU-15 emission change), the Netherlands (contributing with 48 % to the EU-15 emission change due to technical measures that have been implemented at all nitric acid plants in the third quarter of 2007) and France (contributing with 10 % to EU-15 emission change due to improved catalyst efficiency). The $N_2O$ emissions further decreased significantly by minus 30 % between 2007 and 2008 and by minus 23 % during 2008 and 2009. Emissions reductions in 2009 were achieved especially in Germany, Finland and France. In Finland all existing Finnish nitric acid plants have started to use special catalyst to decrease emissions during 2009 whereas in Germany and France further implementation of reduction techniques and improvement of the process efficiency led to a continuation of the trend in emissions since 2007.

**Table 4.24 2B2 Nitric acid production: Member States' contributions to $N_2O$ emissions**

| Member State | $N_2O$ emissions (Gg $CO_2$ equivalents) | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg CO2 equivalents) | (%) | (Gg CO2 equivalents) | (%) | | |
| Austria | 912 | 326 | 165 | 1.5% | -160 | -49% | -747 | -82% | CS | PS |
| Belgium | 3,562 | 1,415 | 1,470 | 12.9% | 54 | 4% | -2,092 | -59% | T3 | PS |
| Denmark | 1,043 | NO | NO | - | - | - | -1,043 | -100% | NA | NA |
| Finland | 1,656 | 1,579 | 793 | 7.0% | -786 | -50% | -863 | -52% | T2 | PS |
| France | 6,570 | 2,768 | 1,991 | 17.5% | -777 | -28% | -4,579 | -70% | CR | PS |
| Germany | 3,384 | 4,202 | 3,309 | 29.1% | -893 | -21% | -75 | -2% | T3 | PS |
| Greece | 1,109 | 422 | 367 | 3.2% | -55 | -13% | -742 | -67% | D | D |
| Ireland | 1,035 | NO | NO | - | - | - | -1,035 | -100% | NA | NA |
| Italy | 2,086 | 358 | 382 | 3.4% | 23 | 6% | -1,705 | -82% | T2 | D,PS |
| Luxembourg | NO | NO | NO | - | - | - | - | - | NA | NA |
| Netherlands | 6,330 | 558 | 447 | 3.9% | -111 | -20% | -5,883 | -93% | T2 | PS |
| Portugal | 567 | 392 | 126 | 1.1% | -266 | -68% | -440 | -78% | D | CR,OTH |
| Spain | 2,800 | 988 | 895 | 7.9% | -92 | -9% | -1,905 | -68% | D | CS |
| Sweden | 814 | 268 | 305 | 2.7% | 36 | 14% | -509 | -63% | T2 | PS |
| United Kingdom | 3,904 | 1,465 | 1,107 | 9.7% | -358 | -24% | -2,797 | -72% | CS | CS |
| **EU-15** | **35,772** | **14,742** | **11,357** | **100.0%** | **-3,384** | **-23%** | **-24,414** | **-68%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

Table 4.25 shows information on methods applied, activity data, emission factors for $N_2O$ emissions from 2B2 Nitric Acid Production for 1990 to 2009. The table shows that all MS report Nitric Acid Production as activity data; for some MS this information is confidential (Netherlands and Portugal). The implied emission factors per tonne of nitric acid produced vary for 2009 between 0.0011 t $N_2O$/t of nitric acid produced for Austria and 0.0070 t $N_2O$/t of nitric acid produced for Greece. The EU-15 IEF (excluding Netherlands and Portugal) is 0.0036 t $N_2O$/t of nitric acid produced. The decrease of the EU-15 IEF during 1990 and 2009 is mainly due to changing production ratios in the different MS that have different technological standards and the closure of older plants in some MS. The table also suggests that about 96 % of EU-15 emissions are estimated with higher tier methods for 2009.

**Table 4.25 2B2 Nitric Acid Production: Information on methods applied, activity data, emission factors for $N_2O$ emissions**

| Member State | Method applied | Emission factor | 1990 | | | | 2009 | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Activity data | | Implied emission factor (t/t) | $N_2O$ emissions (Gg) | Activity data | | Implied emission factor (t/t) | $N_2O$ emissions (Gg) |
| | | | Description | (kt) | | | Description | (kt) | | |
| Austria | CS | PS | Nitric Acid Production | 530 | 0.0056 | 2.9 | Nitric Acid Production | 496 | 0.0011 | 0.5 |
| Belgium | T3 | PS | Nitric Acid Production | 1436 | 0.0080 | 11.5 | Nitric Acid Production | 1563 | 0.0030 | 4.7 |
| Denmark | NA | NA | Nitric Acid Production | 450 | 0.0075 | 3.4 | Nitric Acid Production | NO | NO | NO |
| Finland | T2 | PS | Nitric acid production medium pressure plants | 549 | 0.0097 | 5.3 | Nitric acid production medium pressure plants | 477 | 0.0054 | 2.6 |
| France | CR | PS | Nitric Acid Production | 3200 | 0.0066 | 21.2 | Nitric Acid Production | 2337 | 0.0027 | 6.4 |
| Germany | T3 | PS | Nitric Acid Production | 1698 | 0.0064 | 10.9 | Nitric Acid Production | 2247 | 0.0048 | 10.7 |
| Greece | D | D | Nitric Acid Production | 511 | 0.0070 | 3.6 | Nitric Acid Production | 169 | 0.0070 | 1.2 |
| Ireland | NA | NA | Nitric Acid Production | 339 | 0.0099 | 3.3 | Nitric Acid Production | NO | NO | NO |
| Italy | T2 | D,PS | Nitric Acid Production | 1037 | 0.0065 | 6.7 | Nitric Acid Production | 419 | 0.0029 | 1.2 |
| Netherlands | T2 | PS | Nitric Acid Production | C | C | 20.4 | Nitric Acid Production | C | C | 1.4 |
| Portugal | D | CR,OTH | Nitric Acid Production | C | C | 1.8 | Nitric Acid Production | C | C | 0.4 |
| Spain | D | CS | Nitric Acid Production | 1329 | 0.0068 | 9.0 | Nitric Acid Production | 656 | 0.0044 | 2.9 |
| Sweden | T2 | PS | Nitric Acid Production | 374 | 0.0070 | 2.6 | Nitric Acid Production | 243 | 0.0040 | 1.0 |
| UK | CS | CS | Nitric Acid Production | 2408 | 0.0052 | 12.6 | Nitric Acid Production | 1053 | 0.0034 | 3.6 |
| **EU15** | | | **EU15 w/o NL and PT (81%)** | **13,861** | **0.0067** | **93** | **EU15 w/o NL and PT (95%)** | **9,660** | **0.0036** | **35** |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

The implied emission factors for 2009 are significantly lower than in 1990 for all MS except for Greece. The decrease of the IEF was largest for Austria (-80 %), Belgium (-62 %) and France (-59 %). Explanations for the development of the implied emission factors and for outliers in IEFs are therefore given in the following overview. Besides changing production ratios in the different Member States (which also have different technological standards), also the closure of older plants in Belgium, Denmark, Ireland, Italy and Sweden resulted in reduced emissions.

***Implied Emission Factor, Belgium***

The decrease in IEF was due to further introduction of catalysts in the different installations in the Flemish region.

***Implied Emission Factor, Austria***

Comparable low IEF could be explained with the installation of a $N_2O$ decomposition facility in 2004. The additional decrease of IEF 2008-2009 was due to the introduction of a new catalyst into the nitric acid plant in May 2009.

***Implied Emission Factor, France***

IEF is calculated with activities and $N_2O$ emissions reported under the E-PRTR. Between 2007 and 2008, reported $N_2O$ emissions decreased due to improved processes and catalyst efficiency. In 2009 one older plant producing nitric acid was closed.

***Implied Emission Factor, Finland***

The decrease of the IEF of 34 % during 2008 and 2009 is due to the first joint implementation project in Finnish territory. This project aims on cutting down $N_2O$ emissions of nitric acid plants and was started in 2009. A new $N_2O$ abatement technology - a pelleted catalyst - was installed directly in the ammonia oxidation reactor underneath the ammonia oxidation catalyst (Pt-Rh) in all the three existing nitric acid plants.

***Implied Emission Factor, Germany***

A new plant started production that was build with the best available technology in 2002 and thus IEF significantly decreased from 2002 onwards. An additional decrease of the IEF is due the use of reduction techniques from 2006 onwards.

***Implied Emission Factor, Spain***

Emissions were derived from information about production, emission abatement techniques and plant specific EFs. Emissions thus follow the implementation of the techniques. Relevant information was provided by plant operators with questionnaires. For those plants that are not in operation any more and thus comparable information was not available, emission estimates were made by applying an emission factor of 7 kg $N_2O$ / t nitric acid, as originally published by the Business Federation of the Chemical Industry in Spain (FEIQUE). Thus for early 1990ies IEF was higher than in recent years.

Table 4.26 provides a more detailed overview on methodologies and data sources used in EU-15 Member States for the estimation of emissions from Nitric Acid Production.

**Table 4.26 2B2 Nitric Acid Production: Summary of methodological information provided by Member States**

| **Nitric Acid Production** | |
|---|---|
| **Member State** | **Methodology comment** |
| **Austria** | Following the IPCC Guidelines plant specific measurement data was collected. Activity and emission data of $N_2O$ emissions was obtained directly from the plant operator. Since 1998, emissions are measured continuously. Based on the analysed emission data of 1998 and due to the fact that the production technology has not changed between 1990 and 1998 emission factors per ton of product were calculated for the used technologies. With these estimates of plant specific emission factors and the production volume of the individual plants the total emission of $N_2O$ per year was |

| Nitric Acid Production | |
|---|---|
| **Member State** | **Methodology comment** |
| | calculated. [NIR 2011] |
| **Belgium** | The $N_2O$ emissions from the production of nitric acid are estimated in Flanders untill 2002 by using an emission factor of 8 kg $N_2O$/ton HNO3 from CITEPA [2]. The three plants involved in Flanders agreed with this factor of 8 kg $N_2O$/ton HNO3 since 1990 and give their nitric acid production figures each year. Since 2000 only one plant is still involved in this sector. From 2003 on lower emission factors in this plant are reported, based on monitoring results (approx. 5.6 kg $N_2O$/ton HNO3). The use of catalysts reduces these emissions. A further reduction of these emissions will be obtained in the future because of the extension of the use of catalysts in the different installations involved. From 2003 on a more or less stabilization in production occur, with the exception of the year 2009 due to the economic crisis. From 2006 a further decrease in emissions occurs contrary to the increase in production. As a result the emission factors decreases to 3 and even to 1 kg $N_2O$/ton HNO3.<br><br>In the Walloon region, there is only one producer of nitric acid (one plant with 3 installations). Each year, this plant provides the $N_2O$ emissions based on their production and on monitoring. The global emission factor used is 6,3 kg/t in 2009. For the time being , there is only one installation with an abatement technology (SCR) installed in 1996. However, this installation did not lead to a decrease in the $N_2O$ emissions because of the strong increase of the production since 1996. No emission factors and $N_2O$ emissions are presented by regions as there is only one company by region and the activity data are confidential. [NIR 2011] |
| **Denmark** | The $N_2O$ emission from the production of nitric acid/fertiliser is based on measurement for 2002. For the previous years, the $N_2O$ emission has been estimated from annual production statistics from the company and an emission factor of 7.5 kg $N_2O$/tonne nitric acid, based on the 2002 emission measured. The production of nitric acid ceased in the middle of 2004. [NIR 2011] |
| **Finland** | Statistics Finland co-operates with the nitric acid manufacturers to produce the annual emission estimates. For emissions in 1990–2004 the procedure was as follows: the manufacturers provided the activity data and emission factors (see below), and Statistics Finland carried out the calculations using an agreed methodology that corresponds to the IPCC Good Practice Guidance equation 3.9. Starting from the inventory year 2005 both emissions and activity data have been received from the Vahti system. Currently it is the specific emission factors rather than emissions that are calculated by the inventory unit. Since 2009 all existing nitric acid plants have been equipped with automatic systems according to EU standards to measure the project key parameters. The plant-specific project emission factor representing the average $N_2O$ emissions per tonne of nitric acid over the respective verification period is derived by dividing the total mass of $N_2O$ emissions by the total output of 100% concentrated nitric acid for that period. [NIR 2011] |
| **France** | Emission data obtained from association based on plant-specific data until 2001. Since 2002 plant-specific information directly reported to authorities are available for all sites. Common good practice methodologies for the $N_2O$ estimation was adopted in all plants in 2002. [NIR 2011] |
| **Germany** | Tier 3 methodology has been applied since the 2011 submission. Companies report all information to Industrieverband Agrar (IVA) where data is aggregated and forwarded to UBA. [NIR 2011] |
| **Greece** | Estimates are based on activity data from El.Stat and the individual industrial units for 1990-2009 and average IPCC default EF (IPCC GPG 2000). Actually in the recent years there is only one unit producing nitric acid in Greece therefore, data are sent directly to the inventory team by the unit. No $N_2O$ abatement technologies are used. [NIR 2011] |
| **Irland** | Nitric acid production ceased in 2002 with the liquidation of Irish Fertilizer Industries. For the years 1990-1995, the inventory agency received direct correspondence from the plant operator specifying the quantities of nitric acid produced and the company‟ s estimates of $N_2O$ emitted during the production process. The emissions were estimated from nitrogen loading and the type of catalyst used in the process. [NIR 2011] |
| **Italy** | With regard to nitric acid production (2B2), production figures at national level are published in the national statistical yearbooks (ISTAT, several years), while at plant level they have been collected from industry (Norsk Hydro, several years; Yara, several years; Radici Chimica, several years). In 1990 there were seven production plants in Italy; three of them closed between 1992 and 1995, and another one closed in 2004. The $N_2O$ average emission factors are calculated from 1990 on the basis of the emission factors provided by the existing production plants in the national EPER/EPRTR registry, applied for the whole time series, and default IPCC emission factors for low and medium pressure plants attributed to the plants, now closed, where it was not possible to collect detailed information.<br><br>The implied emission factor varies year by year depending on the production levels of the different plants and it is equal to 6.49 and 7.07 kg $N_2O$/Mg nitric acid production, in 1990 and in 2007 respectively. In 2008, the implementation of catalyst $N_2O$ abatement technology in one of the major production plants, and specifically in one unit of that plant, has led to a significant decrease in total $N_2O$ emissions from nitric acid production, consequently a relevant reduction in the IEF can be observed too (YARA, several years): the implied emission factor for 2008 is in fact 2.29 kg $N_2O$/Mg nitric acid production (the abatement rate in one plant was 82% so far), while the implied emission factor for 2009 is 2.94 kg $N_2O$/Mg nitric acid production. [NIR 2011] |
| **Netherlands** | Activity data are confidential. An IPCC Tier 2 method is used to estimate $N_2O$ emissions. The emission factors are based on plant-specific measured data which are confidential. The emissions are based on data reported by the nitric acid manufacturing industry and are included in the emission reports under EU ETS and the national Pollutant Release and Transfer Register (PRTR). [NIR 2011] |
| **Portugal** | Quantities of Nitric acid for year 1990 are available from a specific questionnaire that had been sent to industrial units by IA under Corinair90 project. From 1992 to 2009, total national production of Nitric Acid was set from INE statistical database (IAPI survey). For 1989-1991 statistical information of Nitric Acid Production is available from the IAIT survey. [NIR 2011] |
| **Spain** | Plant-specific production data for the years 1990 and 2008. Plant-specific AD for the entire time series from industrial |

| Nitric Acid Production | |
|---|---|
| **Member State** | **Methodology comment** |
| | association FEIQUE (the Business Federation of the Chemical Industry in Spain) and MITYC differentiation production types and processes. CS EF from plant-specific questionnaires are used taking into account technologies installed . [NIR 2011] |
| **Sweden** | Activity data, such as the produced amount of nitric acid, has been obtained from the facilities and from official statistics. Emission estimates of $N_2O$ have been reported in the companies' environmental reports or have been provided by the facilities directly. Emission data are not available for all facilities for 1991-1993. Since two plants have been shut down, it is no longer possible to acquire this information. Calculations have therefore been made based on production statistics and an assumed emission factor. [NIR 2011] |
| **United Kingdom** | Estimates are based on PS data as well as calculated using nitric acid production data and production capacities. Across the 1990-2009 time-series, the availability of emissions and production data for UK Nitric Acid (NA) plant is inconsistent, and hence a range of methodologies have had to be used to provide estimates and derive emission factors for this sector. Emissions partly provided directly by operators, site specific EF and default EFs. [NIR 2011] |

*Source: NIR 2011*.

Table 4.27 summarizes the recommendations from the 2010 UNFCCC inventory reviews in relation to the category 2B2 Nitric Acid Production. The overview shows that only four findings occurred of which three recommendations were implemented.

**Table 4.27** **2B2 Nitric Acid Production: Findings of the 2009 UNFCCC inventory reviews in relation to $N_2O$ emissions and responses in 2010 inventory submissions**

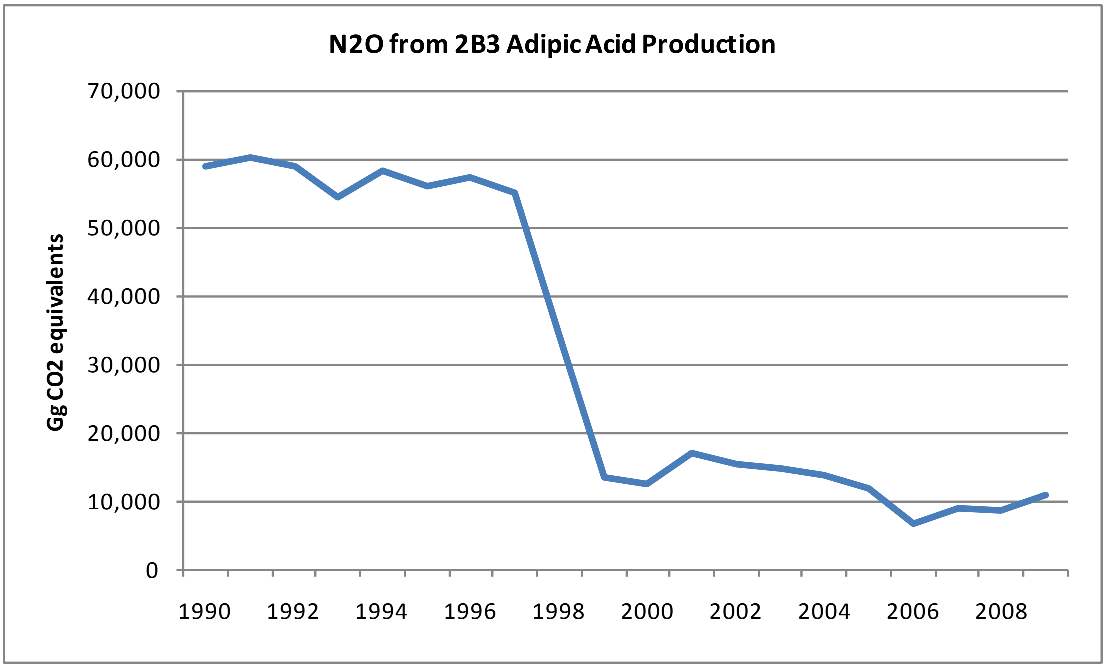
| Member State | Review findings and responses related to 2B2 Nitric Acid Production | |
|---|---|---|
| | **Comment UNFCCC report of the review of the 2010 submission** | **Status in 2011 submission** |
| **Austria** | No recommendation for improvement of this source category in Review Report. (FCCC/ARR/2010/AUT) | No follow-up necessary |
| **Belgium** | The ERT noted that, since 1996, there had been a consistent decrease in the EFs used for estimating emissions from nitric acid production. The reasons for such decreases were not clearly stated in the NIR and the ERT sought elaboration from Belgium during the review week. Belgium stated that this is due to the use of catalysts to reduce emissions. The ERT recommends that elgium include this explanation in its next annual submission. (FCCC/ARR/2010/BEL, para 52) | Not yet adressed. [NIR 2011] |
| **Denmark** | No recommendation for improvement of this source category in Review Report. (FCCC/ARR/2010/DNK) | No follow-up necessary |
| **Finland** | Finland improved transparency in the 2010 submission by reporting EFs and identifying plants that had closed down, plants that had started to operate, as well as process changes in specific plants throughout the time series, thereby justifying the trend in N2O emissions and the implied emission factor (IEF). The ERT noted that plant-specific EFs were reported as confidential but commends the efforts made by Finland to improve transparency regarding the trends for EFs and data as recommended by the previous ERT. The ERT recommends that Finland continue to improve transparency by explaining trends in EFs and data in future submissions if EFs are still reported as confidential. ( FCCC/ARR/2010/FIN, para 46) | The description in the NIR has been improved. (Section 4.3.2) [NIR 2011, p.373] |
| **France** | Review report (In-country review 2010) not yet available. | |
| **Germany** | Review report (In-country review 2010) not yet available. | |
| **Greece** | Greece uses the default methodology from the IPCC good practice guidance to estimate N2O emissions from nitric acid production. The previous ERT had recommended that Greece try to use measurements for this key category; however, the Party explained that, since nitric acid production is decreasing in the country, the effort may not be justified. During the review, the Party provided relevant information regarding the data sources used for the verification of plant-specific AD used to estimate these emissions. The ERT recommends that Greece include this information in its next annual submission, in order to improve transparency. (FCCC/ARR/2010/GRC, para 58) | Done. Included in paragraph 4.7.4 of NIR 2011. [NIR 2011, p.312] |
| **Ireland** | No recommendation for improvement of this source category in Review Report. (FCCC/ARR/2010/IRL) | No follow-up necessary |
| **Italy** | No recommendation for improvement of this source category in Review Report. (FCCC/ARR/2010/ITA) | No follow-up necessary |
| **Luxembourg** | No recommendation for improvement of this source category in Review Report. (FCCC/ARR/2010/LUX) | No follow-up necessary |
| **Netherlands** | Review report (Centralized review 2010) not yet available. | |
| **Portugal** | No key source category. (FCCC/ARR/2010/PRT) | |
| **Spain** | Review report (Centralized review 2010) not yet available. | |
| **Sweden** | Review report (Centralized review 2010) not yet available. | |
| **UK** | The method used by plants to estimate emissions in recent years was not described in the NIR, but this information was provided during the review. To improve the transparency of the NIR, the ERT recommends that the United Kingdom provide this information in the NIR as well as a more accurate description of how the AD for the early 1990s were estimated. Moreover,<br>since all N2O emissions are currently determined by continuous emission monitoring systems, the ERT recommends that the EF uncertainty estimate for the last year be updated.<br>The ERT noted that the AD reported in the CRF tables are too low by a factor of 1,000. The ERT recommends that the units used be checked, and corrected if necessary. (FCCC/ARR/2010/GBR, para 53) | We have recently received information from the operators of all nitric acid plant that still operate (several have closed in recent years), and all now use Continuous Emission Monitoring systems to estimate the nitrous oxide emissions. As a result of this information, we have revised the uncertainty allocations within the UK GHGI Monte Carlo uncertainty analysis (Tier 2). .<br>A units error in the activity data in the CRF has been identified and corrected for the 2011 submission. [NIR 2011, p.258, 262] |

*Source: NIR 2011, UNFCCC inventory review reports, as published at UNFCCC: http://unfccc.int/national_reports/annex_i_ghg_inventories/inventory_review_reports/items/5687.php*

### 4.2.2.3 2B3 Adipic Acid Production

$N_2O$ emissions from 2B3 Adipic Acid Production account for 0.29 % of total EU-15 GHG emissions in 2009. Between 1990 and 2009, $N_2O$ emissions from this source decreased by 82 % (Figure 4.8). Only France, Germany, Italy and the UK produce adipic acid and all four countries were able to decrease emissions from this source category significantly due to the retrofitting of installations with abatement technologies.

**Figure 4.8** **2B3 Adipic Acid Production: EU-15 $N_2O$ emissions**




During 1997 and 1999, $N_2O$ emissions for EU-15 decreased significantly by 76 %. The country's share in this change of emission trend was 43 % for Germany ,31 % for France and 28 % for the UK, whereas Italy increased its emissions during that time period and reduced its emissions significantly during 2005 and 2006 (-77%).

In Germany decomposition takes place nearly completely. At the end of 1997, both producers have put a catalytic reactor system into operation that, in constant operation, achieves an $N_2O$-decomposition rate of 96-98 %. A $N_2O$ abatement system was fitted to the single plant that produces adipic acid in 1998. The abatement system is a thermal oxidation unit and is reported by the operators to be 99.99 % efficient at $N_2O$ destruction. The only plant that produces adipic acid in France installed an abatement technique in 1998.

The decrease of $N_2O$ emissions in Italy between 2005 and 2006 is the result of the application of the best available technique to reduce emission in the only existing adipic acid production plant. The technology has been applied in trial for a few months both in 2004 and in 2005. The technology of catalytic decomposition of $N_2O$ was fully operational from December 2005 onwards and reduced $N_2O$ emissions and IEF significantly (Table 4.28).

The increase of $N_2O$ emissions between 2000 and 2001 and between 2006 and 2007 was dominated by the raise of emissions in Germany due to damaged abatement techniques. During 2008 and 2009 German $N_2O$ emissions increased by 56 % because the exhaust air cleaning system of one producer in Germany was not working for a longer period of time. In 2008-2009, the largest reduction of emissions could be found for the UK. The UK's only remaining adipic acid plant closed during early 2009 - therefore emissions are much lower than in previous years. The emission will be zero for 2010.

**Table 4.28 2B3 Adipic Acid Production: Member States' contributions to $N_2O$ emissions**

| Member State | $N_2O$ emissions (Gg $CO_2$ equivalents) | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg CO2 equivalents) | (%) | (Gg CO2 equivalents) | (%) | | |
| Austria | NO | NO | NO | - | - | - | - | - | NO | NO |
| Belgium | NO | NO | NO | - | - | - | - | - | NO | NO |
| Denmark | NO | NO | NO | - | - | - | - | - | NA | NA |
| Finland | NO | NO | NO | - | - | - | - | - | NA | NA |
| France | 14,806 | 1,460 | 1,415 | 13.1% | -45 | -3% | -13,391 | -90% | CR | PS |
| Germany | 18,805 | 5,502 | 8,570 | 79.3% | 3,068 | 56% | -10,235 | -54% | T3 | PS |
| Greece | NO | NO | NO | - | - | - | - | - | NA | NA |
| Ireland | NO | NO | NO | - | - | - | - | - | NA | NA |
| Italy | 4,579 | 707 | 748 | 6.9% | 41 | 6% | -3,831 | -84% | T2 | D,PS |
| Luxembourg | NO | NO | NO | - | - | - | - | - | NA | NA |
| Netherlands | NO | NO | NO | - | - | - | - | - | NA | NA |
| Portugal | NO | NO | NO | - | - | - | - | - | NO | NO |
| Spain | NA | NA | NA | - | - | - | - | - | NA | NA |
| Sweden | NO | NO | NO | - | - | - | - | - | NA | NA |
| United Kingdom | 20,737 | 947 | 71 | 0.7% | -876 | -93% | -20,666 | -100% | CS | CS |
| **EU-15** | **58,927** | **8,617** | **10,804** | **100.0%** | **2,187** | **25%** | **-48,123** | **-82%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

Table 4.29 shows information on methods applied, activity data, emission factors for $N_2O$ emissions from 2B3 Adipic Acid Production for 1990 to 2009. The table shows that in 2009 adipic acid was produced in four MS only. All four MS use adipic acid production as activity data but the information is confidential in France, Germany and the UK. The implied emission factors per tonne of adipic acid produced is only provided by Italy with 0.3 t/t for 1990 and 0.03 t/t for 2009. The table suggests that in 2009 100 % of EU-15 emissions are estimated with higher Tier methods.

**Table 4.29 2B3 Adipic Acid Production: Information on methods applied, activity data, emission factors for $N_2O$ emissions**

| Member State | Method applied | Emission factor | 1990 | | | | 2009 | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Activity data | | Implied emission factor (t/t) | $N_2O$ emissions (Gg) | Activity data | | Implied emission factor (t/t) | $N_2O$ emissions (Gg) |
| | | | Description | (kt) | | | Description | (kt) | | |
| France | CR | PS | Adipic acid production | C | C | 47.8 | Adipic acid production | C | C | 4.6 |
| Germany | T3 | PS | Adipic acid production | C | C | 60.7 | Adipic acid production | C | C | 27.6 |
| Italy | T2 | D,PS | Adipic acid production | 49 | 0.30 | 14.8 | Adipic acid production | 78 | 0.03 | 2.4 |
| UK | CS | CS | Adipic acid production | C | C | 66.9 | Adipic acid production | C | C | 0.2 |
| EU15 | | | **EU15** | | | **190** | **EU15** | | | **35** |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

Table 4.30 provides a more detailed overview on methodologies and data sources used in EU-15 Member States for the estimation of emissions from adipic acid production.

**Table 4.30 2B3 Adipic Acid Production: Summary of methodological information provided by Member States**

| Adipic Acid Production | |
|---|---|
| **Member State** | **Methodology comment** |
| **France** | Emissions are based on plant-specific data. Good practice guidance for the emissions measurement and estimation at plant level have been developed and approved by AFNOR. In regular situations emissions are continuously measured, in irregular situations, emissions are estimated based on a material balance [NIR 2011] |
| **Germany** | Estimates are based on detailed plant-specific data since mid-90ies; before that emissions are calculated using nitric acid production and the IPCC default value. [NIR 2011] |
| **Italy** | Italian production figures and emission estimates for adipic acid have been provided by the process operator (Radici Chimica, several years); for the whole time series. N2O emissions from adipic acid production (2B3) have been estimated using the default IPCC emission factor equal to 0.30 kg N2O/kg adipic acid produced, from 1990 to 2003. The abatement system is generally run together with the adipic acid production process. In 2004, the N2O catalytic decomposition abatement technology has been tested so that the value of emission factor has been reduced taking into account the efficiency and the time, one month, that the technology operated. From the end of 2005 the abatement technology is fully operational; the average emission factor in 2006 is equal to 0.05 kg N2O/kg adipic acid produced and the abatement system had been operating continuously for 9 months; since 2007 the average emission factor has been 0.03 kg N2O/kg adipic acid produced and the operating time of the abatement system was 11 months. Improving the efficiency in operation, the technology system it is expected to reach 95% of abatement rate in the future with respect to the default emission factor 300 kg/t adipic acid produced. Thus, both for the period 1990-2005 and from 2006 onwards the estimates are provided according to the GPG (default EF has been used when no abatement system was operational; abatement rates have been considered in estimating emission values since 2006). The operator reports also under EPER/E-PRTR both adipic acid production and the N2O emissions related to this production. Based on this information EFs are calculated for the plant and compared to those resulting from the formula included in the |
| **UK** | Production data and emission estimates have been estimated based on data provided by the process operator (Invista, 2010). The emission estimates are based on the use of plant-specific emission factors for unabated flue gases, which were determined through a series of measurements on the plant, combined with plant production data and data on the proportion of flue gases that are unabated. In 1998 an N2O abatement system was fitted to the plant. The abatement system is a thermal oxidation unit and is reported by the operators to be 99.99% efficient at N2O destruction. In 2004 it was operational 92.6 % of the time (when compared to plant operation). Variation in the extent to which this abatement plant is operational, account for the large variations in emission factors for the adipic acid plant since 1999. [NIR 2011] |

*Source: NIR 2011*

Table 4.31 summarizes the recommendations from the 2010 UNFCCC inventory reviews in relation to the category 2B3 Adipic Acid Production. Only one review finding could be listed so far; ten review reports were available by now. The overview shows that the only recommendation has been implemented.

**Table 4.31** **2B3 Adipic Acid Production: Findings of the 2009 UNFCCC inventory reviews in relation to $N_2O$ emissions and responses in 2010 inventory submissions**

| Member State | Review findings and responses related to 2B3 Adipic Acid Production | |
|---|---|---|
| | **Comment UNFCCC report of the review of the 2010 submission** | **Status in 2011 submission** |
| **Austria** | No recommendation for improvement of this source category in Review Report. (FCCC/ARR/2010/AUT) | No follow-up necessary |
| **Belgium** | No recommendation for improvement of this source category in Review Report. (FCCC/ARR/2010/BEL) | No follow-up necessary |
| **Denmark** | No recommendation for improvement of this source category in Review Report. (FCCC/ARR/2010/DNK) | No follow-up necessary |
| **Finland** | No recommendation for improvement of this source category in Review Report. (FCCC/ARR/2010/FIN) | No follow-up necessary |
| **France** | Review report (In-country review 2010) not yet available. | |
| **Germany** | Review report (In-country review 2010) not yet available. | |
| **Greece** | No recommendation for improvement of this source category in Review Report. (FCCC/ARR/2010/GRC) | No follow-up necessary |
| **Ireland** | No recommendation for improvement of this source category in Review Report. (FCCC/ARR/2010/IRL) | No follow-up necessary |
| **Italy** | The ERT noted that Italy has improved the documentation on this category in its NIR, in response to the recommendation made in the previous annual review report. New information has been incorporated into the 2010 NIR on the efficiency of the abatement technology and how this information is used when verifying emission estimates, which has enhanced the understanding of how the emissions from this category are estimated. However, the ERT recommends that Italy further improve transparency by correcting the formula that is reported in the NIR and explaining how this formula is used to check EFs provided by the production plant, and include a description of the emission estimation methodology applied by the production plant that was used by Italy for its 2010 annual submission. (FCCC/ARR/2010/ITA, para 45) | Additional information has been provided in the NIR (paragraph 4.3.2). [NIR 2011, p. 482] |
| **Luxembourg** | No recommendation for improvement of this source category in Review Report. (FCCC/ARR/2010/LUX) | No follow-up necessary |
| **Netherlands** | Review report (Centralized review 2010) not yet available. | |
| **Portugal** | No recommendation for improvement of this source category in Review Report. (FCCC/ARR/2010/PRT) | No follow-up necessary |
| **Spain** | Review report (Centralized review 2010) not yet available. | |
| **Sweden** | Review report (Centralized review 2010) not yet available. | |
| **UK** | No recommendation for improvement of this source category in Review Report. (FCCC/ARR/2010/GBR) | No follow-up necessary |

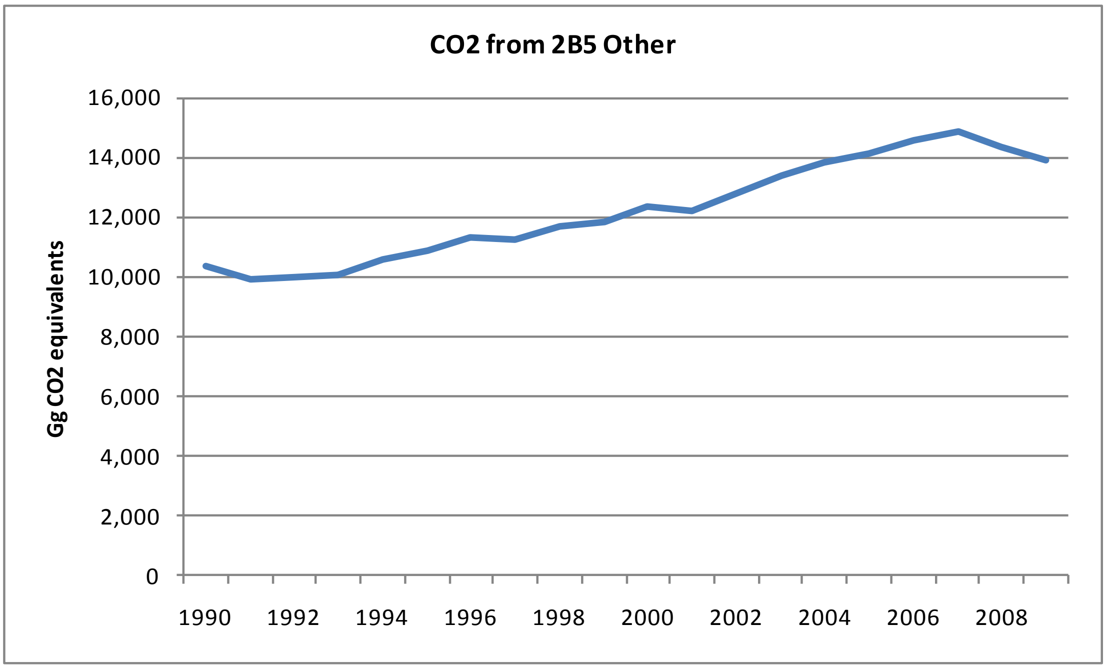
*Source: NIR 2011, UNFCCC inventory review reports, as published at UNFCCC: http://unfccc.int/national_reports/annex_i_ghg_inventories/inventory_review_reports/items/5687.php*

The ERT identified that the NIR does not include a section on 2B4 Carbide Production (FCCC/ARR/2008/EC, para 55). This is due to the fact that carbide production is not a key source in the sector 2 Industrial processes. An overview of Member States' methodologies, emission factors, quality estimates and emission trends is only provided in this report if identified with the key category analysis at EU-15 level.

In response to a recommendation raised during the EU Centralized Review in 2010, information on the trend of EU-15 $CO_2$ emissions from Carbide Production that was provided during the review is given in this NIR: The EU-15 $CO_2$ emissions trend from carbide production is mainly influenced by Germany and France. In Germany, emissions dropped by 79 % in 1991 compared to 1990. During the reunification period, calcium carbide production took place primarily in former East Germany. Shortly after reunification, production discontinued in former East Germany, while only one producer remained in former West Germany. In the period 1990 to 2008, this producer cut production by about half. In France, carbide production occurred in one plant up to 2003, and since 2003 there has been no carbide production in that MS any more.

$CO_2$ emissions from 2B5 Other account for 0.37 % of total EU-15 GHG emissions in 2009. Between 1990 and 2009, $CO_2$ emissions from this source increased by 33 % (Table 4.32). Germany is responsible for 63 % of these emissions in the EU-15, followed by the UK (14 %) and Belgium (7 %). Germany had the largest growth of emissions in absolute terms due to the increased production of methanol in the past and a new producer for carbon black. Additionally emissions of the conversion loss increased with further development of the production. Belgium, Finland and the UK also show an increase of emissions.

**Figure 4.8 2B5 Other: EU-15 $CO_2$ emissions**




The noticeable increase of $CO_2$ emissions in Finland 2006-2007 was caused by a new plant for hydrogen production. The British $CO_2$ emissions increased steadily during 1990 and 2008 due to the emissions from the breakdown of organic chemicals contained in household consumer products (detergents) subsequent to release to sewer. The activity data used to calculate emissions are extrapolated from data for a single year using household numbers and population as proxy statistics, both of which have increased every year of the time series.

During 2008 and 2009 the reduction of $CO_2$ emission in relative terms was largest in Austria, where reported emissions are based on plant specific measurements for fertilizer production. In addition to a decline in the rate production of -17 % in that period, $CO_2$ emissions also depend on the kind of fertilizers being produced which changed over time. Germany had the largest emission reduction in absolute terms. The downward trend in emissions occurred since 2007 and is due to a decline in the production of carbon black and methanol. This decline is assumed to originate from the economic development. The Italian emissions – showing the second largest reduction in absolute terms during 2008 and 2009 – declined by 20 % due to a decrease in carbon black production of -21 %.

For an overview of sources included in the source 2B5 see Table 4.34.

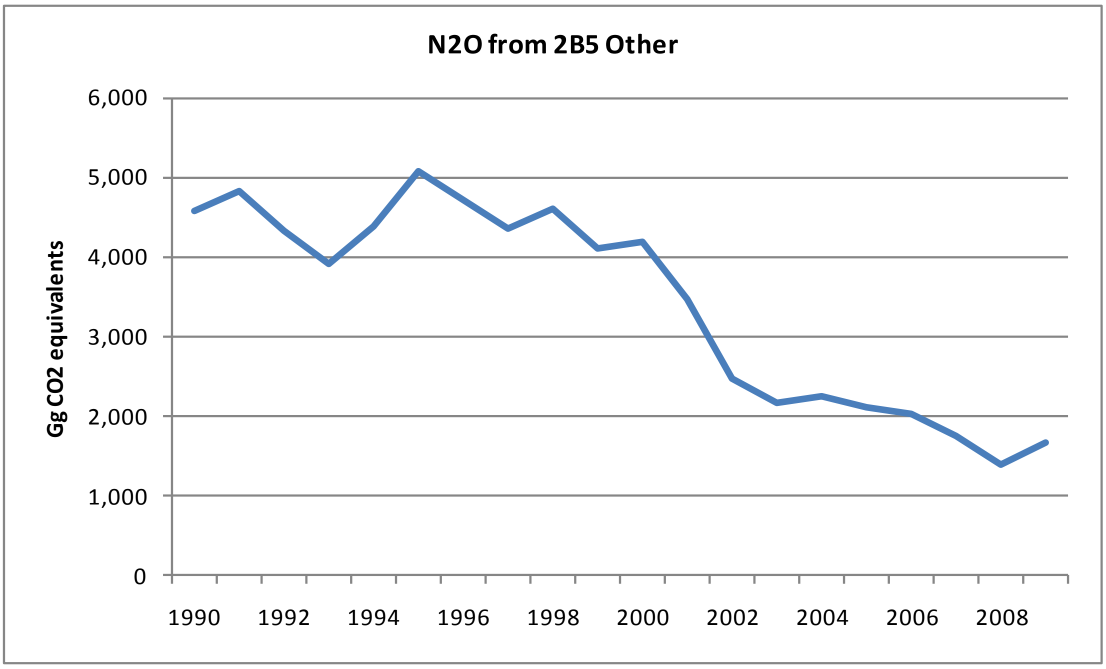
**Table 4.32 2B5 Other: Member States' contributions to $CO_2$ emissions**

| Member State | CO2 emissions in Gg | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg CO2 equivalents) | (%) | (Gg CO2 equivalents) | (%) | | |
| Austria | 31 | 26 | 17 | 0.1% | -9 | -36% | -14 | -46% | CS | PS |
| Belgium | 224 | 938 | 1,014 | 7.3% | 76 | 8% | 790 | 352% | T3 | PS |
| Denmark | 1 | 2 | 2 | 0.0% | 0 | -11% | 1 | 166% | CS | D |
| Finland | 81 | 657 | 685 | 4.9% | 28 | 4% | 603 | 742% | T2 | CS,D |
| France | 367 | 274 | 229 | 1.7% | -45 | -16% | -138 | -38% | CR | PS |
| Germany | 6,888 | 9,074 | 8,750 | 63.0% | -324 | -4% | 1,861 | 27% | CS,T2 | CS,D |
| Greece | NA,NE,NO | NA,NE,NO | NA,NE,NO | - | - | - | - | - | NA | NA |
| Ireland | NO | NO | NO | - | - | - | 0 | -100% | NA | NA |
| Italy | 475 | 605 | 481 | 3.5% | -124 | -20% | 6 | 1% | T1,T2 | D,PS |
| Luxembourg | NO | NO | NO | - | - | - | - | - | NA | NA |
| Netherlands | 649 | 672 | 651 | 4.2% | -20 | -3% | 3 | 0% | CS,T1 | CS,D,PS |
| Portugal | 63 | 135 | 92 | 0.6% | -43 | -32% | 29 | 45% | D | CS |
| Spain | NA | NA | NA | - | - | - | - | - | NA | NA |
| Sweden | 64 | 60 | 46 | 0.3% | -14 | -24% | -18 | -28% | CS | PS |
| United Kingdom | 1,563 | 1,889 | 1,914 | 13.8% | 25 | 1% | 351 | 22% | CS | CS,OTH |
| **EU-15** | **10,406** | **14,331** | **13,881** | **100.0%** | **-451** | **-3%** | **3,475** | **33%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

$N_2O$ emissions from 2B5 Other account for 0.05 % of total EU-15 GHG emissions in 2009. Between 1990 and 2009, $N_2O$ emissions from this source decreased by 64 % (Table 4.33). The Netherlands, Belgium and France are responsible for almost all of these emissions in the EU-15. Emissions decreased especially in France – besides the Netherlands – and had the largest influence on the reductions in the EU-15, whereas Belgium increased its $N_2O$ emissions during 1990 and 2009.

**Figure 4.9 2B5 Other: EU-15 $N_2O$ emissions**




$N_2O$ emissions in France decreased strongly between 1998 and 2003 and again from 2005 onwards. The first decline in emissions can be explained by the closing of one of the two sites which produced glyoxylic acid until 2001 and the installation of an abatement technique for the other site in 1998. The second decrease is due to the efficiency improvement of the abatement technique for glyoxylic acid production and by the decrease of the production of PTTB and industrial and medical $N_2O$. During 2008 and 2009, $N_2O$ emissions again increased, which is caused by an increase of Uranium tetrafluoride production which emits $N_2O$, and by an increase of glyoxilic acid production.

In response to the recommendations by the ERT (FCCC/ARR/2009/EC, para 53), additional explanations of the trends or inter-annual fluctuations of $N_2O$ emissions are given. For the Netherlands, $N_2O$ emissions derive from the production of caprolactam; these emissions decreased by 48 % during 2004 and 2008. During the period 1990 to 2004, the Dutch emissions are based on production-indexes; as a result of an increasing production level the emissions increased, too. A better process control and a lower production level resulted in an emission reduction during 2004 and 2008. Plant-specific $N_2O$ emission factors are used for caprolactam production. Emission factors as well as activity data on caprolactam production are confidential. Only emissions are reported by the companies.

$N_2O$ emissions in Belgium increased during 1990 and 2009, especially during 2003 and 2007. Emissions of $N_2O$ originate mainly from the production of caprolactam. Only one company is involved in Belgium in the Flemish region and since 1997 this company offers each year the results of the monitoring carried out.

In Italy, $N_2O$ emissions from caprolactam production have been estimated and reported and emissions are related to only one producing plant, which closed in 2003.

**Table 4.33 2B5 Other: Member States' contributions to $N_2O$ emissions**

| Member State | $N_2O$ emissions (Gg $CO_2$ equivalents) | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg CO2 equivalents) | (%) | (Gg CO2 equivalents) | (%) | | |
| Austria | NA,NO | NA,NO | NA,NO | - | - | - | - | - | NO | NO |
| Belgium | 381 | 505 | 559 | 33.4% | 53 | 11% | 177 | 47% | T3 | PS |
| Denmark | NA,NO | NA,NO | NA,NO | - | - | - | - | - | NA | NA |
| Finland | NO | NO | NO | - | - | - | - | - | NA | NA |
| France | 3,176 | 405 | 503 | 30.1% | 98 | 24% | -2,674 | -84% | CR | PS |
| Germany | 231 | C,IE,NA,NO | C,IE,NA,NO | - | - | - | -231 | -100% | NA | NA |
| Greece | NA,NO | NA,NO | NA,NO | - | - | - | - | - | NA | NA |
| Ireland | NO | NO | NO | - | - | - | - | - | NA | NA |
| Italy | 11 | NA,NO | NA,NO | - | - | - | -11 | -100% | T1,T2 | D,CS,PS |
| Luxembourg | NO | NO | NO | - | - | - | - | - | NA | NA |
| Netherlands | 766 | 481 | 603 | 36.1% | 122 | 25% | -163 | -21% | T2 | PS |
| Portugal | 0.03 | 0.1 | 0.0 | 0.0% | 0 | -35% | 0 | 55% | D | CR,OTH |
| Spain | NA | NA | NA | - | - | - | - | - | NA | NA |
| Sweden | 22 | 7 | 7 | 0.4% | 0 | -2% | -14 | -66% | CS | PS |
| United Kingdom | NO | NO | NO | - | - | - | - | - | NA | NA |
| **EU-15** | **4,587** | **1,399** | **1,672** | **100.0%** | **273** | **19%** | **-2,915** | **-64%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

Table 4.34 provides an overview of all sources reported under 2B5 Other Chemical Production by EU-15 Member States for the year 2009. The largest contributor to the total EU-15 emissions is Germany. Emissions of $CO_2$ in Germany are dominated by the production of carbon black and methanol as well as catalytic burning and conversion loss. Country specific emission factors are based on a study from 2006 and activity data on national statistics. In the UK $CO_2$ emissions are due to carbon from non energy use of products. For Belgium, Flanders reported non energy use of fuels in the chemical industry, flaring as well as the production of ethylene oxide, acrylic acid from propene, cyclohexanone from cyclo-hexane and production of paraxylene/meta-xylene in this source category, whereas in the Wallon region other chemical industrial processes include the production of 1,2 dichloromethane, vinychloride and anhydride maleique and phtalique.

During the centralized review of the 2009 annual submission of the European Union, the ERT recommended EU to improve the completeness of its inventory by providing emission estimates for categories that have not currently been estimated, e.g. $CH_4$ from chemical industries such as the production of ethylene and dichloroethylene (FCCC/ARR/2009/EC, para 45). For these emissions only France reported 'NE' and in response to the recommendations by the ERT during the centralized review of the 2007 and 2008 greenhouse gas (GHG) inventory submissions of France (FCCC/ARR/2008/FRA), the Member State provided estimates of $CH_4$ from the production of ethylene and dichloroethylene with its 2010 greenhouse gas (GHG) inventory submission that was included in the European GHG inventory, thus improving the completeness for this source categories.

**Table 4.34 2B5 Other: Overview of sources reported under this source category for 2009**

| Member State | 2.B.5 Other Chemical Industry | $CO_2$ emissions [Gg] | $CH_4$ emissions [Gg] | $N_2O$ emissions [Gg] | Total emissions [Gg CO2 equivalents] | Share in EU-15 Total |
|---|---|---|---|---|---|---|
| Austria | Ethylene, Other chemical industry, CO2 from nitric | 16.8 | 0.8 | NA,NO | 33.0 | 0.2% |
| Belgium | Caprolactam Production, Other chemical production | 1,014.0 | 0.0 | 1.8 | 1,573.5 | 9.8% |
| Denmark | Catalysts/Fertilizers, Pesticides and Sulphuric acid | 2.1 | NA,NO | NA,NO | 2.1 | 0.0% |
| Finland | Hydrogen, chemicals production | 684.8 | NO | NO | 684.8 | 4.3% |
| France | Ethylene, Styrene, Glyoxylic acid production, Anhydrid Phtalic Production, Other chemical | 229.1 | 2.9 | 1.6 | 791.8 | 5.0% |
| Germany | Carbon Black, Methanol, Caprolactam, Catalytic Burning, Conversion loss, N-Dodecandiacid | 8,749.6 | 0.0 | C,IE,NA,NO | 8,749.9 | 54.7% |
| Greece | Organic chemicals production | NA,NE,NO | NA,NO | NA,NO | - | 0.0% |
| Ireland | | NO | NO | NO | - | - |
| Italy | Carbon Black, Ethylene, Dichloroethylene, Styrene, Titanium Dioxide Production, Propylene, Caprolactam | 481.2 | 0.3 | NA,NO | 487.1 | 3.0% |
| Luxembourg | | NO | NO | NO | - | - |
| Netherlands | Carbon Black, Ethylene, Styrene, Methanol, Graphite, Caprolactam, Other chemical industry, Carbon | 651.4 | 10.9 | 1.9 | 1,482.4 | 9.3% |
| Portugal | Carbon Black, Ethylene, Ammonium sulphate, Monomer and polymer production, Production of | 92.2 | 0.4 | 0.0 | 101.6 | 0.6% |
| Spain | Carbon Black, Ethylene, Styrene | NA | 1.8 | NA | 37.2 | 0.2% |
| Sweden | Pharmaceutical industry, Other inorganic chemical production, Other organic chemical production, Base | 46.0 | 0.3 | 0.0 | 59.0 | 0.4% |
| UK | Ethylene, Methanol, Chemical Industry (All), Carbon from NEU products | 1,913.8 | 3.6 | NO | 1,990.0 | 12.4% |
| **EU-15 Total** | | **13,881** | **21** | **5** | **15,992** | **100.0%** |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

In response to the recommendation by the ERT in its review report, the methodologies for the largest emission sources in this category are provided (FCCC/ARR/2008/EC, para 53). Table 4.35 gives an overview on methodologies and data sources used all Member States which estimate $CO_2$ and $N_2O$ emissions from other chemical production.

**Table 4.35 2B5 Other Chemical Production: Summary of methodological information provided by Member States**

| Other Production | |
|---|---|
| **Member State** | **Methodology comment** |
| **Austria** | Production of Fertilizers and Urea: No IPCC methodology is available for these sources. Data for urea production were directly reported by the Austrian producer of urea and thus represent plant-specific data. The $CH_4$ emissions are calculated from the ammonia input in the urea production process and the methane content of the ammonia. $CH_4$ emissions from the production of urea were reported for the years 2002–2009. For the years before no data is available; therefore the implied emission factor for the year 2002 was used for all years. $CO_2$ emissions are reported by the operator since 1995. The IEF from this year was applied to calculate emissions from the previous years. Data for fertilizer production for 1990 to 1994 were taken from national statistics (STATISTIK AUSTRIA), for 1995 to 2009 production data were reported directly by the main producer of fertilizers in Austria. $CH_4$ emissions from the production of fertilizers were reported for the years 2002–2009; these data became available due to a measurement programme for $CH_4$ at the plant starting in 2002. Before no data is available; therefore the IEF for the year 2002 was used |

| Other Production | |
|---|---|
| **Member State** | **Methodology comment** |
| | for all years. [NIR 2011] |
| | Ethylene Production: Emissions were estimated using the IPCC default methodology. Activity data are the capacity of the only ethylene producing plant in Austria and amount to 350 000 t Ethylene per year until 2005. In 2006 the capacity of the ethylene plant was expanded to 500 000 t. The IPCC default emission factor of 1 g $CH_4$/kg Ethylene production was used to calculate the emissions that amount to 350 tonnes $CH_4$ until 2005 and 500 tonnes $CH_4$ since 2006. [NIR 2011] |
| **Belgium** | The emissions of $N_2O$ originate mainly from the production of caprolactam. Only one company is involved in Belgium in the Flemish region and since 1997 this company offers each year the results of the monitoring carried out. This company estimated the emissions of the previous years from 1990 on as accurate as possible. No emission factors and emissions of $N_2O$ are presented in this report because only one company is involved in Belgium. [NIR 2011] |
| | Other process $CO_2$ emissions are reported by the chemical industry in Flanders (for example production of ethylene oxide, production of acrylic acid from propene, production of cyclohexanone from cyclo-hexane, production of para-xylene/meta-xylene, the emissions of $CO_2$ of flaring in the chemical industry etc). These $CO_2$ emissions result from surveys in the chemical sector in Flanders. [NIR 2011] |
| | The emissions of $CO_2$ originate from the production of 1,2 dichloromethane, vinychloride and anhydride maleique and phtalique in the Walloon region. The emissions are estimated by the chemical industry. [NIR 2011] |
| **Finland** | Activity or emission data for hydrogen production have been received directly from companies, a minor part of earlier years' data having been estimated. There are no default emission factors for hydrogen production in the IPCC Guidelines, for which reason the stoichiometric ratio of chemical reactions is used. [NIR 2011] |
| **France** | For the chemical sector, emissions are generally determined by a bottom up approach based on data provided through the annual reports of pollutant releases and supplemented by information from the industry. [NIR 2011] |
| | Fertilizer: National production data for fertilizers are known from the Union of Industry for Fertilization or from national statistics SESSI. Default factors are used for most pollutants. Since 2003, annual statements of releases are used to determine emission factor. [NIR 2011] |
| | Uranium tetrafluoride: Emissions data is taken directly from annual statements of pollutant emissions since 1990. [NIR 2011] |
| **Germany** | Carbon Black: Estimation of $CO_2$ emissions is based on IPCC default $CO_2$-EFs from IPCC-Guidelines 2006 (Table 3.23, Furnace Black Process) and AD, which were provided by the Federal Statistical Office. [NIR 2011] |
| **Greece** | Organic chemicals: Default emission factors (IPCC Guidelines) are used. Activity data (production of ethylene and 1,2 dichloro-ethane) are confidential and provided by the ElStat. The available data cover the period 1990 – 2007, whereas the ethylene and 1,2 dichloro-ethane production has ceased in 1998 and 2000 respectively. [NIR 2011] |
| **Italy** | Caprolactame: $N_2O$ emissions from caprolactame have been estimated on the basis of information supplied by the only plant present in Italy, production activity data published by ISTAT (ISTAT, several years), and production and emission data reported in the national EPER/E-PRTR registry. The average emission factor is equal to 0.3 kg $N_2O$/Mg caprolactame production. The plant closed in 2003. [NIR 2011] |
| | Carbon Black: $CO_2$ and $CH_4$ emissions from carbon black production process have been estimated on the basis of information supplied by the Italian production plants in the framework of the national EPER/EPRTR registry and the European emissions trading scheme. In 1996 a change in the production technology in the existing plants caused a reduction of $CH_4$, NMVOC, NOx, SOx and PM10 emissions. In 2005, the $CO_2$ implied emission factor is 2.55 t $CO_2$/t carbon black production, in 2008 it is equal to 2.59 t $CO_2$/t carbon black production, while in 2009 the IEF is 2.49 t $CO_2$/t carbon black production. [NIR 2011] |
| | Calcium Carbide: $CO_2$ emissions from calcium carbide production process have been estimated on the basis of the activity data provided by the sole Italian producer and referred to the years from 1990 to 1995 when the production stopped. The default IPCC $CO_2$ emission factor (IPCC, 2006) has been used to estimate the emissions. [NIR 2011] |
| **Netherlands** | Caprolactam production: Plant-specific $N_2O$ emission factors are used for Caprolactam production (confidential). [NIR 2011] |
| | Industrial gases: $CO_2$ emissions are estimated based on use of fuels (mainly natural gas) as chemical feedstock. An oxidation fraction of 20% is assumed, based on reported data in environmental reports from the relevant facilities. [NIR 2011] |
| | Carbon electrodes: $CO_2$ emissions are estimated based on fuel use (mainly petroleum coke and coke). A small oxidation fraction – 5% – is assumed, based on reported data in the environmental reports.[NIR 2011] |
| | Activated carbon: $CO_2$ emissions are estimated on the basis of the production data for Norit and by applying an emission factor of 1 t/t Norit. The emission factor is derived from the carbon losses from peat uses reported in the environmental reports. As peat consumption is not included in the national energy statistics, the production data since 1990 have been estimated based on an extrapolation of production level of 33 Tg reported in 2002. This is considered to be justified because this source contributes relatively little to the national inventory of greenhouse gases. [NIR 2011] |
| | Ethylene oxide: $CO_2$ emissions are estimated based on capacity data by using a default capacity utilisation rate of 86% and applying an emission factor of 0.45 t/t ethylene oxide. [NIR 2011] |

| Other Production | |
|---|---|
| **Member State** | **Methodology comment** |
| **Portugal** | The major organic chemical plant in Portugal is BOREALIS unit, a petrochemical unit. The basic process in this unit is Ethylene production by Thermal Steam Cracking of petroleum feedstock. A specific and detailed inventory survey was made for BOREALIS Petrochemical Plant in Sines unit in 1993-1994. Emissions estimated for this period where used to determine plant-specific process emission factors that were used to estimate emissions for all time series from 1990 to 2001 and using ethylene production as activity rate indicator. For BOREALIS Petrochemical Plant in Sines - produced quantities are available from 1990 to 1997 and were forecasted thereafter. [NIR 2011] |
| | The second chemical industry LPS is the sole Carbon Black plant in Portugal. In the case of carbon black, where $CO_2$ emissions result from liberation of carbon in tail gas to atmosphere, emissions were estimated using a simple mass balance. Production of carbon black and explosives is available from 1990 to 2009 from INE Statistical Database (IAIT and IAPI surveys). Emissions from flares and flue gas combustor where included in the emission factors. Statistical information for all emissions sources other than Sines industrial Plants were obtained from the National Statistical Institute (INE). [NIR 2011] |
| **Sweden** | This sub-category includes various chemical industries, such as sulphuric acid production, the pharmaceutical industry, production of base chemicals for plastic industry, various organic and inorganic chemical productions and other non speci-fied chemical production, which are not covered elsewhere. The primary information on emissions of $CO_2$, $CH_4$, $N_2O$, NOX, CO, NMVOC and SO2 is as reported by the companies in their environmental reports. In the IPCC Guidelines, methods for estimating $CH_4$ emissions for several chemical products are presented and conse-quently the CRF Reporter is divided on those products (2B5.1-5). Since several plants in Sweden produce several chemicals products each but report emissions aggregated by plant, it is not possible to report emissions in accordance with the suggested split in the CRF Reporter. In Sweden there is one company producing carbon black. $CH_4$ emissions are included from 1990 and onwards based on production data from the company" s environmental reports and IPCC Guidelines default EF (11 g $CH_4$/kg production). [NIR 2011] |
| **United Kingdom** | $CO_2$ emissions can occur direct from chemical processes, and estimates are made in the case of production of ammonia (see Section 4.9). It is possible that other chemical processes also result in direct $CO_2$ emissions but none have been identified. Chemical processes can result indirectly in emissions if wastes from the process are subsequently used as fuels and emission estimates for this type of source have been included in the inventory. [NIR 2011] |
| | Methane emissions are reported separately for production of ethylene and production of methanol, these chemicals being suggested as sources by the IPCC Guidelines for National Greenhouse Gas Inventories. Ethylene was manufactured on four sites at the end of 2009 while the only methanol plant closed in 2001. [NIR 2011] |

*Source: NIR 2011*
*Abbreviations explained in the Chapter 'Units and abbreviations'.*

Table 4.36 summarizes the recommendations from the 2010 UNFCCC inventory reviews in relation to the category 2B5 Other Chemical Production. The overview shows that the only recommendation available so far was implemented.

**Table 4.36** **2B5 Other Chemical Production: Findings of the 2009 UNFCCC inventory reviews in relation to $CO_2$ emissions and responses in 2010 inventory submissions**

| Member State | Review findings and responses related to 2B5 Other | |
|---|---|---|
| | **Comment UNFCCC report of the review of the 2010 submission** | **Status in 2011 submission** |
| **Austria** | No recommendation for improvement of this source category in Review Report. (FCCC/ARR/2010/AUT) | No follow-up necessary |
| **Belgium** | No recommendation for improvement of this source category in Review Report. (FCCC/ARR/2010/BEL) | No follow-up necessary |
| **Denmark** | No recommendation for improvement of this source category in Review Report. (FCCC/ARR/2010/DNK) | No follow-up necessary |
| **Finland** | Finland calculated CO2 emissions from hydrogen production using EFs derived from stoichiometric ratios of the chemical reaction of hydrocarbon feeds and hydrocarbon consumption of individual companies. The ERT recommends that Finland report in its next annual submission the consumption by type of feedstock and the EFs of each type in order to improve transparency. In its response to the draft annual review report, Finland indicated that it cannot provide plant-level consumption data in the NIR for onfidentiality reasons. However, the Party clarified that EFs by type of feedstock can be reported in its next annual submission. (FCCC/ARR/2010/FIN, para 47) | In its response to the draft annual review report, Finland indicated that it cannot provide plant-level consumption data in the NIR for confidentiality reasons. However, that EFs by type of feedstock have been reported. [NIR 2011, p.374] |
| **France** | Review report (In-country review 2010) not yet available. | |
| **Germany** | Review report (In-country review 2010) not yet available. | |
| **Greece** | No recommendation for improvement of this source category in Review Report. (FCCC/ARR/2010/GRC) | No follow-up necessary |
| **Ireland** | No recommendation for improvement of this source category in Review Report. (FCCC/ARR/2010/IRL) | No follow-up necessary |
| **Italy** | No recommendation for improvement of this source category in Review Report. (FCCC/ARR/2010/ITA) | No follow-up necessary |
| **Luxembourg** | No recommendation for improvement of this source category in Review Report. (FCCC/ARR/2010/LUX) | No follow-up necessary |
| **Netherlands** | Review report (Centralized review 2010) not yet available. | |
| **Portugal** | No recommendation for improvement of this source category in Review Report. (FCCC/ARR/2010/PRT) | No follow-up necessary |
| **Spain** | Review report (Centralized review 2010) not yet available. | |
| **Sweden** | Review report (Centralized review 2010) not yet available. | |
| **UK** | No recommendation for improvement of this source category in Review Report. (FCCC/ARR/2010/GBR) | No follow-up necessary |

*Source: NIR 2011, UNFCCC inventory review reports, as published at UNFCCC:*
***http://unfccc.int/national_reports/annex_i_ghg_inventories/inventory_review_reports/items/5687.php***
*Abbreviations explained in the Chapter 'Units and abbreviations'.*

### 4.2.3 Metal production (CRF Source Category 2C) (EU-15)

This source category includes the following key sources: $CO_2$ from 2C1 Iron and Steel Production, PFC from 2C3 Aluminium Production.

Table 4.37 summarises information by Member State on total GHG emissions, $CO_2$, $SF_6$ and PFC emissions from Metal Production. Between 1990 and 2009, $CO_2$ emission from 2C Metal Production decreased by 52 %. The absolute decrease was largest in Germany, Italy and the Netherlands,

**Table 4.37 2C Metal Production: Member States' contributions to total GHG, $CO_2$, PFC and $SF_6$ emissions**

| Member State | GHG emissions in 1990 (Gg $CO_2$ equivalents) | GHG emissions in 2009 (Gg $CO_2$ equivalents) | CO2 emissions in 1990 (Gg) | CO2 emissions in 2009 (Gg) | PFC emissions in 1990 (Gg CO2 equivalents) | PFC emissions in 2009 (Gg CO2 equivalents) | $SF_6$ emissions in 1990 (Gg CO2 equivalents) | SF6 emissions in 2009 (Gg CO2 equivalents) |
|---|---|---|---|---|---|---|---|---|
| Austria | 4,786 | 4,429 | 3,725 | 4,429 | 1,050 | NO | 253 | 1 |
| Belgium | 2,434 | 955 | 2,434 | 938 | NO | NO | NO | NO |
| Denmark | 30 | 0 | 28 | NA,NO | NO | NO | 31 | NO |
| Finland | 1,941 | 1,949 | 1,936 | 1,942 | NO | NO | NO | C,NO |
| France | 7,444 | 3,383 | 4,377 | 3,343 | 3,032 | 29 | 809 | 239 |
| Germany | 26,681 | 12,341 | 24,153 | 12,076 | 2,489 | 247 | 177 | 86 |
| Greece | 1,210 | 725 | 947 | 688 | 263 | 36 | NA,NO | NA,NO |
| Ireland | 0 | 0 | NO | NO | NO | NO | NO | NO |
| Italy | 5,608 | 1,486 | 3,878 | 1,307 | 1,673 | 146 | NA,NO | 9 |
| Luxembourg | 985 | 129 | 985 | 129 | NA,NO | NA,NO | NA,NO | NA,NO |
| Netherlands | 5,155 | 1,321 | 2,909 | 1,278 | 2,246 | 43 | NO | NO |
| Portugal | 19 | 21 | 19 | 21 | NE | NO | NE | NO |
| Spain | 4,291 | 2,701 | 3,386 | 2,608 | 883 | 82 | NA | NA |
| Sweden | 3,454 | 1,718 | 3,075 | 1,684 | 377 | 33 | 24 | 29 |
| United Kingdom | 3,687 | 1,282 | 2,309 | 1,193 | 1,333 | 61 | 426 | 78 |
| **EU-15** | **67,725** | **32,441** | **54,160** | **31,635** | **13,347** | **677** | **1,720** | **441** |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

Table 4.38 provides information on the contribution of Member States to EU recalculations in $CO_2$ from 2C Metal production for 1990 and 2008 and main explanations for the largest recalculations in absolute terms.

**Table 4.38** **2C Metal Production: Contribution of MS to EU recalculations in $CO_2$ for 1990 and 2008 (difference between latest submission and previous submission in Gg of $CO_2$ equivalents and percent)**

| | 1990 | | 2008 | | Main explanations |
|---|---|---|---|---|---|
| | Gg CO2 equiv. | Percent | Gg CO2 equiv. | Percent | |
| Austria | 0 | 0.0 | 36 | 0.6 | Update of activity data. |
| Belgium | 488 | 25.1 | 510 | 34.0 | Process emissions in the iron and steel sector (2C1) are revised for the complete time series in the 2011 submission in the Flemish region. A.o. the emissions of CO2 from the addition of lime are newly added. |
| Denmark | 0 | 0.0 | 0 | 0.0 | |
| Finland | 0 | 0.0 | 0 | 0.0 | |
| France | 692 | 18.8 | 102 | 2.7 | Ajout de sites qui n'étaient pas encore pris en compte |
| Germany | -25,614 | -51.5 | -24,087 | -54.7 | Recalculation of CO2 emissions from blast furnace gas combustion in industrial power plants from source category 2C1 to 1A2f and 1A1 |
| Greece | 0 | 0.0 | 0 | 0.0 | |
| Ireland | 0 | 0.0 | 0 | 0.0 | |
| Italy | 0 | 0.0 | -101 | -5.1 | update of ferroalloys activity data on the basis of ETS detailed data and information |
| Luxembourg | 0 | 0.0 | 0 | 0.0 | |
| Netherlands | 0 | 0.0 | -256 | -14.3 | reallocation from 2C15 to 1B1b |
| Portugal | 3 | 15.9 | 8 | 50.5 | In Iron and Steel Production (2C1) we start using EU-ETS activity data. |
| Spain | -62 | -1.8 | -259 | -6.9 | - For electric steel plants, the amount of natural gas that was allocated to processes (category 2.C.1) in the previous inventory edition has been reallocated to category 1.A.2.a (Combustion in iron and steel industries), which affects to the carbon balance for this activity. - Revision of CO2 emissions estimate as a result of the corresponding revision of carbon balance in intregrated iron and steel plants. The latter is in turn a consequence of the revision of estimates for collieries in such plants according to ERT suggestions concerning the calculation of the carbon balance from coke production. |
| Sweden | 0 | 0.0 | 1 | 0.0 | use of limestone added for one facility |
| UK | 0 | 0.0 | -3 | -0.1 | Revision to emission factor for blast furnace gas based on carbon balance approach |
| **EU-15** | **-24,493** | **-31.1** | **-24,051** | **-33.2** | |

Table 4.39 provides information on the contribution of Member States to EU recalculations in PFC from 2C Metal Production for 1990 and 2008 and main explanations for the largest recalculations in absolute terms.

**Table 4.39** **2C Metal Production: Contribution of MS to EU recalculations in PFC for 1990 and 2008 (difference between latest submission and previous submission in Gg of $CO_2$ equivalents and percent)**

| | 1990 | | 2008 | | Main explanations |
|---|---|---|---|---|---|
| | Gg CO2 equiv. | Percent | Gg CO2 equiv. | Percent | |
| Austria | 0 | 0.0 | 0 | 0.0 | |
| Belgium | 0 | 0.0 | 0 | 0.0 | |
| Denmark | 0 | 0.0 | 0 | 0.0 | |
| Finland | 0 | 0.0 | 0 | 0.0 | |
| France | 0 | 0.0 | 0 | 0.0 | |
| Germany | 0 | 0.0 | 0 | 0.0 | |
| Greece | 6 | 2.2 | 2 | 2.6 | The plant is using IPCC 2006 Tier 3 methodology for years 2005-2007. For time series consistency the same methodology has been used for the whole time series. |
| Ireland | 0 | 0.0 | 0 | 0.0 | |
| Italy | 0 | 0.0 | 0 | -0.3 | From 2000 both activity data (primary aluminium production) and CF4 and C2F6 emissions have been updated on the basis of new comunication by Alcoa |
| Luxembourg | 0 | 0.0 | 0 | 0.0 | |
| Netherlands | 0 | 0.0 | 0 | 0.0 | |
| Portugal | 0 | 0.0 | 0 | 0.0 | |
| Spain | 0 | 0.0 | 0 | 0.0 | |
| Sweden | 0 | 0.0 | 0 | 0.0 | |
| UK | 0 | 0.0 | 0 | -0.4 | Revision to emission data supplied by one of the operators |
| **EU-15** | **6** | **0.0** | **1** | **0.1** | |

### 4.2.3.1 Iron and steel production

This source category includes emissions from the iron and steel industry. Crude iron is produced by the reduction of iron oxide ores mostly in blast furnaces, generally using the carbon in coke or charcoal (sometimes supplemented with coal or oil) as both the fuel and reductant. In most iron furnaces, the process is aided by the use of carbonate fluxes (limestone). Additional emissions occur as the limestone or dolomite flux gives off $CO_2$ during reduction of pig iron in the blast furnace, but this source category is covered as emissions from limestone use. Carbon plays the dual role of fuel and reductant. Member states use different methods for the allocation of emissions that are described in Table 4.42

$CO_2$ emissions from 2C1 Iron and Steel Production account for 0.12% of total EU-15 GHG emissions in 2009. Germany is responsible for 42% of these emissions in the EU-15. Germany had the largest decreases in absolute terms between 1990 and 2009 while the only increases were in Finland and in Austria. Between 1990 and 2009 emissions are fluctuating. The emission trend follows mainly the emissions from Germany that are fluctuating due to varying production figures. Overall, between 1990 and 2009, $CO_2$ emissions from this source decreased by 42 % (Table 4.40), however, emissions from this source category decreased by 35% between 2008 and 2009 which was mainly due to the economic recession.

**Figure 4.10** **2C1 Iron and Steel Production: EU-15 $CO_2$ emissions**

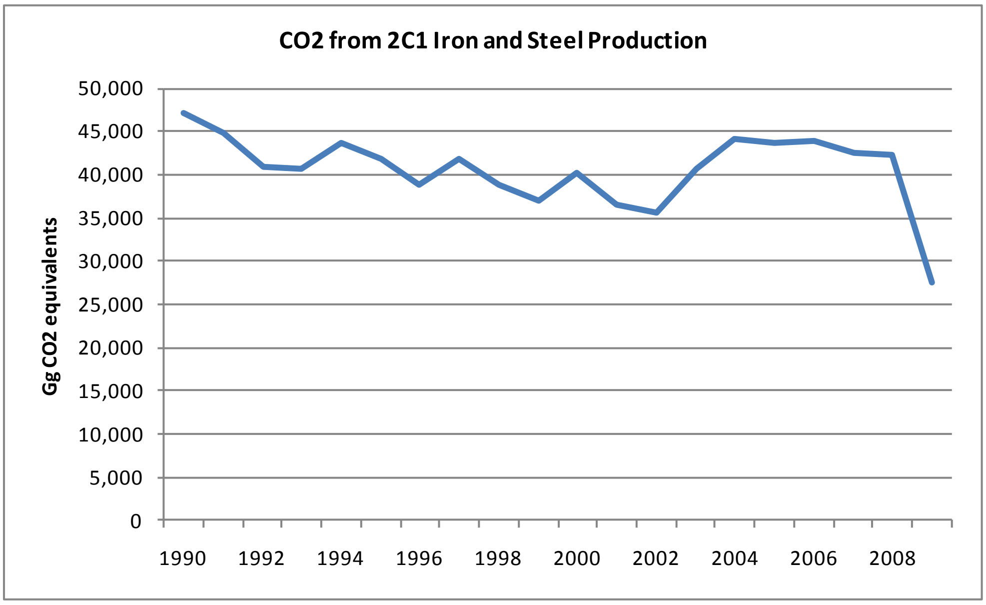



**Table 4.40** **2C1 Iron and Steel Production: Member States' contributions to $CO_2$ emissions and information on method applied, activity data and emission factor**

| Member State | CO2 emissions in Gg | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg CO2 equivalents) | (%) | (Gg CO2 equivalents) | (%) | | |
| Austria | 3,546 | 5,807 | 4,412 | 16.0% | -1,395 | -24% | 866 | 24% | T2 | CS,D |
| Belgium | 2,434 | 2,008 | 938 | 3.4% | -1,070 | -53% | -1,497 | -61% | D,T3,PS | PS |
| Denmark | 28 | NA,NO | NA,NO | - | - | - | -28 | -100% | NA | NA |
| Finland | 1,935 | 2,523 | 1,941 | 7.0% | -582 | -23% | 6 | 0% | S,T1,T2,T3 | CS,D |
| France | 3,151 | 3,044 | 2,588 | 9.4% | -456 | -15% | -563 | -18% | CR | CS |
| Germany | 22,712 | 19,092 | 11,669 | 42.3% | -7,423 | -39% | -11,042 | -49% | T2 | CS |
| Greece | 93 | 207 | 137 | 0.5% | -70 | -34% | 44 | 48% | CS | PS |
| Ireland | NO | NO | NO | - | - | - | - | - | NA | NA |
| Italy | 3,124 | 1,424 | 901 | 3.3% | -524 | -37% | -2,223 | -71% | D | CR,CS,PS |
| Luxembourg | 985 | 169 | 129 | 0.5% | -41 | -24% | -856 | -87% | CS,T2 | CS |
| Netherlands | 2,514 | 1,093 | 1,054 | 3.8% | -39 | -4% | -1,460 | -58% | T2 | CS |
| Portugal | 16 | 22 | 18 | 0.1% | -3 | -16% | 2 | 13% | T2 | PS |
| Spain | 2,428 | 1,956 | 1,684 | 6.1% | -272 | -14% | -744 | -31% | T2 | PS,CS |
| Sweden | 2,462 | 2,445 | 1,334 | 4.8% | -1,111 | -45% | -1,127 | -46% | CS,T2 | PS |
| United Kingdom | 1,859 | 2,560 | 803 | 2.9% | -1,757 | -69% | -1,056 | -57% | T3 | CS |
| **EU-15** | **47,287** | **42,352** | **27,608** | **100.0%** | **-14,744** | **-35%** | **-19,679** | **-42%** | | |

Table 4.41 shows information on activity data, emission factors for $CO_2$ emissions from 2C1 Iron and Steel Production for 1990 and 2009. For 2C1 Iron and Steel Production it is not useful to give an average IEF for the EU-15 because the allocation of emissions (the split between process and combustion related emissions for pig iron production, which is the most important sub category) is differing between MS. The table and the method descriptions included in Table 4.42 suggest that for 2009 more than 90% of the reported emissions are estimated using higher tier methods.

**Table 4.41 2C1 Iron and Steel Production: Information on activity data, emission factors for $CO_2$ emissions**

| Member State | 1990 | | | | 2009 | | | |
|---|---|---|---|---|---|---|---|---|
| | Activity data | | Implied emission factor (t/t) | CO2 emissions (Gg) | Activity data | | Implied emission factor (t/t) | CO2 emissions (Gg) |
| | Description | (kt) | | | Description | (kt) | | |
| Austria | **Iron and steel production** | | **0.26** | **3546** | **Iron and steel production** | **0** | **0.31** | **4412** |
| | Steel Production [kt] | 3921 | 0.12 | 484 | Steel Production [kt] | 5077 | 0.12 | 614 |
| | Iron Production [kt] | 3444 | 0.88 | 3043 | Iron Production [kt] | 4376 | 0.86 | 3756 |
| | Sinter Production [kt] | 4384 | NA | NA | Sinter Production [kt] | 3528 | NA | NA |
| | Coke Production [kt] | 1725 | NA | NA | Coke Production [kt] | 1281 | NA | NA |
| | Other | | | 20 | Other | 0 | 0.00 | 42 |
| Belgium | **Iron and steel production** | | **0.06** | **2434** | **Iron and steel production** | **0** | **0.06** | **938** |
| | Steel | 11570 | 0.09 | 1021 | Steel | 5765 | 0.02 | 102 |
| | Pig Iron | 9415 | 0.11 | 1033 | Pig Iron | 3087 | 0.26 | 814 |
| | Sinter | 13735 | 0.03 | 381 | Sinter | 4095 | 0.00 | 18 |
| | Coke | 4542 | | | Coke | 1515 | IE | IE |
| | Other | | | | Other | 0 | 0.00 | 4 |
| Denmark | **Iron and steel production** | | **0.05** | **28** | **Iron and steel production** | **0** | **NA,NO** | **NA,NO** |
| | Steel | 614 | 0.05 | 28 | Steel | NO | NO | NO |
| | Pig Iron | NO | NO | NO | Pig Iron | NO | NO | NO |
| | Sinter | NO | NO | NO | Sinter | NO | NO | NO |
| | Coke | NO | NO | NO | Coke | NO | NO | NO |
| | Other | | | NA | Other | 0 | 0.00 | NA |
| Finland | **Iron and steel production** | | **0.58** | **1935** | **Iron and steel production** | **0** | **0.51** | **1941** |
| | Produced steel | 2861 | 0.68 | 1931 | Produced steel | 3066 | 0.63 | 1939 |
| | Pig Iron | IE | IE | IE | Pig Iron | IE | IE | IE |
| | Sinter | IE | IE | IE | Sinter | IE | IE | IE |
| | Produced coke | 487 | 0.001 | 1 | Produced coke | 740 | 0.001 | 1 |
| | Other | | | 3 | Other | 0 | 0.00 | 2 |
| France | **Iron and steel production** | | **0.10** | **3151** | **Iron and steel production** | **0** | **0.11** | **2588** |
| | Steel: kt Production | 19073 | 0.09 | 1639 | Steel: kt Production | 14471 | 0.08 | 1126 |
| | Pig Iron: kt Production | 14088 | 0.09 | 1210 | Pig Iron: kt Production | 9519 | 0.12 | 1170 |
| | Sinter: kt Production | IE | IE | IE | Sinter: kt Production | IE | IE | IE |
| | Coke: kt Production | IE | IE | IE | Coke: kt Production | IE | IE | IE |
| | Other | | | 302 | Other | 0 | 0.00 | 292 |
| | 2.C.1.5.1 Rolling mills, blast furnace charging | 16848 | 0.02 | 302 | 2.C.1.5.1 Rolling mills, blast furnace charging | 14471 | 0.02 | 292 |

| | 1990 | | | | 2009 | | | |
|---|---|---|---|---|---|---|---|---|
| Member State | Activity data | | Implied emission factor (t/t) | CO2 emissions (Gg) | Activity data | | Implied emission factor (t/t) | CO2 emissions (Gg) |
| | Description | (kt) | | | Description | (kt) | | |
| Germany | **Iron and steel production** | | **0.19** | **22712** | **Iron and steel production** | **0** | **0.22** | **11669** |
| | Steel | 87878 | 0.26 | 22712 | Steel | 32670 | 0.36 | 11669 |
| | Pig Iron | 32263 | IE | IE | Pig Iron | 20104 | IE | IE |
| | Sinter | IE | IE | IE | Sinter | IE | IE | IE |
| | Coke | IE | IE | IE | Coke | IE | IE | IE |
| | Other | | | NO | Other | 0 | 0.00 | NO |
| Greece | **Iron and steel production** | | **0.09** | **93** | **Iron and steel production** | **0** | **0.07** | **137** |
| | steel production in EAF | 999 | 0.09 | 93 | steel production in EAF | 1999 | 0.07 | 137 |
| | Pig Iron | NO | NO | NO | Pig Iron | NO | NO | NO |
| | Sinter | NO | NO | NO | Sinter | NO | NO | NO |
| | Coke | NO | NO | NO | Coke | NO | NO | NO |
| | Other | | | NO | Other | 0 | 0.00 | NO |
| Ireland | **Iron and steel production** | | **NO** | **NO** | **Iron and steel production** | **0** | **NO** | **NO** |
| | Steel | NO | NO | NO | Steel | NO | NO | NO |
| | Pig Iron | NO | NO | NO | Pig Iron | NO | NO | NO |
| | Sinter | NO | NO | NO | Sinter | NO | NO | NO |
| | Coke | NO | NO | NO | Coke | NO | NO | NO |
| | Other | | | NO | Other | 0 | 0.00 | NO |
| Italy | **Iron and steel production** | | **0.05** | **3124** | **Iron and steel production** | **0** | **0.03** | **901** |
| | Steel: Production | 25467 | 0.05 | 1346 | Steel: Production | 19848 | 0.02 | 490 |
| | Pig Iron: Production | 11852 | 0.15 | 1778 | Pig Iron: Production | 5692 | 0.07 | 410 |
| | Sinter: Production | 13577 | NA | NA | Sinter: Production | 5823 | NA | NA |
| | Coke: Production | 6356 | NA | NA | Coke: Production | 2755 | NA | NA |
| | Other | | | NA | Other | 0 | 0.00 | NA |
| Luxembourg | **Iron and steel production** | | **0.09** | **985** | **Iron and steel production** | **0** | **0.06** | **129** |
| | steel production | 3506 | 0.12 | 404 | steel production | 2120 | 0.06 | 129 |
| | pig iron production | 2645 | 0.08 | 200 | pig iron production | NO | NO | NO |
| | sinter production | 4804 | 0.08 | 380 | sinter production | NO | NO | NO |
| | coke production in non-integrated plants | NO | NO | NO | coke production in non-integrated plants | NO | NO | NO |
| | Other | | | NA | Other | 0 | 0.00 | NA |

| Member State | 1990 | | | | 2009 | | | |
|---|---|---|---|---|---|---|---|---|
| | Activity data | | Implied emission factor (t/t) | CO2 emissions (Gg) | Activity data | | Implied emission factor (t/t) | CO2 emissions (Gg) |
| | Description | (kt) | | | Description | (kt) | | |
| Netherlands | **Iron and steel production** | | **0.49** | **2514** | **Iron and steel production** | **0** | **0.20** | **1054** |
| | Crude steel production | 5162 | 0.01 | 43 | Crude steel production | 5244 | 0.00 | 21 |
| | Pig Iron | NO | NO | NO | Pig Iron | NO | NO | NO |
| | Sinter | NO | NA | NA | Sinter | NO | NA | NA |
| | See 1B1b | IE | IE | IE | See 1B1b | IE | IE | IE |
| | Other | | | 2471 | Other | 0 | 0.00 | 1033 |
| | Limestone equiv. use | 595 | 0.42 | 249 | Limestone equiv. use | 554 | 0.42 | 232 |
| | Carbon loss | 12 | 190.11 | 2223 | Carbon loss | 6 | 142.74 | 802 |
| Portugal | **Iron and steel production** | | **0.01** | **16** | **Iron and steel production** | **0** | **0.01** | **18** |
| | Steel | 1247 | 0.01 | 14 | Steel | 2143 | 0.01 | 18 |
| | Pig Iron | IE | IE | IE | Pig Iron | IE | IE | IE |
| | Sinter | IE | IE | IE | Sinter | IE | IE | IE |
| | Coke | 230 | 0.01 | 2 | Coke | IE | NO | NO |
| | Other | | | NO | Other | 0 | 0.00 | NO |
| Spain | **Iron and steel production** | | **0.18** | **2428** | **Iron and steel production** | **0** | **0.12** | **1684** |
| | Steel production | 13163 | 0.07 | 979 | Steel production | 14296 | 0.06 | 868 |
| | Pig iron production | C | C | 246 | Pig iron production | C | C | 417 |
| | Sinter production | C | C | 538 | Sinter production | C | C | 325 |
| | Coke production | IE | IE | IE | Coke production | IE | IE | IE |
| | Other | | | 666 | Other | 0 | 0.00 | 74 |
| Sweden | **Iron and steel production** | | **0.16** | **2462** | **Iron and steel production** | **0** | **0.08** | **1334** |
| | Production of secondary steel | 1743 | 0.09 | 156 | Production of secondary steel | 967 | 0.13 | 129 |
| | Production of primary iron | 2845 | 0.81 | 2306 | Production of primary iron | 2062 | 0.58 | 1204 |
| | Sinter | 10977 | NA | NA | Sinter | 14704 | 0.00 | 1 |
| | Coke | IE | IE | IE | Coke | IE | IE | IE |
| | Other | | | NA | Other | 0 | 0.00 | NA |
| UK | **Iron and steel production** | | **0.08** | **1859** | **Iron and steel production** | **0** | **0.06** | **803** |
| | Steel Production (EAF) | 4546 | 0.01 | 37 | Steel Production (EAF) | 2145 | 0.01 | 16 |
| | Iron Production (blast furnace) | 12463 | IE | IE | Iron Production (blast furnace) | 7671 | IE | IE |
| | Sinter | NA | IE | IE | Sinter | NA | IE | IE |
| | Coke consumed in blast furnaces | 5180 | IE | IE | Coke consumed in blast furnaces | 3180 | IE | IE |
| | Other | | | 1822 | Other | 0 | 0.00 | 787 |
| | Blast furnace gas flared (PJ) | 7 | 275.67 | 1805 | Blast furnace gas flared (PJ) | 3 | 294.82 | 778 |
| | Steel Production (OC) | 13169 | 0.00 | 17 | Steel Production (OC) | 7955 | 0.00 | 9 |

According to the IPCC methodology, processes including auto-producers - power and heat production facilities located in iron and steel plants excluding heating of coke ovens (where usually coke oven gas is combusted) and fuel combustion (gaseous fuels and coke) in sinter plants (agglomeration of iron ores) should be taken into account in 1A2a; while processes including consumption of carbonaceous reducing agents, especially in blast furnaces, oxidation of carbon contained in a pig iron or scrap and the burning off carbonaceous electrodes should be taken into account in 2C1. Additionally, emissions coming from limestone and dolomite use in iron and steel plants should be included under 2A3 and Emissions coming from heating of coke ovens should be reported under 1A1c.

However, some EU-15 Member States do not keep this boundary for different reasons (local traditions used in history and in this context an attempt to keep consistency in data series). E. g. some Member States report emission from blast furnace gas and from converter gas under 1A2a instead of under 2C1, because they interpret it as emissions from energy supply.

Thus, for an overview of EU-15 total emissions it seems to be more convenient to take into account all emissions covered by the combined category 1A2a + 2C1. Resulting emissions for the EU-15 Member States in the combined category 1A2a + 2C1 are given inTable 4.42.

**Table 4.42 $CO_2$ Emissions of EU-15 Member States in 1A2a and 2C1 Iron and Steel**

| Member State | $CO_2$ emissions in Gg | | | Share in EU15 emissions in 2009 | Share 2C1 |
|---|---|---|---|---|---|
| | 1A2a | 2C1 | Combined | | |
| | | | | | |
| Austria | 5,218 | 4,412 | 9,629 | 10.0% | 46% |
| Belgium | 4,067 | 938 | 5,005 | 5.2% | 19% |
| Denmark | 89 | NA,NO | 89 | 0.1% | 0% |
| Finland | 2,296 | 1,941 | 4,237 | 4.4% | 46% |
| France | 10,685 | 2,588 | 13,273 | 13.8% | 19% |
| Germany | 11,564 | 11,669 | 23,234 | 24.2% | 50% |
| Greece | 160 | 137 | 297 | 0.3% | 46% |
| Ireland | 2 | NO | 2 | 0.0% | NA |
| Italy | 8,551 | 901 | 9,451 | 9.8% | 10% |
| Luxembourg | 326 | 129 | 454 | 0.5% | 28% |
| Netherlands | 4,075 | 1,054 | 5,129 | 5.3% | 21% |
| Portugal | 139 | 18 | 157 | 0.2% | 11% |
| Spain | 5,689 | 1,684 | 7,373 | 7.7% | 23% |
| Sweden | 1,123 | 1,334 | 2,457 | 2.6% | 54% |
| United Kingdom | 14,480 | 803 | 15,283 | 15.9% | 5% |
| **EU-15** | **68,464** | **27,608** | **96,072** | **100.0%** | **29%** |

It is obvious, that the ratio 2C1 / (1A2a + 2C1) entitled as "Share 2C1" differs significantly for individual Member States. Therefore, boundary between 1A2a and 2C1 is not uniformly interpreted in individual Member States. The seven Member States that are significant $CO_2$ emitters from iron and steel production (accounting together for 90% of EU-15) allocate emissions in the following ways:

- **Germany**: Nearly 90 % of emissions is reported under 2C1. To calculate process specific emissions the Tier 2 approach is used (using a carbon / tonne pig iron factor for the ideal blast furnace process) and emissions are subtracted from total emissions calculated by the total fuel input to obtain energy related emissions. Process emissions include furthermore electrode combustion in the electric steel production. Emissions from carbonates used in metal production are reported in sector 2C1 instead of 2A3.

- **United Kingdom:**Major share of emissions is reported under 1A2a. Emissions from pig iron, sinter and coke production are allocated in 1A2a (or 1A1) instead of 2C1.

- **France:**Major share of emissions is reported under 1A2a. In the CRF tables it is specified that emissions from sinter are reported under 1A2a and emissions from coke are included in 1B1b.

- **Italy:** Major share of emissions is reported under 1A2a. $CO_2$ emissions due to the consumption of coke, coal or other reducing agents used in the iron and steel industry have been accounted for as fuel consumption and reported in the energy sector. In the sector 2C1 emissions are reported from: the carbonates used in the sinter plant and in basic oxygen furnaces to remove impurities and to the steel and pig iron scraps, instead of sector 2A3; and graphite electrodes consumed in electric arc furnaces.

- **Austria:** About half of emissions is reported under 2C1. Process specific emissions are calculated according to the IPCC good practice guidance Tier 2 approach (using a fix percentage of coke used as reducing agent); these emissions are subtracted from total $CO_2$ emissions reported by the company. The remaining emissions are reported in the energy sector as emissions due to combustion in category 1A2a Iron and Steel. Emissions from sinter and coke production are included in 1A2a. Emissions from limestone and dolomite use are reported under 2A3. Process emissions include furthermore electrode combustion in the electric steel production.

- **Belgium:** Major share of emissions is reported under 1A2a. Emissions from coke are included in the energy sector. Emissions from carbonates used in metal production are reported in sector 2C1 instead of 2A3.

- **Spain:** About three quarters of emissions is reported under 1A2a. Emissions from coke are included in the energy sector.

Table 4.43 summarises information by Member State on methods used for estimating $CO_2$ emission from 2C1 Iron and Steel Production.

**Table 4.43 2C1 Iron and Steel Production : Information on activity data and methods used for $CO_2$ emissions for 1990 and 2007**

| Member states | Description of methods |
|---|---|
| *Austria* | Total $CO_2$ emissions from the two main integrated iron and steel production sites in Austria were reported directly by industry until 2002. They are calculated by applying a very detailed mass balance approach for carbon. For the years 2003 and 2004 total $CO_2$ emissions were not reported by industry, thus they were estimated using information from the national energy balance and from the years before. For 2005 and 2006 verified $CO_2$ emissions, reported under the EU ETS, were taken for the inventory. These data cover $CO_2$ emissions from pig iron and basic oxygen furnace steel.<br><br>Process specific emissions are calculated by the Umweltbundesamt according to the IPCC good practice guidance; these emissions are subtracted from total $CO_2$ emissions reported by the company. The remaining emissions are reported in the energy sector as emissions due to combustion in category 1 A 2 a Iron and Steel.<br><br>$CO_2$ emissions from pig iron production were calculated following closely the IPCC GPG guidelines Tier 2 approach, applying the default emission factor of table 3.6 of the IPCC GPG.<br><br>$CO_2$ emissions from steel production (which corresponds to steel production at the two integrated sites operating basic oxygen furnaces) were calculated following the IPCC GPG guidelines Tier 2 approach.<br><br>$CO_2$ emissions from electric steel production were estimated using a country specific methodology.<br><br>For 2005- 2008 $CO_2$ emissions from non-carbonatious ore and other additives were taken into account additionally. This information became available from background data reported under the ETS. Again it has to be stressed that this additional accounting does not affect total $CO_2$ emissions, but only improves the accuracy of the split made between process and combustion specific emissions. |
| *Belgium* | During the 2011 submission the emissions of $CO_2$ in the iron and steel sector are completely revised in the Flemish region and based on the ETS-methodology instead of C-balance-approach in previous emissions. One company produces rust-free steel. The process emissions in this company are rather small and calculated on the basis of the production of fluid steel on one side. An emission factor of 1.11 – 1.17 %C is still used, being the C-amount blowed off in the convertor. On the other hand, the consumption of electrodes is also taken into account. The sum of both emissions of $CO_2$ are total process emissions in this company.<br><br>In the second company that produces steel in the Flemish region, process emissions are originating from (1) production of fluid pig iron, (2) amount of lime used directly in the sinter factory to fix the alkalinity of the slags and (3) the amount of lime used (indirectly) in the grinded mixture (mixture of ores, recovery products, MgCO3, |

| Member states | Description of methods |
|---|---|
| | $CaCO3$, …) in the sinter factory as well. The process emissions in the iron and steel sector are allocated in this category 2C, the energy emissions are included in category 1A2a. Emissions of production of coke are separately put in category 1A1c.In the Walloon region, iron is produced through the reduction of iron oxides (ore) with metallurgical coke (as the reducing agent) in a blast furnace to produce pig iron. Steel is made from pig iron and/or scrap steel using electric arc or basic oxygen furnace. The emission estimates in this sub-sector include also emissions from the production of steel in basic oxygen type furnaces but not the emissions from the combustion of the fuel. Until 2004, the emission factors in the basic oxygen furnace steel plant are used as indicated in table 4.5.2.The plants approved these emission factors. Until 2002, 100 % of the $CO_2$ in the pig iron produced in the blast furnace has been estimated to be emitted in the basic oxygen furnace due to the lack of data's (purchased pig iron, C in steel produced, C in steel scrap). Since 2005, $CO_2$ emissions have been obtained directly by the obliged reporting of the plants under the emission trading scheme. |
| *Denmark* | The $CO_2$ emission from the consumption of metallurgical coke at steelworks has been estimated from the annual production of steel sheets and steel bars combined with the consumption of metallurgical coke per produced amount (Stålvalseværket, 2002). The carbon source is assumed to be coke and all the carbon is assumed to be converted to $CO_2$ as the carbon content in the products is assumed to be the same as in the iron scrap. The emission factor (3.6 tonnes $CO_2$/ton metallurgical coke) is based on values in the IPCC-guideline (IPCC (1997), vol. 3, p. 2.26). Emissions of $CO_2$ for 1990-1991 and for 1993 have been determined with extrapolation and interpolation, respectively. |
| *Finland* | The calculation method of $CO_2$ emission from iron and steel industry is country specific. Both fuel based emissions and process emissions are calculated in connection with the ILMARI calculation system (see chapter 3.2 Emissions from fuel combustion) using plant/process level (bottom-up) data. The methodology is slightly plant-specific, because all plants are different from each other.<br><br>The main common feature for all plants is, that fuel-based emissions for each installation are calculated in ILMARI system from the use of fuels, excluding coke and heavy bottom oil used in blast furnaces, and subtracted from total $CO_2$ emissions (described below). Fuel-based emissions are allocated to CRF 1A 2a and CRF1A 1c (coke ovens) The rest of emissions are allocated to process emissions in CRF 2C 1 (and CRF 2.A 1 in the case of lime kilns).<br><br>Total $CO_2$ emissions for each installation (coke oven, sinter plant, blast furnace, lime kiln, steel converter, rolling mills, power plants/boilers) in each plant are mostly taken from VAHTI database. These emissions are basically calculated by plant operators using carbon inputs (fuel inputs and reducing materials) and they are reported by installations separately.<br><br>From 2005 on, all four iron and steel plants in Finland report to the ETS. Starting from 2007 submission, the total $CO_2$ emissions for GHG inventory have been taken from the ETS data, although the split between process and fuel-based emissions has been done in the same way as in the previous years' calculation. |
| *France* | Country specific based on carbon mass balance approach<br><br>Data sources: Annual pollutant emission reports; French Steel Association. |
| *Germany* | The total process-related emissions to be reported under 2.C.1 consist of the following:<br><br>1. The $CO_2$ emissions resulting from use of reducing agents in primary steel production,<br><br>where the relevant top gas and converter gas is not used in other source categories<br><br>and thus reported under other categories as $CO_2$ emissions<br><br>2. The $CO_2$ emissions from limestone inputs in pig iron production, and<br><br>3. The $CO_2$ emissions from electrode consumption in electrical steel production |
| *Greece* | Steel production in Greece is based on the use of electric arc furnaces (EAF). There are no integrated iron and steel plants for primary production as no units for primary production of iron exist, but there are several iron and steel foundries.<br><br>The methodology used for the estimation of emissions is based on tracked carbon oxidation throughout the production processes in electric arc furnace operation. |
| *Ireland* | NO |
| *Italy* | $CO_2$ emissions from iron and steel production refer to the carbonates used in sinter plants, in blast furnaces and in steel making plants to remove impurities; they are also related to the steel and pig iron scraps, and graphite electrodes consumed in electric arc furnaces. Basic information for this sector derives from different sources in the period 1990-2008. Activity data are supplied by official statistics published in the national statistics yearbook (ISTAT, several years) and by the sectoral industrial association (FEDERACCIAI, several years).For the integrated plants, emission and production data have been communicated by the two largest plants for the years 1990-1995 in the framework of the CORINAIR emission inventory, distinguished by sinter, blast furnace and BOF, and by combustion and processes emissions. From 2000 $CO_2$ emissions and production data have been supplied by all the plants in the framework of the ETS scheme, for the years 2000-2004 disaggregated for sinter, blast furnace and BOF plants, from 2005 specifying carbonates and fuels consumption and related $CO_2$ emissions. For 2002-2006 data have also been supplied by all the four integrated iron and steel plants in the framework of the European EPER/E-PRTR registry not distinguished for combustion and processes. Qualitative information and documentation available on the plants allowed reconstructing their history including closures or modifications of part of the plants; additional qualitative information regarding the plants collected and checked |

| Member states | Description of methods |
| --- | --- |
| | for other environmental issues or directly asked to the plant permitted to individuate the main driving of the emission trends for pig iron and steel productions. Time series of carbonates used in basic oxygen furnaces have been reconstructed on the basis of the above mentioned information resulting in no emissions in the last years. Indeed, as regards the largest Italian producer of pig iron and steel, lime production has increased significantly from 2000 to 2008 by about 250,000 over 410,000 tonnes and the amount introduced in basic oxygen furnaces was, in 2004, about 490,000 tonnes (ILVA, 2006). Emissions from lime production in steel making industries are reported in 1A2 Manufacturing Industries and Construction. Concerning the electric arc furnaces, additional information on the consumption of scraps, pig iron, graphite and electrodes and their average carbon content has been supplied together with the steel production by industry for a typical plant in 2004 (FEDERACCIAI, 2004) and checked with other sectoral study (APAT, 2003). On the basis of these figures an average emission factor has been calculated.$CO_2$ emissions due to the consumption of coke, coal or other reducing agents used in the iron and steel industry have been accounted for as fuel consumption and reported in the energy sector, including fuel consumption of derived gases. |
| *Luxembourg* | Sinter Plant (SP): The emissions in 1990 are calculated from the mass of carbon in the ore. It is therefore a country specific methodology. The data were collected directly from the operator. Blast furnace (BF) and basic oxygen furnace steel production (BOF): The 2000 IPCC-GPG Tier 2 methodology is applied for calculating the emissions in 1990. The emissions from iron production in BF and from steel production in BOF are calculated separately based on a carbon balance over the production processes. Electric arc furnace steel production (EAF): The 2000 IPCC-GPG Tier 2 methodology has been applied for calculating the emissions from the year 2004 onward. The emissions are calculated based on a carbon balance over the production process. [NIR 2008] |
| *Netherlands* | $CO_2$ emissions are estimated using a Tier 2 IPCC method and country-specific carbon contents of the fuels. Carbon losses are calculated from coke and coal input used as reducing agent in blast and oxygen furnaces , including other carbon sources such as limestone and the carbon contents in the iron ore (corrected for the fraction that ultimately remains in the steel produced).<br><br>Only the net carbon losses are reported in category 2C1. The carbon contained in the blast furnace gas and oxygen furnace gas produced as by-products and subsequently used as fuels for energy purposes is subtracted from the carbon balance and is included in the Energy sector (1A1a and 1A2a, see Sections 3.2.2 and 3.2.3). |
| *Portugal* | Emissions are simply calculated from multiplication of activity levels by a suitable emission factor.<br><br>To avoid double counting, carbon dioxide emissions in coquerie and blast furnace, from oxidation of the carbon that was used as a reducing agent were not estimated from steel or coke production data but simply from use of coke derivative fuels (coke gas and blast furnace gas) in all combustion equipments. Methodology to estimate emissions from combustion of coke gas and blast furnace gas were already discussed in chapter 3.2A – Energy Industries and emissions are included in source sector 1A.2 - manufacturing industries and construction - and 1A.1.c.1 - Manufacture of Solid Fuels. Emissions factors for production process where set mostly from CORINAIR/EMEP also with contributions from IPCC96 and US-EPA AP42. The $CO_2$ emission factors for Electric Arc Furnace, and that were used for each one of the two iron and steel plants that are included in the European Union Emission Trading Scheme (EU-ETS), were determined from consumption of carbon bearing materials in these units: limestone, calcium carbide and coke for years 2002 and 2003. It was assumed that the same carbon content exists in both scrap and final steel produced in EAF furnaces and consequently no additional emissions are estimated apart from carbon in additives. |
| *Spain* | La estimación de las emisiones de $CO_2$ en los procesos de fabricación de sínter, arrabio y acero se ha realizado utilizando el método de nivel 2 de IPCC según el cual se rastrea el carbono a través del proceso de producción, evitándose de esta manera la contabilidad por partida doble de las emisiones. La elección de este método ha sido posible debido a que se ha podido disponer de balances de masa de carbono en las materias de entrada y salida correspondientes para cada uno de los procesos encuadrados dentro de esta categoría, tal y como se describe más adelante en este mismo apartado, con distinción entre las tecnologías utilizadas en la fabricación de acero (acerías eléctricas vs acerías de oxígeno básico), dadas las diferencias sustanciales en cuanto a la tecnología y las materias primas utilizadas. En cuanto a las antorchas, la estimación de las emisiones de $CO_2$ se basa en el contenido de carbono de cada gas incinerado y en los factores de oxidación, tal y como se detalla más adelante en este mismo epígrafe. |
| *Sweden* | Process emissions arising from reducing agents in the primary steel works and secondary iron and steel works are reported in CRF 2C1. As the plants also generate emissions from fuel combustion (CRF 1A1c and CRF 1A2a) and fugitive emissions (CRF 1B1c), the text in this section is closely connected to the text in the<br><br>corresponding section in the energy chapter. In the Swedish inventory, emissions from primary iron and steel production and secondary steel production are reported separately and fed into the CRF Reporter under 2C1.2 Pig iron and 2C1.1 Steel, respectively. This enables process emissions from the two integrated iron and steel production plants in Sweden to be reported together (2C1.2 Pig iron), and thus not introducing further sources of uncertainty due to additional data handling.<br><br>Steel: The reported $CO_2$ emissions include emissions from reducing agents such as coke, coal and electrodes in electric arc furnaces in secondary steel plants. Reported $CO_2$ emissions also include emissions from the use of limestone and dolomite in secondary steel industry. In most cases data from the Swedish inquiry for the Swedish national allocation plan (NAP) for the EU emissions trading scheme could be used for the years 1998-2002. Data for remaining years (1990-1997 and 2003-2004) has been collected directly from the plants. From 2005, the equivalent data are acquired from the ETS, environmental reports and through contacts with the companies. Data in the ETS also includes information on other sources for process-related<br><br>$CO_2$ emissions as well as information concerning carbon bound in products, slag, etc., Reported $CO_2$ emissions are for all facilities except the one which closed down in 2004 based on data in the ETS, and reported $CO_2$ emissions can therefore be classified to follow the Good Practice Guidance method Tier 2. According to the ETS guidelines, reported emissions shall be based on all carbon input to and carbon output from the process. For the |

| Member states | Description of methods |
|---|---|
| | remaining facility plant specific methods are applied<br>Iron powder: In Sweden there is one producer of iron ore based iron powder. The emissions of $CO_2$ are calculated by using the Good Practice Guidance method Tier 2. The method includes plant specific activity data on emissions from carbon-containing input materials such as coke and anthracite and also specific carbon-contents of output iron and rest products for all years.<br>Pig iron: The recommended Tier 2 methodaccording to the IPCC Guidelines is applied: calculations of $CO_2$ emissions are based on carbon mass-balances in order to reduce the risk of double counting or omitting $CO_2$ emissions. The carbon contents of external input materials such as coking coal, coke, injection coal, limestone, etc., are balanced against final output materials; coke86, pig iron86, steel, tar, sludge, slag, etc. The remaining carbon contents are accounted for as $CO_2$ emissions. |
| *United Kingdom* | The methodology for the prediction of carbon dioxide emissions from fuel combustion, fuel transformation, and processes at integrated steelworks is based on a detailed carbon balance (this methodology is described in more detail within the section on CRF sector 1A2a).Carbon emissions from electric arc furnaces are calculated using an emission factor provided by Corus (2005) |

*Source: NIR 2011 unless stated otherwise*

Table 4.44 summarizes the recommendations from the latest UNFCCC review of the inventory report in relation to the category 2C1 Iron and Steel Production. The overview shows that most recommendations could be implemented.

**Table 4.44 2C1 Iron and Steel Production : Findings of the latest UNFCCC review of the inventory report in relation to $CO_2$ emissions and responses in 2011 inventory submissions**

| Member State | Review findings and responses related to 2.C.1 Iron and Steel Production | |
|---|---|---|
| | **Comment in the latest UNFCCC review report** | **Status in 2011 submission** |
| *Austria* | Between 2005 and 2008 the $CO_2$ IEF for electric arc furnaces varies<br>between 72 kg/t steel and 82 kg/t steel, thus being considerably higher than the average value used for the period 1990–2004. The ERT recommends that Austria validate the consistency of the time series and provide explanations for the high variation in the $CO_2$ IEF in its next annual submission. | Not resolved |
| *Belgium* | The description in the NIR of the method used to estimate iron and steel emissions is not transparent. The ERT reiterates the recommendation of the previous review report that Belgium improve the transparency of its reporting by enhancing the description of the method, AD and EFs, and include a discussion of the time-series consistency of the emission estimates in its next annual submission. | Resolved,<br>revision of the calculations and methods described for Flanders were provided. |
| *Denmark* | No recommendation for improvement for this source category in the latest review report. | No follow-up necessary |
| *Finland* | The ERT also noted that Finland reported that some streams of carbon stored had not been taken into account. Finland stated that EU ETS data found these streams to be very small, with an overall cumulative effect on emissions of less than 1 per cent of the plant's total emissions. Failing to take account of carbon stored is not consistent with the IPCC good practice guidance. The ERT recommends that Finland include carbon stored in the calculation of $CO_2$ emissions in its next annual submission. | Not resolved;<br>In its response to the draft annual review report, Finland informed the ERT that it will not be able to act upon the recommendation, as the resources needed for this task would be significant and resulting improvements in the accuracy of the emissions very minor, and much smaller than overall uncertainties in emissions from this category. |
| | The ERT noted that coke and steel production almost doubled from 1990 to 2008 and therefore recommends that Finland explain the increasing trend in its next annual submission. | Not resolved |
| *France* | No 2010 review report available at the time of the compilation of this NIR | |

| Member State | Review findings and responses related to 2.C.1 Iron and Steel Production | |
|---|---|---|
| | Comment in the latest UNFCCC review report | Status in 2011 submission |
| *Germany* | No 2010 review report available at the time of the compilation of this NIR | |
| *Greece* | Information justifying the time-series consistency of the EF for iron and steel production between the period 1990–1994 and the period 2005–2009, when EU ETS data were used, was not provided in the NIR. The ERT recommends that Greece provide this information in its next annual submission | Resolved |
| *Ireland* | No recommendation for improvement for this source category in the latest review report. | No follow-up necessary |
| *Italy* | No recommendation for improvement for this source category in the latest review report. | No follow-up necessary |
| *Luxembourg* | No recommendation for improvement for this source category in the latest review report. | No follow-up necessary |
| *Netherlands* | No 2010 review report available at the time of the compilation of this NIR | |
| *Portugal* | No recommendation for improvement for this source category in the report of the review of the initial report. [IRR] | No follow-up necessary |
| *Spain* | No 2010 review report available at the time of the compilation of this NIR | |
| *Sweden* | No 2010 review report available at the time of the compilation of this NIR | |
| *UK* | The ERT recommends that the United Kingdom provide information about relevant recalculations, QA/QC processes and verification in its next annual submission. | The ERT recommends that the United Kingdom provide information about relevant recalculations, QA/QC processes and verification in its next annual submission. |

*Sources: Review Report 2010 unless stated otherwise; NIR 2011 unless stated otherwise*

#### 4.2.3.2 Aluminium production and magnesium foundries

This category includes PFC and $SF_6$ emissions from aluminum production and magnesium foundries. Two PFCs, tetrafluoromethane (CF4), and hexafluoroethane (C2F6) are known to be emitted from the process of primary aluminum smelting. These PFCs are formed during the phenomenon known as the anode effect (AE), when the aluminum oxide concentration in the reduction cell electrolyte is low. In the magnesium industry, $SF_6$ is used as a cover gas in foundries to prevent oxidation of molten magnesium. It is assumed that all $SF_6$ used as cover gas is emitted to the atmosphere.

Table 4.45 summarizes information by Member State on emission trends for the key source PFCs from 2C3 Aluminium Production. PFC emissions from 2C3 Aluminium production account for 0.02 % of total EU-15 GHG emissions in 2009. Between 1990 and 2009, PFC emissions from this source decreased by 95 % (Table 4.45). Germany, Spain, UK and Italy are responsible for 79 % of these emissions in the EU-15. All Member States reduced their emissions from this source between 1990 and 2009. France, and the Netherlands had the largest decreases in absolute terms, in Austria, aluminium production ended in 1992. The decreasing trend of PFC emissions from this key source between 1990 and 2009 is due to production stop (AT, 90-92) or decline (DE, ES) and due to process improvements (FR, DE, ES, NL). The peak in 2002 is due to technological changes and not well optimized operations (NL, FR).

**Figure 4.11** **2C3 Aluminium Production: EU-15 PFC emissions**

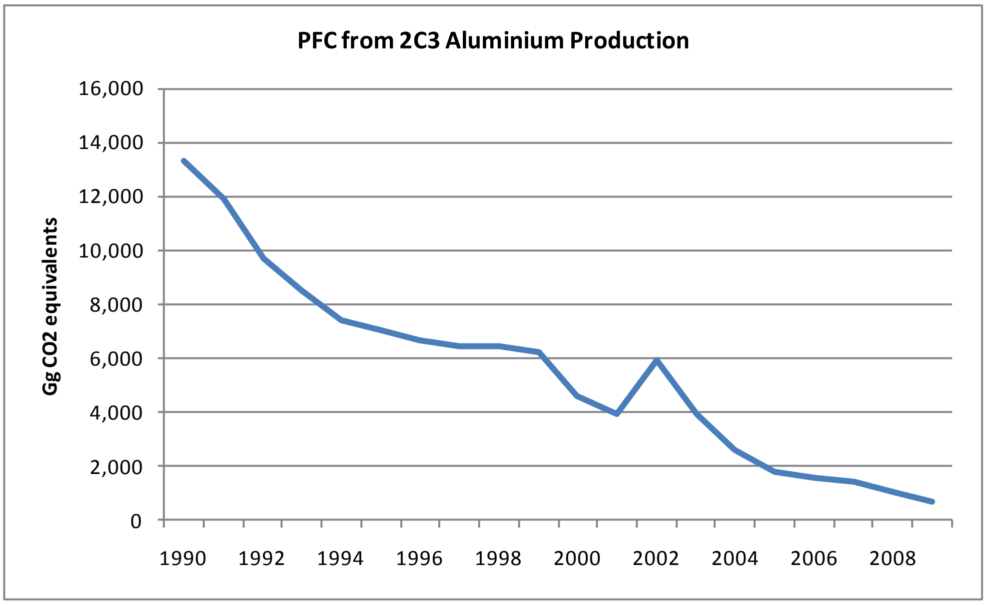



**Table 4.45** **2C3 Aluminium Production: Member States' contributions to PFC emissions and information on method applied, activity data and emission factor**

| Member State | PFC emissions (Gg $CO_2$ equivalents) | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg CO2 equivalents) | (%) | (Gg CO2 equivalents) | (%) | | |
| Austria | 1,050 | NO | NO | - | - | - | -1,050 | -100% | T3b | PS |
| Belgium | NO | NO | NO | - | - | - | - | - | NO | NO |
| Denmark | NO | NO | NO | - | - | - | - | - | NA | NA |
| Finland | NO | NO | NO | - | - | - | - | - | NA | NA |
| France | 3,032 | 85 | 29 | 4.2% | -57 | -66% | -3,003 | -99% | CR | PS |
| Germany | 2,489 | 247 | 247 | 36.5% | 0 | 0% | -2,242 | -90% | T3 | CS |
| Greece | 263 | 76 | 36 | 5.3% | -40 | -53% | -227 | -86% | T3 | PS |
| Ireland | NO | NO | NO | - | - | - | - | - | NA | NA |
| Italy | 1,673 | 111 | 146 | 21.5% | 35 | 31% | -1,528 | -91% | T1,T2 | PS |
| Luxembourg | NO | NO | NO | - | - | - | - | - | NA | NA |
| Netherlands | 2,246 | 72 | 43 | 6.3% | -29 | -40% | -2,203 | -98% | T1a | CS |
| Portugal | NE | NO | NO | - | - | - | - | - | NA | NA |
| Spain | 883 | 119 | 82 | 12.1% | -37 | -31% | -801 | -91% | T2 | PS |
| Sweden | 377 | 223 | 33 | 4.9% | -190 | -85% | -343 | -91% | T2 | CS |
| United Kingdom | 1,333 | 118 | 61 | 9.0% | -57 | -49% | -1,272 | -95% | CS | CS,PS |
| **EU-15** | **13,347** | **1,051** | **677** | **100.0%** | **-374** | **-36%** | **-12,670** | **-95%** | | |

Table 4.46 shows information on activity data and emission factors for PFC emissions from 2C Metal Production for 1990 to 2009. The table shows that in 2009 aluminium production was reported by all MS as activity data; for some MS this information is confidential. The implied emission factors for CF4 per tonne of aluminium produced vary for 2009 between 0.03 kg/t for the NL and IT, and 0.12 kg/t for Italy. The EU-15 IEF (excluding Greece, France and Spain) is 0.07 kg/t. The implied emission factors for C2F6 per tonne of aluminium produced vary for 2009 between less than 0.01 kg/t and 0.01 kg/t. The EU-15 IEF (excluding Greece, France and Spain) is 0.01 kg/t. The table suggests that for 2009 all reported emissions are estimated using higher tier methods (based on plant specific data). For 1990 Italy used a T1 approach to estimate emissions. The EU-15 IEFs generally decrease due to reduced durations and frequencies of the anode effects.

**Table 4.46** **2C Metal Production: Information on methods applied, activity data, emission factors for PFC emissions**

| Member State | Method applied | Emission factor | Gas | 1990 | | | | 2009 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Activity data | | Implied emission factor | Emissions | Activity data | | Implied emission factor | Emissions |
| | | | | Description | (kt) | (kg/t) | (t) | Description | (kt) | (kg/t) | (t) |
| Austria | T3b | PS | $CF_4$ | Aluminium production | 88 | 1.56 | 137 | Aluminium production | NO | NO | NO |
| | | | $C_2F_6$ | Aluminium production | 88 | 0.19 | 17 | Aluminium production | NO | NO | NO |
| France | CR | PS | $CF_4$ | Aluminium production | C | C | 369 | Aluminium production | C | C | 4 |
| | | | $C_2F_6$ | Aluminium production | C | C | 69 | Aluminium production | C | C | 0 |
| Germany | T3 | CS | $CF_4$ | Aluminium production | 740 | 0.45 | 336 | Aluminium production | 292 | 0.11 | 33 |
| | | | $C_2F_6$ | Aluminium production | 740 | 0.05 | 34 | Aluminium production | 292 | 0.01 | 3 |
| Greece | T3 | PS | $CF_4$ | Aluminium production | C | C | 35 | Aluminium production | C | C | 5 |
| | | | $C_2F_6$ | Aluminium production | C | C | 4 | Aluminium production | C | C | 1 |
| Italy | T1,T2 | PS | $CF_4$ | Aluminium production | 232 | 0.86 | 198 | Aluminium production | 166 | 0.12 | 19 |
| | | | $C_2F_6$ | Aluminium production | 232 | 0.18 | 42 | Aluminium production | 166 | 0.01 | 2 |
| Netherlands | T1a | CS | $CF_4$ | Aluminium production | 272 | 1.02 | 277 | Aluminium production | 166 | 0.03 | 5 |
| | | | $C_2F_6$ | Aluminium production | 272 | 0.18 | 48 | Aluminium production | 166 | 0.00 | 1 |
| Spain | T2 | PS | $CF_4$ | Aluminium production | C | C | 122 | Aluminium production | C | C | 12 |
| | | | $C_2F_6$ | Aluminium production | C | C | 10 | Aluminium production | C | C | 1 |
| Sweden | T2 | CS | $CF_4$ | Aluminium production | 96 | 0.56 | 54 | Aluminium production | 70 | 0.06 | 4 |
| | | | $C_2F_6$ | Aluminium production | 96 | 0.03 | 3 | Aluminium production | 70 | 0.01 | 1 |
| UK | CS | CS,PS | $CF_4$ | Aluminium production | 290 | 0.60 | 174 | Aluminium production | 254 | 0.03 | 8 |
| | | | $C_2F_6$ | Aluminium production | 290 | 0.08 | 22 | Aluminium production | 254 | 0.00 | 1 |
| **EU-15** | | | **$CF_4$** | **EU-15 w/o FR, GR; ES (97%)** | **1718** | **0.68** | **1176** | **EU-15 w/o FR, GR; ES (78%)** | **947** | **0.07** | **70** |
| | | | **$C_2F_6$** | **EU-15 w/o FR,GR, ES (98%)** | **1718** | **0.10** | **165** | **EU-15 w/o FR,GR, ES (83%)** | **947** | **0.01** | **8** |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

Table 4.47 provides key information on methods used for 2C3 by the EU15 Member States.

**Table 4.47** **2C3 Aluminium Production: Description of national methods used for estimating PFC emissions**

| **Member States** | **Description of methods** |
|---|---|
| *Austria* | PFC emissions were estimated using the IPCC Tier 3b methodology. The specific CF4 emissions (and C2F6 emissions respectively) of the anode effect were calculated by applying the following formula (BARBER 1996), (GIBBS & JACOBS 1996), (TABERAUX 1996):<br>kg CF4/tAl = (1.7 x AE/pot/day x F x AEmin)/CE<br>For the aluminium production in Austria the rate of C2F6 is about 8% and the current efficiency (CE) about 85.4%.<br>Activity data were taken from national statistics (1990 to 1992). Primary aluminium production in Austria was terminated in 1992. |
| *Belgium* | NO |
| *Denmark* | NO |
| *Finland* | NO |
| *France* | Deux types de technologies sont employées sur les sites, la plus ancienne, dénommée SWPB correspondant à une alimentation mécanisée sur les côtés des cuves, et la plus récente, dénommée PFPB correspondant à une alimentation ponctuelle automatique au centre de la cuve. Emission declarations from plants are used that follow a tier 2 approach . |
| *Germany* | The production figures for the year 20089were taken from the aluminium-industry monitoring report for the year 2009 [GDA, 2009]. Emission data is available for PFC emissions from primary aluminium foundries, thanks to a voluntary commitment on the part of the aluminium industry. Since 1997, the aluminium industry has reported annually on the development of PFC emissions from this sector. The measurement data is not published, but it is made available to the Federal Environmental Agency.<br>The measurements conducted in all German smelters in the years 1996 and 2001 form the basis for calculation of CF4 emissions. In this context, specific CF4 emission factors per anode effect were calculated, in keeping with the technology used. The number of anode effects is recorded and documented in the smelters. The total CF4 emissions were calculated by multiplying the total anode effects for the year by the specific CF4 emissions per anode effect determined in 2001. The total emission factor for CF4 is obtained by adding the CF4 emissions of the smelters and then dividing the sum by the total aluminium production of the smelters. C2F6 and CF4 occur in |

| Member States | Description of methods |
|---|---|
| | a constant ratio of about 1:10. The above-described method was applied to the entire time series, and the emissions for the years 1990 to 1996 were filled in via recalculations. |
| *Greece* | PFC emissions estimates are based on anode effect performance by calculating the anode effect overvoltage statistic (Overvoltage method). This methodology concerns measurements and recordings that are being performed concerning the parameters of the equation used for the CF4 emission's calculation, namely the overvoltage and the aluminium production process current efficiency. The estimations are provided directly by the plant to the inventory team. |
| *Ireland* | NO |
| *Italy* | For the estimation of PFC emissions from aluminium production, both IPCC Tier 1 and Tier 2 methods are used. These emissions, specifically CF4 and C2F6, have been calculated on the basis of information provided by national statistics (ENIRISORSE, several years; ASSOMET, several years) and the national primary aluminium producer (ALCOA, several years),, with reference to the document drawn up by the International Aluminium Institute (IAI, 2003) and the IPCC Good Practice Guidance (IPCC, 2000).<br>Tier 1 method has been used to calculate PFC emissions related to the entire period 1990-1999. The emission factors for CF4 and C2F6 were provided by the main national producer (ALCOA, 2004) based on the IAI document (IAI, 2003). PFC emissions for the period from the year 2000 result from the more accurate IPCC Tier 2 method, based on default technology specific slope factors and facility specific anode effect minutes. The EFs for PFCs were then calculated by ALCOA as weighted arithmetic mean values of EFs for the different technologies (IAI, 2003), the weights representing the technologies implemented. |
| *Luxembourg* | NO |
| *Netherlands* | PFC emissions from primary aluminium production reported by the two facilities are based on the IPCC Tier 2 method for the complete period 1990-2008. Emission factors are plant specific and are based on measured data. |
| *Portugal* | NO |
| *Spain* | Para el cálculo de las emisiones de PFC, se ha optado por utilizar el método de nivel 2 referido en la Guía de Buenas Prácticas 2000 IPCC en el epígrafe 3.3 (ecuación 3.10 y Box 3.3 "Tabereaux approach"). Para la aplicación de la fórmula anterior se han utilizado los valores por defecto de la variable "pendiente" (slope = 1,698 (p/CE)) de la Guía de Buenas Prácticas 2000 IPCC (epígrafe 3.3.1, tabla 3.9), y de la información sobre las variables "AEF" y "AED" facilitadas por las plantas productoras mediante un cuestionario específico diseñado al efecto, distinguiendo por planta y series el método de fabricación seguido (ánodos precocidos picado lateral o central y proceso Söderberg de agujas verticales). Dentro de cada serie se recibe información del número de efectos ánodos por cuba y día y de la duración en minutes del efecto ánodo. |
| *Sweden* | Tier 2: Activity data used for the PFC emission calculations, anode effects in min/oven day and production statistics, were provided by the company, and specified for the Prebaked and Söderberg processes. |
| *United Kingdom* | The estimates were based on actual emissions data provided by the aluminium-smelting sector. There are two main aluminium smelting operators in the UK. One operator uses a Tier 2 methodology Smelter-specific relationship between emissions and operating parameters based on default technology-based slope and over-voltage coefficients, using the default factors for the CWPB (Centre Worked Prebaked) plant. The other operator uses a Tier 3b methodology (as outlined in the IPCC guidance) Smelter-specific relationship between emissions and operating parameters based on field measurements. Emissions estimates were based on input parameters, including frequency and duration of anode effects, and number of cells operating. Emission factors were then used to derive the type of PFC produced. All emissions occur during manufacturing. These emissions were provided directly by the operators. |

*Source: NIR 2011 unless stated otherwise*

Table 4.48 summarizes the recommendations from the latest UNFCCC review of the inventory report in relation to the category 2C3 Aluminium Production. The overview shows that few recommendations were made, and some could be implemented.

**Table 4.48 2C3 Aluminium Production: Findings of the latest UNFCCC review of the inventory report in relation to PFC emissions and responses in 2011 inventory submissions**

| Member State | Review findings and responses related to 2.C.3 Aluminium Production | |
|---|---|---|
| | Comment in the latest UNFCCC review report | Status in 2011 submission |
| *Austria* | No recommendation for improvement for this source category in the latest review report. | No follow-up necessary |
| *Belgium* | No recommendation for improvement for this source category in the latest review report. | No follow-up necessary |
| *Denmark* | No recommendation for improvement for this source category in the report of the review of the initial report. | No follow-up necessary |
| *Finland* | No recommendation for improvement for this source category in the latest | No follow-up necessary |

| Member State | Review findings and responses related to 2.C.3 Aluminium Production | |
|---|---|---|
| | Comment in the latest UNFCCC review report | Status in 2011 submission |
| | review report. | |
| *France* | No 2010 review report available at the time of the compilation of this NIR | |
| *Germany* | No 2010 review report available at the time of the compilation of this NIR | |
| *Greece* | Greece does not report AD on aluminium production in the CRF tables, as the data are considered confidential. However, the ERT noted that data on primary aluminium production are reported to the United Nations Statistics Division and published in the United Nations Industrial Commodity Statistics (Yearbook and Database). The ERT recommends that the Party report in the CRF tables of its next annual submission publicly available data on aluminium production (e.g. from the United Nations Statistics Division or from the United States Geological Survey, referencing the data source used) to enable the assessment of the approximate level and trend of the IEFs for PFC emissions for crosscountry comparison and trend analysis. | Partly resolved, reasons for not including data in inventory given and alternative for QC check found. |
| *Ireland* | No recommendation for improvement for this source category in the latest review report. | No follow-up necessary |
| *Italy* | For this category, emissions were estimated using a variant of the tier 1 methodology for the period 1990–1999 and a tier 2 methodology for the period 2000–2008. The default EFs used in the tier 1 approach were from the 2003 Aluminium Sector Greenhouse Gas Protocol rather than from the IPCC good practice guidance. The previous ERT recommended that Italy explore whether historical operating data were available to extend the use of the tier 2 methodology in order to estimate emissions for the whole time series; Italy did this but the result was negative. In the case that such data are not available, the previous ERT recommended that Italy enhance the transparency of its inventory by adding more discussion on why the current approach to estimating these emissions is conservative, including a comparison of the IPCC default EFs and the EFs used by Italy for 1990. In addition, if Italy wishes to show that its time series is conservative by comparing it with a time series using another approach, the previous ERT recommended that Italy use default EFs from the IPCC good practice guidance for this alternate approach. According to its latest annual submission, Italy plans to follow these recommendations for its next submission. The ERT strongly recommends that Italy include the results in its next annual submission. | Resolved |
| *Luxembourg* | No recommendation for improvement for this source category in the latest review report. | No follow-up necessary |
| *Netherlands* | No 2010 review report available at the time of the compilation of this NIR | |
| *Portugal* | No recommendation for improvement for this source category in the report of the review of the initial report. | No follow-up necessary |
| *Spain* | No 2010 review report available at the time of the compilation of this NIR | |
| *Sweden* | No 2010 review report available at the time of the compilation of this NIR | |
| *UK* | No recommendation for improvement for this source category in the latest review report. | No follow-up necessary |

*Sources: Review Report 2010 unless stated otherwise; NIR 2011 unless stated otherwise*

Table 4.49 summarise information by Member State on emission trends and methodologies for the source category $SF_6$ from 2C Metal Production.

**Table 4.49** **2C-Aluminium and Magnesium Foundries: Description of national methods used for estimating $SF_6$ emissions**

| Member states | Description of methods |
|---|---|
| *Austria* | Emissions were estimated following the IPCC methodology using annual consumption data of $SF_6$.<br>Information about the amount of $SF_6$ used was obtained directly from the aluminium and mag-nesium producers in Austria and thus represents plant-specific data (for verification data was checked against data from $SF_6$ suppli-ers). Actual emissions of $SF_6$ equal potential emissions and correspond to the annual consumption of $SF_6$ for magnesium casting, by two companies that used $SF_6$ as fire-extinguishing cover gas until 2006. $SF_6$ has not been used in magnesium casting since 2006.<br>From the six secondary aluminium smelters only one stated the use of $SF_6$ as a cleaning gas from 2006 onwards. For these recent years an EF of 1.5% of $SF_6$ consumed was applied. This EF is based on measurements in a German aluminium plant that have shown significant destruction of $SF_6$ (decomposition into sulphur and fluo-rine) during the process. |
| *Belgium* | NO |
| *Denmark* | The emission of $SF_6$ has been decreasing in recent years due to the fact that activities under Magnesium Foundry no longer exist |
| *Finland* | Direct reporting method, Tier 1a. Tier 1b is not applicable to this category because all $SF_6$ used is imported in bulk. Emissions from this source are not reported separately due to confidentiality (Included in 2 F). |
| *France* | Les émissions de $SF_6$ sont déterminées par bilan matière à partir de l'estimation des consommations annuelles et de certaines informations communiquées par les industriels. Les quantités consommées sont considérées totale-ment relarguées à l'atmosphère. |
| *Germany* | Aluminium production: All of the $SF_6$ used in Germany to purify molten aluminium is emitted completely upon use (consumption = emission; EF = 1). The practice of assuming the equivalence between consumption (AR) and emissions conforms to the IPCC method (IPCC, 1996a: 2.34).<br>$SF_6$ consumption was determined via direct surveys, regarding sales, of the few providers of the $SF_6$-containing gas mixture. The survey for the report year 2000 revealed that the gas mixture has no longer been sold since 2000.<br>For the report year 2002, a first survey of gas providers' $SF_6$ sales figures was carried out, and these figures were compared with data obtained from a first survey of amounts consumed by industry. This made it possible to iden-tify $SF_6$ users, in the area of aluminium casting, who use pure $SF_6$. Since 2007, data on the sale of $SF_6$ gas are ob-tained from the central bureau of statistics.<br>Magnesium production: Until 2006, $SF_6$-input quantities have been determined via direct surveys of foundries' annual consumption levels. In 2006, thusly determined input data were cross-checked for the first time against sales quantities as determined via surveys of gas sellers in this sector. The described procedure has been applied to all report years other than 1996 and 1999, for which lacking yearly data was obtained via interpolation. Good agreement was found, and thus since then, data on gas sales are obtained from the central bureau of statistics. |
| *Greece* | NO |
| *Ireland* | NO |
| *Italy* | For $SF_6$ used in magnesium foundries, according to the IPCC Guidelines (IPCC, 1997), emissions are estimated from consumption data made available by the company (Magnesium products of Italy, several years), assuming that all $SF_6$ used is emitted. In 2007, $SF_6$ has been used partially, replaced in November by HFC 125, due to the enforcement of fluorinated gases regulation (EC, 2006). This regulation allows for the use of $SF_6$ in annual amounts less than 850 kg starting from 1 January 2008, that's why in 2008 $SF_6$ was still reported together with HFC125 emissions. HFC125 emissions have been reported in the CRF sector 2G OTHER. |
| *Luxembourg* | NO |
| *Netherlands* | NO |
| *Portugal* | NO |
| *Spain* | NO |
| *Sweden* | The total annual amount of $SF_6$ used in the magnesium foundries is reported as emissions, according to the IPCC Guidelines and Good Practice Guidance. Data is obtained from companies using $SF_6$. In Sweden, no $SF_6$ is used in aluminum foundries (CRF 2C4.1) as far as known, and thus reported as not occurring (NO). |
| *United Kingdom* | For magnesium alloy production, emissions from 1998-2008 were estimated based on the emission data reported by the company to the UK's Pollution Inventory. These data are considered reasonably robust whilst earlier data (pre-1998) are estimated based on consultation with the manufacturer. In 2004, for the first time, one of the main industry users has implemented a cover gas system using HFC134a as a cover gas for some of its produc-tion capacity. There has not been a complete switch to HFC 134a, although the operator is considering this on an ongoing basis depending on suitability for the different alloys produced. In addition to having a significantly lower GWP than $SF_6$ (and thus reducing emissions on a $CO_2$ equivalent basis), use of HFC134a is further advan-tageous in that a significant fraction of it is destroyed by the high process temperatures thus reducing the fraction of gas emitted as a fugitive emission. It is assumed 90% of the used HFC cover gas is destroyed in the process (CSIRO 2005). In 2008, for the first time, emissions of HFCs have been reported in the Pollution Inventory, and |

| Member states | Description of methods |
|---|---|
| | therefore this figure has been used for 2008. Note that actual emissions of $SF_6$ for this sector are reported for practical reasons under 2C5 'Other metal production'. This is because the CRF Reporter does not allow reporting of HFC emissions under the 2C4 sector category. |

#### 4.2.3.3 Other metal production

Table 4.50 provides an overview of all sources reported under 2C5 Other Metal Production by EU-15 Member States for the year 2009. Three Member States report emissions from silicium, magnesium or non-ferrous metals: the largest contributor to emissions is Sweden with 57 %.

**Table 4.50 2C5 Other: Overview of sources reported under this source category for 2009**

| Member State | 2.C.5 Other Metal Production | $CO_2$ emissions [Gg] | $CH_4$ emissions [Gg] | $N_2O$ emissions [Gg] | HFC emissions [Gg $CO_2$ equivalents] | PFC emissions [Gg $CO_2$ equivalents] | $SF_6$ emissions [Gg] | Total emissions [Gg CO2 equivalents] | Share in EU-15 Total |
|---|---|---|---|---|---|---|---|---|---|
| Austria | NA, NO | NA | NA | NA | NA,NO | NA,NO | NO | - | 0.0% |
| Belgium | NA | NO | NO | NO | NA,NO | NA,NO | NO | - | 0.0% |
| Denmark | NA, NO | NO | NO | NO | NA,NO | NA,NO | NO | - | 0.0% |
| Finland | Non-ferrous metals | 0.2 | NO | NO | NA,NO | NA,NO | NO | 0.2 | 0.1% |
| France | NA | NA | NA | NA | NA | NA | NA | - | 0.0% |
| Germany | Magnesium production | NA,NO | NA,NO | NA,NO | C,NA,NO | NA,NO | IE,NA,NO | - | 0.0% |
| Greece | NA, NO | NO | NO | NA | NA,NO | NA,NO | NA | - | 0.0% |
| Ireland | NA, NO | NO | NO | NO | NA,NO | NA,NO | NO | - | 0.0% |
| Italy | Magnesium Foundries | NA | NA | NA | NA | NA | NA | - | 0.0% |
| Luxembourg | NA | NA | NA | NA | NA | NA | NA | - | 0.0% |
| Netherlands | NA, NO | NO | NO | NO | NA,NO | NA,NO | NO | - | 0.0% |
| Portugal | NA, NO | NO | NO | NO | NA,NO | NA,NO | NO | - | 0.0% |
| Spain | Silicium production | 62.7 | NA | NA | NA | NA | NA | 63 | 17.5% |
| Sweden | Non-ferrous metals | 203.8 | NE,NO | NA,NO | NA,NO | NA,NO | NA,NO | 204 | 57.0% |
| UK | Non-ferrous metals | NO | NO | NO | 13.3 | NA,NO | 0.0033 | 91.2 | 25.5% |
| **EU-15 Total** | | **267** | **0** | **0** | **13** | **0** | **0.0033** | **358** | **100.0%** |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

### *4.2.4 Production of halocarbons and $SF_6$ (CRF Source Category 2E) (EU-15)*

Emissions related to the production of halocarbons as well as $SF_6$ are reported under this source category. This includes chemical by-products of processes related to the production of these substances that may be released into the atmosphere as well as fugitive emissions of the chemicals that occur during the production and distribution of the chemical.

Table 4.51 summarise information by Member State on emission trends for the key source HFCs from 2E Production of Halocarbons and $SF_6$.

**Table 4.51** **2E Production of Halocarbons and $SF_6$: Member States' contributions to total GHG and HFC emissions**

| Member State | GHG emissions in 1990 (Gg $CO_2$ equivalents) | GHG emissions in 2009 (Gg $CO_2$ equivalents) | HFC emissions in 1990 (Gg $CO_2$ equivalents) | HFC emissions in 2009 (Gg $CO_2$ equivalents) |
|---|---|---|---|---|
| Austria | NA, NO | NA,NO | NA | NA |
| Belgium | 3,313 | 121 | NO | NA,NO |
| Denmark | 0 | 0 | NO | NA,NO |
| Finland | 0 | 0 | NA,NO | NA,NO |
| France | 4,691 | 270 | 3,635 | 245 |
| Germany | 4,449 | 817 | 4,329 | 746 |
| Greece | 935 | 0 | 935 | NA,NO |
| Ireland | NA, NO | NA, NO | NA,NO | NA,NO |
| Italy | 605 | 0 | 351 | NA,NO |
| Luxembourg | 0 | 0 | NA,NO | NA,NO |
| Netherlands | 4,432 | 263 | 4,432 | 263 |
| Portugal | NE, NO | NE, NO | NE,NO | NA,NO |
| Spain | 2,403 | 483 | 2,403 | 483 |
| Sweden | 0 | 0 | NO | NA,NO |
| United Kingdom | 11,385 | 116 | 11,374 | 104 |
| **EU-15** | **32,211** | **2,070** | **27,459** | **1,841** |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

Table 4.52 provides information on the contribution of Member States to EU recalculations in HFC from 2E Production of Halocarbons for 1990 and 2008 and main explanations for the largest recalculations in absolute terms.

**Table 4.52** **2E Production of Halocarbons and $SF_6$: Contribution of MS to EU recalculations in HFC for 1990 and 2008 (difference between latest submission and previous submission in Gg of $CO_2$ equivalents and percent)**

| | 1990 | | 2008 | | Main explanations |
|---|---|---|---|---|---|
| | Gg CO2 equiv. | Percent | Gg CO2 equiv. | Percent | |
| Austria | 0 | 0.0 | 0 | 0.0 | |
| Belgium | 0 | 0.0 | 0 | 0.0 | |
| Denmark | 0 | 0.0 | 0 | 0.0 | |
| Finland | 0 | 0.0 | 0 | 0.0 | |
| France | 0 | 0.0 | 0 | 0.0 | |
| Germany | 4,329 | 100.0 | 425 | 100.0 | From the submission 2011 the so far confidential emissions of the production can be reported in 2E. But the producer requested to report the HFCs as unspecified mix. |
| Greece | 0 | 0.0 | 0 | 0.0 | |
| Ireland | 0 | 0.0 | 0 | 0.0 | |
| Italy | 0 | 0.0 | 0.01 | 100.0 | update of activity data |
| Luxembourg | 0 | 0.0 | 0 | 0.0 | |
| Netherlands | 0 | 0.0 | 0 | -0.1 | Improved sectoral and plant specific AD |
| Portugal | 0 | 0.0 | 0 | 0.0 | |
| Spain | 0 | 0.0 | 0 | 0.0 | |
| Sweden | 0 | 0.0 | 0 | 0.0 | |
| UK | 0 | 0.0 | 0 | 0.0 | |
| **EU-15** | **4,329** | **18.7** | **425** | **28.9** | |

HFC emissions from 2E1 By-Product Emissions account for 0.02 % of total EU-15 GHG emissions in 2009. In 2009 France, the Netherlands and Spain together account for 85 % of these emissions in the EU-15. Between 1990 and 2009, HFC emissions from this source decreased by 97 % (Table 4.53). The initial increase of emissions from 1990 to 1997 by 54 % is due to increased production in UK, Spain, Greece and the Netherlands. Since 1997 emissions decreased in nearly all Member States strongly; in UK due to the installation of thermal oxider pollution abatement equipments; in the Netherlands due to the installation of a thermal afterburner; in Spain due to the installation of a condensation equipment; and in Greece due to production stop in 2006. In contrast to the trend described above, emissions in France decreased already between 1990 and 1997 due to the installation of a thermal afterburner and remained stable since then.

**Figure 4.12 2E1 By-Product Emissions: EU-15 HFC emissions**

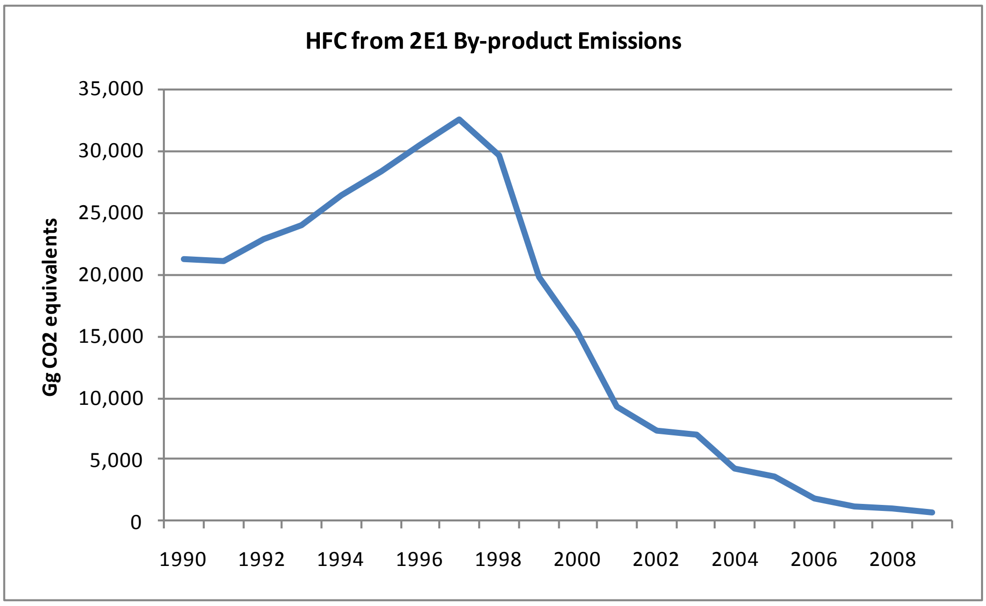



**Table 4.53 2E1 By-Product Emissions: Member States' contributions to HFC emissions and information on method applied, activity data and emission factor**

| Member State | HFC (Gg $CO_2$ equivalents) | | | Share in EU15 emissions | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg CO2 equivalents) | (%) | (Gg CO2 equivalents) | (%) | | |
| Austria | NA | NA | NA | - | - | - | - | - | NO | NO |
| Belgium | NO | NA,NO | NA,NO | - | - | - | - | - | CS | PS |
| Denmark | NO | NA,NO | NA,NO | - | - | - | - | - | NA | NA |
| Finland | NA,NO | NA,NO | NA,NO | - | - | - | - | - | NA | NA |
| France | 1,663 | 341 | 153 | 22.0% | -188 | -55% | -1,510 | -91% | CR | PS |
| Germany | C,NA | C,NA | C,NA | - | - | - | - | - | NA | NA |
| Greece | 935 | NA,NO | NA,NO | - | - | - | -935 | -100% | NA | NA |
| Ireland | NA,NO | NA,NO | NA,NO | - | - | - | - | - | NA | NA |
| Italy | 351 | NA,NO | NA,NO | - | - | - | -351 | -100% | CS | PS |
| Luxembourg | NA,NO | NA,NO | NA,NO | - | - | - | - | - | NA | NA |
| Netherlands | 4,432 | 212 | 154 | 22.1% | -58 | -27% | -4,278 | -97% | T2 | PS |
| Portugal | NE,NO | NA,NO | NA,NO | - | - | - | - | - | NA | NA |
| Spain | 2,403 | 330 | 286 | 41.0% | -45 | -14% | -2,118 | -88% | T2 | PS |
| Sweden | NO | NA,NO | NA,NO | - | - | - | - | - | NA | NA |
| United Kingdom | 11,374 | 126 | 104 | 15.0% | -21 | -17% | -11,269 | -99% | T2 | PS |
| **EU-15** | **21,158** | **1,009** | **697** | **100.0%** | **-312** | **-31%** | **-20,461** | **-97%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

Table 4.54 shows information on methods used for HFC emissions from 2E1 By-Product Emissions for 1990 and 2009. For 2E1 By-Product Emissions it is not possible to give an average IEF for the EU-15 because for most countries activity data is confidential. Except for Greece, all reported emissions are estimated with higher Tier methods. This means that for the latest inventory year (2009) all reported emissions are estimated using higher tier methods (based on plant specific data).

**Table 4.54 2E1 By-Product Emissions: Description of national methods used for estimating HFC emissions and abatements applied**

| Member States | Description of methods |
|---|---|
| *Austria* | NO |
| *Belgium* | NO |
| *Denmark* | NO |
| *Finland* | NO |
| *France* | Il existe un site en France, producteur de HCFC-22, émetteur de HFC-23. Les émissions ont été réduites de façon importante depuis 1992 après l'introduction d'un incinérateur.<br>Les émissions sont déterminées à partir d'une approche bottum-up à partir des données communiquées directement par les sites industriels conformément aux déclarations faites aux DRIRE/DREAL. Parmi les activités de la chimie du nucléaire, la réalisation d'électrolyses de HF occasionnent des émissions de fluor. Ces émissions sont neutralisées par des pots à soufre pour transformer le fluor en sous-produit $SF_6$ (neutre chimiquement). Ce procédé a été modifié fin 2006 afin de recycler le fluor : les émissions de $SF_6$ sont ainsi évitées. Les émissions sont communiquées annuellement par le site.<br>Les HFC sont distingués en fonction de leur composition et de leur provenance (i.e. « sous-produit » ou émission « directe »). Ces émissions sont communiquées par les contacts avec les sites concernés et les déclarations annuelles des rejets. Les émissions ont été considérablement réduites depuis 1990 suite à l'installation d'unités de traitement des produits fluorés par oxydation thermique dans les différentes usines. Seules les émissions résiduelles subsistent. De même que pour les HFC, les PFC sont distingués en fonction de leur origine. |
| *Germany* | Since 1995 emissions have been calculated (via mass balance) on the basis of the amount of H-CFC-22 produced, of annual measurements of HFC-23 concentrations in the facility's waste gas, of amounts of HFC-23 sold and of the amounts of HFC-23 delivered to the cracking facility; for the 1995 report year, emissions reduction measures (cracking facility) have been taken into account, as of the middle of the year, for the first production facility.<br>Since produced quantities of H-CFC are not reported, no emission factor can be determined and compared with the IPCC standard emission factor. The producer reports only emissions of HFC-23. These are reported in aggregated form, together with emissions from the CRF sub - source category 2.E.2, since they are confidential.<br>In 1995, in Frankfurt, a CFC cracking plant went into operation that cracks, at high temperature, excess HFC-23 produced during production of H-CFC-22 and that recovers hydrofluoric acid; i.e. no significant emissions are produced. HFC-23 produced at the second German production facility is captured in large amounts at the production system itself; the substance is then sold as a refrigerant or – following further distillative purification – as an etching gas for the semiconductor industry. |
| *Greece* | According to the IPCC Good Practice Guidance, the analytical methodology (Tier 2) should be applied for the calculation of HFC-23 emissions from HCFC-22 production, as it constitutes a key source. This methodology is based on the collection and elaboration of on site measurement data.<br>However, due to the lack of such data, calculation of emissions is based on production statistics and a reference emission factor. It should be noticed that data on the production of HCFC-22 are confidential and therefore are not presented in the current report. The reference emission factor used is suggested by the IPCC GPG. HFC-23 emissions from HCFC-22 manufacture do not occur since 2006, since the plant manufacturing HCFC-22 has stopped operating since. |
| *Ireland* | NO |
| *Italy* | For source category "By-product emissions", the IPCC Tier 2 method is used, based on plant-level data communicated by the national producer (Solvay, several years).<br>Also for source category "Fugitive emissions", emission estimates are based on plant- level data communicated by the national producer (Solvay, several years). [NIR 2011] |
| *Luxembourg* | NO |
| *Netherlands* | Production of HCFC-22(2E1): To comply with the IPCC Good Practice Guidance (IPCC, 2001) an IPCC Tier 2 method is used to estimate emission of this source category. HFC-23 emissions are calculated using both (measured) data on the mass flow of HFC23 produced in the process and a destruction factor to estimate the reduction of this HFC 23 flow by the thermal afterburner. |
| *Portugal* | NO |
| *Spain* | The information on HFC-23 emissions is based on the estimates made by the centres themselves, complemented |

| Member States | Description of methods |
|---|---|
| | for the years 1990-1998 by a default emission factor. Therefore, the estimation methodology applied in this case is a combination of Tier 1 and Tier 2 in the IPCC's terminology.<br>No se presenta aquí la información sobre variables de actividad y parámetros de proceso por ser de carácter confidencial al corresponder actualmente la propiedad de las plantas únicamente a dos empresas. Cabe asimismo mencionar que en una de las plantas existe un descenso de la emisión a partir del año 2001 debido a la construcción y puesta en servicio de una instalación para disminuir la emisión de HFC-23 mediante su compresión, condensación, licuación y almacenamiento. El HFC-23 licuado se carga en cisternas y se envía a un gestor exterior para su tratamiento. |
| *Sweden* | NO |
| *United Kingdom* | Within the model, manufacturing emissions from UK production of HFCs, PFCs and HFC 23 (by-product of HCFC 22 manufacture) are estimated from reported data from the respective manufacturers. Manufacturers have reported both production and emissions data, but only for certain years, and for a different range of years for different manufacturers.Therefore the emissions model is based on implied emission factors, and production estimates are used to calculate emissions in those years for which reported data was not available. Two of the three manufacturers were members of the UK greenhouse gas Emissions Trading Schemes. As a requirement of participation in the scheme, their reported emissions are verified annually via external and independent auditors. All three now report their emissions to the Environment Agency's Pollution Inventory and these reported emissions have been used to calculate total emissions in later years for two of the operating plant, where full speciated emissions data were provided by one of the operators for most of the time series. There is a significant decrease in HFC emissions in 1998/1999. This step-change in emissions is due to the installation of thermal oxider pollution abatement equipment at one of the UK manufacturing sites. Fugitive HFC emissions from both an HCFC22 plant and HFC manufacturing plant (run by the same operator) are treated using the same thermal oxidiser unit. Emissions also decrease in 2004, reflecting the installation of a thermal oxider at the second of the UK's HCFC22 manufacturing sites. This was installed in late 2003, and became fully operational in 2004. |

*Source: NIR 2011 unless stated otherwise*

Table 4.19 provides an overview of Member States' contributions to HFC emissions from sector 2E2, Fugitive Emissions. Only 3 Member States report emissions from this sector. Germany accounts for 72.1% of all emissions, Spain for 19.1%, and France for 8.9%.

**Table 4.55 2E2 Fugitive Emissions: Member States' contributions to HFC emissions and information on method applied, activity data and emission factor**

| Member State | HFC (Gg $CO_2$ equivalents) | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg CO2 equivalents) | (%) | (Gg CO2 equivalents) | (%) | | |
| Austria | NA | NA | NA | - | - | - | - | - | NA | NA |
| Belgium | NO | NA,NO | NA,NO | - | - | - | - | - | NA | NA |
| Denmark | NO | NA,NO | NA,NO | - | - | - | - | - | NA | NA |
| Finland | NA,NO | NA,NO | NA,NO | - | - | - | - | - | NA | NA |
| France | 1,972 | 105 | 92 | 8.9% | -13 | -13% | -1,880 | -95% | CR | PS |
| Germany | 4,329 | 425 | 746 | 72.1% | 321 | 75% | -3,583 | -83% | T3 | PS |
| Greece | NO | NA,NO | NA,NO | - | - | - | - | - | NA | NA |
| Ireland | NO | NA,NO | NA,NO | - | - | - | - | - | NA | NA |
| Italy | NO | 0 | NA,NO | - | - | - | - | - | NA | NA |
| Luxembourg | NO | NA,NO | NA,NO | - | - | - | - | - | NA | NA |
| Netherlands | NO | NA,NO | NA,NO | - | - | - | - | - | NA | NA |
| Portugal | NE | NA,NO | NA,NO | - | - | - | - | - | NA | NA |
| Spain | NA | 340 | 197 | 19.1% | -143 | -42% | - | - | T2 | PS |
| Sweden | NO | NA,NO | NA,NO | - | - | - | - | - | NA | NA |
| United Kingdom | NA | NA | NA | - | - | - | - | - | NA | NA |
| **EU-15** | **6,301** | **870** | **1,035** | **100.0%** | **164** | **19%** | **-5,266** | **-84%** | | |

Table 4.56 shows that only one Member State reports GHG emissions under 2E3 Other for the year 2009. The Netherlands include HFC emissions from handling activities, like repackage HFCs from large units (e.g. containers) into smaller units (e.g. Cylinders).

**Table 4.56 2E3 Other: Overview of sources reported under this source category for 2009**

| Member State | 2.E.3 Other | HFC emissions [Gg $CO_2$ equivalents] | PFC emissions [Gg $CO_2$ equivalents] | $SF_6$ emissions [Gg] | Total emissions [Gg CO2 equivalents] | Share in EU-15 Total | Information from NIR-2008 |
|---|---|---|---|---|---|---|---|
| Austria | NA | NA | NA | NA | - | 0.0% | |
| Belgium | Other non-specified | NA,NO | NA,NO | NO | - | 0.0% | |
| Denmark | Other non-specified | NA,NO | NA,NO | NO | - | 0.0% | |
| Finland | Other non-specified | NA,NO | NA,NO | NO | - | 0.0% | |
| France | Other non-specified | NA,NO | NA,NO | NA | - | 0.0% | |
| Germany | Other non-specified | NA,NO | C,NA,NO | NO | - | 0.0% | Includes confidential HFC emissions from 2E1 and 2E2 |
| Greece | Other non-specified | NA,NO | NA,NO | NO | - | 0.0% | |
| Ireland | Other non-specified | NA,NO | NA,NO | NO | - | 0.0% | |
| Italy | NA | NA | NA | NA | - | 0.0% | |
| Luxembourg | NA | NA | NA | NA | - | - | |
| Netherlands | Not specific attributable due to Confidential Bussiness Information | 109.1 | NA,NO | NO | 109.1 | 100.0% | 2E3 Handling activities: emissions of HFCs. There is one company in the Netherlands that repackage HFCs from large units (e.g. containers) into smaller units (e.g. Cylinders) and in addition trading with HFCs. Besides this company there are a lot of companies in the Netherlands which are importing small units with FCs and sell them in the trading areas. |
| Portugal | Other non-specified | NA,NO | NA,NO | NO | - | 0.0% | |
| Spain | NA | NA | NA | NA | - | 0.0% | |
| Sweden | Other non-specified | NA,NO | NA,NO | NO | - | 0.0% | |
| UK | Other non-specified | NA | NA | NA | - | 0.0% | |
| **EU-15 Total** | | **109** | **0** | **-** | **109** | **100.0%** | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

Table 4.57 summarizes the recommendations from the latest UNFCCC review of the inventory report in relation to the category 2E Production of Halocarbons.

**Table 4.57 2E Production of Halocarbons and $SF_6$: Findings of the latest UNFCCC review of the inventory report and responses in 2011 inventory submissions**

| Member State | Review findings and responses related to 2.E. Production of halocarbons and $SF_6$ | |
|---|---|---|
| | **Comment in the latest UNFCCC review report** | **Status in 2011 submission** |
| *Austria* | No recommendation for improvement for this source category in the latest review report. | No follow-up necessary |
| *Belgium* | No recommendation for improvement for this source category in the latest review report. | No follow-up necessary |
| *Denmark* | No recommendation for improvement for this source category in the latest review report. | No follow-up necessary |
| *Finland* | No recommendation for improvement for this source category in the latest review report. | No follow-up necessary |
| *France* | No 2010 review report available at the time of the compilation of this NIR | |
| *Germany* | No 2010 review report available at the time of the compilation of this NIR | |
| *Greece* | No recommendation for improvement for this source category in the latest review report. | No follow-up necessary |
| *Ireland* | No recommendation for improvement for this source category in the latest review report. | No follow-up necessary |

| Member State | Review findings and responses related to 2.E. Production of halocarbons and $SF_6$ | |
|---|---|---|
| | **Comment in the latest UNFCCC review report** | **Status in 2011 submission** |
| *Italy* | No recommendation for improvement for this source category in the latest review report. | No follow-up necessary |
| *Luxembourg* | No recommendation for improvement for this source category in the latest review report. | No follow-up necessary |
| *Netherlands* | No 2010 review report available at the time of the compilation of this NIR | |
| *Portugal* | No recommendation for improvement for this source category in the report of the review of the initial report. [IRR] | No follow-up necessary |
| *Spain* | No 2010 review report available at the time of the compilation of this NIR | |
| *Sweden* | No 2010 review report available at the time of the compilation of this NIR | |
| *UK* | No recommendation for improvement for this source category in the latest review report. | No follow-up necessary |

*Sources: Review Report 2010 unless stated otherwise; NIR 2011 unless stated otherwise*

### 4.2.5 Consumption of halocarbons and $SF_6$ (CRF Source Category 2F) (EU-15)

Emissions related to the consumption of Halocarbons (HFCs, PFCs) and Sulphur Hexafluoride ($SF_6$) are reported under this source category. These substances are serving as alternatives to ozone depleting substances (ODS) that are being phased out under the Montreal Protocol. The main applications for Halocarbons include refrigeration and air conditioning, fire suppression and explosion protection, aerosols, solvent cleaning, and foam blowing, as well as some other applications. Primary uses of $SF_6$ include gas insulated switch gear and circuit breakers, fire suppression and explosion protection, and other applications.

Table 4.58 summarises information by Member State on emission trends of total GHG emissions and for the two key sources (HFCs and $SF_6$) from 2F Consumption of Halocarbons and $SF_6$.

**Table 4.58** **2F Consumption of Halocarbons and $SF_6$: Member States' contributions to total GHG, HFC and $SF_6$ emissions**

| Member State | GHG emissions in 1990 (Gg $CO_2$ equivalents) | GHG emissions in 2009 (Gg $CO_2$ equivalents) | $SF_6$ emissions in 1990 (Gg $CO_2$ equivalents) | SF6 emissions in 2009 (Gg $CO_2$ equivalents) |
|---|---|---|---|---|
| Austria | 296 | 1,439 | 241 | 349 |
| Belgium | 546 | 1,901 | 103 | 96 |
| Denmark | 13 | 850 | 13 | 37 |
| Finland | 94 | 939 | 94 | 41 |
| France | 1,518 | 15,835 | 1,070 | 335 |
| Germany | 4,511 | 14,240 | 4,333 | 2,873 |
| Greece | 3 | 2,574 | 3 | 5 |
| Ireland | 36 | 632 | 35 | 65 |
| Italy | 213 | 8,632 | 213 | 389 |
| Luxembourg | 15 | 73 | 1 | 7 |
| Netherlands | 236 | 2,098 | 217 | 175 |
| Portugal | 0 | 1,116 | NE | 8 |
| Spain | 67 | 7,445 | 67 | 351 |
| Sweden | 87 | 987 | 84 | 53 |
| United Kingdom | 674 | 11,393 | 604 | 583 |
| **EU-15** | **8,310** | **68,476** | **7,080** | **5,368** |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

HFC emissions from 2F Consumption of Halocarbons and $SF_6$ account for 1.66 % of total EU-15 GHG emissions in 2009. HFC emissions in 2001 were 95 times higher than in 1990. The main reason for this is the phase-out of ozone-depleting substances such as chlorofluorocarbons under the Montreal Protocol and the replacement of these substances with HFCs (mainly in refrigeration, air conditioning, foam production and as aerosol propellants). France, Germany, UK, Spain and Italy had the most significant absolute increases from this source between 1990 and 2009.

$SF_6$ emissions from 2F Consumption of Halocarbons and $SF_6$ account for 0.15 % of total EU-15 GHG emissions in 2009. Between 1990 and 2009, $SF_6$ emissions from this source decreased by 23 %. Germany, France, UK, Austria and Spain are responsible for 84 % of total EU-15 emissions from this source. In absolute terms, Germany had also the most significant decreases from this source between 1990 and 2009.

Table 4.59 provides information on the contribution of Member States to EU recalculations in HFC from 2F Consumption of Halocarbons for 1990 and 2008 and main explanations for the largest recalculations in absolute terms.

**Table 4.59** **2F Consumption of halocarbons: Contribution of MS to EU recalculations in HFC for 1990 and 2008 (difference between latest submission and previous submission in Gg of $CO_2$ equivalents and percent)**

| | 1990 | | 2008 | | Main explanations |
|---|---|---|---|---|---|
| | Gg CO2 equiv. | Percent | Gg CO2 equiv. | Percent | |
| Austria | 0 | 0.0 | 0 | 0.0 | |
| Belgium | 4 | 0.8 | -3 | -0.1 | - As requested in the review process, the AD and EFs used to estimate emissions of HFC-32, HFC-125, HFC-134a, HFC-143a, HFC-152a and SF6 from refrigeration and air-conditioning equipment, foam blowing and electrical equipment, aerosols and semiconductors, as applicable, have been provided or enhanced, including for all past years. - The emissions of the semiconductor industry have been taken into account (with data for the years 2005-2009). |
| Denmark | 0 | 0.0 | 0 | 0.0 | |
| Finland | 0 | 0.0 | -1 | -0.1 | Error in the calculation of AD (gas banked in stocks) in the foam blowing sector corrected |
| France | 44 | 70.0 | -248 | -1.7 | Mise a jour de la méthodologie de par l'EMP |
| Germany | 0 | 0.0 | 0 | 0.0 | |
| Greece | 0 | 0.0 | 406 | 19.5 | Updated data due to recently published sectoral survey |
| Ireland | 0 | - | 0 | 0.0 | |
| Italy | 0 | 0.0 | 134 | 1.8 | New information on HFC-245fa. Moreover, update of HFC-134a consumption in mobile air conditioning and HFC-23 consumption in semiconductor manufacturing has occurred due to errors. |
| Luxembourg | -1 | -4.7 | -32 | -33.7 | The sector 2F was completely revised following a new study (see ARR 2009, para 72 & 73). AD and parameters are based on country-specific data, and where no such data was available, AD was estimated based on Belgian data. The situation for F-Gases in Luxembourg is very similar to the one in Belgium, and due to the very strong economic relations with Belgium, most of the F-gases used in Luxembourg are sold by belgian companies. More details are given in the NIR. |
| Netherlands | 0 | 0.0 | -34 | -2.0 | Improved sectoral and plant specific AD |
| Portugal | 0 | 0.0 | 5 | 0.5 | AD update. |
| Spain | 0 | 0.0 | 825 | 14.8 | Revision of the activity data according to new information provided by one of the main fire extinction operating plants. Additionally, the activity data for other fire extinction operating plant has been revised after detecting an error in the estimates of the fluorinated gases consumed |
| Sweden | 0 | 0.0 | -5 | -0.5 | Due to one year lag of updating the data from the Product Register, reported emission is updated |
| UK | 0 | 0.1 | -391 | -3.5 | Changes to refrigeration model following peer review. Allocation of fluids between commercial and industrial changed. |
| **EU-15** | **47** | **7.8** | **656** | **1.1** | |

Table 4.60 provides information on the contribution of Member States to EU recalculations in $SF_6$ from 2F Consumption of Halocarbons for 1990 and 2008 and main explanations for the largest recalculations in absolute terms.

**Table 4.60 2F Consumption of halocarbons and $SF_6$: Contribution of MS to EU recalculations in $SF_6$ for 1990 and 2008 (difference between latest submission and previous submission in Gg of $CO_2$ equivalents and percent)**

| | 1990 | | 2008 | | Main explanations |
|---|---|---|---|---|---|
| | Gg CO2 equiv. | Percent | Gg CO2 equiv. | Percent | |
| Austria | 0 | 0.0 | 1 | 0.4 | Update of activity data. |
| Belgium | 20 | 23.3 | 2 | 2.9 | EF and AD revised as requested in the review process. The emissions of the semiconductor industry have been taken into account (with data for the years 2005-2009). |
| Denmark | 0 | 0.0 | 0 | 0.0 | |
| Finland | 0 | 0.0 | 0 | 0.0 | |
| France | -6 | -0.6 | -14 | -3.2 | |
| Germany | 0 | 0.0 | -241 | -7.9 | - Improvement of the calculation model for double glaze windows.<br>- Recaclulation because of new Informations from solar industry |
| Greece | 0 | 0.0 | 0 | 0.0 | |
| Ireland | 0 | 0.0 | 0 | 0.0 | |
| Italy | 0 | 0.0 | 1 | 0.3 | Update due to an error |
| Luxembourg | -2 | -61.2 | 3 | 63.5 | The sector 2F was completely revised following a new study (see ARR 2009, para 72 & 73). AD and parameters are based on country-specific data, and where no such data was available, AD was estimated based on Belgian data. The situation for F-Gases in Luxembourg is very similar to the one in Belgium, and due to the very strong economic relations with Belgium, most of the F-gases used in Luxembourg are sold by belgian companies. More details are given in the NIR. |
| Netherlands | 0 | 0.0 | -38 | -17.0 | Improved sectoral and plant specific AD |
| Portugal | 0 | 0.0 | 0 | -2.8 | AD update. |
| Spain | 0 | 0.0 | 0 | 0.0 | |
| Sweden | 0 | 0.0 | 0 | 1.1 | Due to one year lag of updating the data from the Product Register, reported emission is updated |
| UK | 0 | 0.0 | 0 | 0.0 | |
| **EU-15** | **11** | **0.2** | **-285** | **-4.9** | |

Table 4.61 shows the sub-categories of HFC emissions from 2F Consumption of Halocarbons and $SF_6$ by Member State. It shows that 2F1 Refrigeration and Air Conditioning Equipment is by far the largest sub-category accounting for 78 % of HFC emissions in this source category; 2F4 Aerosols/Metered Dose Inhalers and 2F2 Foam Blowing account for 12% and 4 % respectively.

**Table 4.61** **2F Consumption of Halocarbons and $SF_6$: Member States' sub-categories of HFC emissions for 2009 (Gg $CO_2$ equivalents)**

| Member State | Consumption of Halocarbons and $SF_6$ | Refrigeration and Air Conditioning Equipment | Foam Blowing | Fire Extinguishers | Aerosols/ Metered Dose Inhalers | Solvents | Other applications using ODS substitutes | Semiconductor Manufacture | Electrical Equipment | Other (please specify) |
|---|---|---|---|---|---|---|---|---|---|---|
| Austria | **1,056** | 994 | 30 | 10 | 19 | NO | NO | 2 | NO | NA,NO |
| Belgium | **1,801** | 1,620 | 96 | 12 | 72 | NO | NO | 1 | NO | NA,NO |
| Denmark | **799** | 683 | 96 | NO | 18 | NO | NO | NO | NO | 3 |
| Finland | **889** | 799 | 7 | C,NO | 80 | NO | NO | C,NA,NO | NO | 2 |
| France | **15,188** | 10,671 | 593 | 128 | 3,433 | 356 | NO | 8 | NO | NA,NO |
| Germany | **11,186** | 9,982 | 731 | 14 | 452 | C,NO | NO | 8 | NO | C,NA,NO |
| Greece | **2,569** | 2,354 | 37 | 39 | 139 | NA,NO | NO | NO | NO | NA,NO |
| Ireland | **501** | 353 | 28 | 23 | 94 | NO | NO | 3 | NO | NA,NO |
| Italy | **8,171** | 7,144 | 478 | 146 | 398 | NO | NO | 6 | NO | NA,NO |
| Luxembourg | **66** | 61 | 2 | NO | 3 | NO | NO | NO | NA | NA,NO |
| Netherlands | **1,798** | 1,489 | IE | NO | IE | NO | NO | NO | NO | 309 |
| Portugal | **1,108** | 1,053 | 49 | 6 | 1 | NO | NO | NO | NO | NA,NO |
| Spain | **6,878** | 4,697 | 62 | 1,980 | 139 | NA | NA | NA | NA | NA |
| Sweden | **932** | 861 | 40 | 6 | 25 | NO | NO | NO | NA | NA,NO |
| UK | **10,734** | 7,360 | 288 | 202 | 2,784 | 95 | NA | IE | IE | 6 |
| **EU-15** | **63,676** | **50,122** | **2,535** | **2,564** | **7,657** | **451** | **0** | **26** | **0** | **320** |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

Table 4.62 shows MS contribution to EU-15 HFC emissions from the two most important sub-sources 2F1 and 2F4.

**Table 4.62** **2F1 Refrigeration and Air conditioning: Member States' contributions to HFC emissions and information on method applied, activity data and emission factor**

| Member State | HFC (Gg $CO_2$ equivalents) | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg CO2 equivalents) | (%) | (Gg CO2 equivalents) | (%) | | |
| Austria | 2 | 993 | 994 | 2.0% | 1 | 0% | 992 | 56371% | CS | CS |
| Belgium | 79 | 1,527 | 1,620 | 3.2% | 93 | 6% | 1,541 | 1960% | T2 | CS,PS,D |
| Denmark | NA,NE | 730 | 683 | 1.4% | -48 | -7% | 683 | - | M,CS | M,CS |
| Finland | 0 | 902 | 799 | 1.6% | -103 | -11% | 799 | 6343045% | T2 | D |
| France | 83 | 10,016 | 10,671 | 21.3% | 656 | 7% | 10,588 | - | M | CS,D |
| Germany | NA,NO | 9,578 | 9,982 | 19.9% | 404 | 4% | 9,982 | - | T2 | CS,D |
| Greece | NO | 2,264 | 2,354 | 4.7% | 91 | 4% | 2,354 | - | T2 | D |
| Ireland | IE,NO | 378 | 353 | 0.7% | -25 | -7% | 353 | - | T1,T3 | CS |
| Italy | NO | 6,574 | 7,144 | 14.3% | 570 | 9% | 7,144 | - | CS | CS |
| Luxembourg | 0 | 59 | 61 | 0.1% | 2 | 3% | 61 | 2359039% | CS | CS |
| Netherlands | IE,NA | 1,421 | 1,489 | 3.0% | 68 | 5% | 1,489 | - | T2 | CS |
| Portugal | NE | 981 | 1,053 | 2.1% | 72 | 7% | 1,053 | - | T2 | D,CS |
| Spain | NA | 4,349 | 4,697 | 9.4% | 348 | 8% | 4,697 | - | T1,T2 | T1,T2 |
| Sweden | 3 | 827 | 861 | 1.7% | 34 | 4% | 858 | 33732% | CS,T2 | CS,D |
| UK | NO | 7,118 | 7,360 | 14.7% | 243 | 3% | 7,360 | - | T3 | CS |
| **EU-15** | **166** | **47,717** | **50,122** | **100.0%** | **2,405** | **5%** | **49,956** | **30081%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

In 2009, HFC emissions from 2F1 were about 300 times higher than in 1990 (Table 4.62). France, Germany, Italy and the UK are responsible for 70% of total EU-15 emissions from this source. Between 2008 and 2009 EU-15 emissions increased by 5 %. The largest increase of HFC emissions from 2F1 between these years was in Italy. Finland, Denmark and Ireland reported decreasing emissions from this source in the latest years.

**Figure 4.13** **2F1 Refrigeration and Air conditioning: EU-15 HFC emissions**

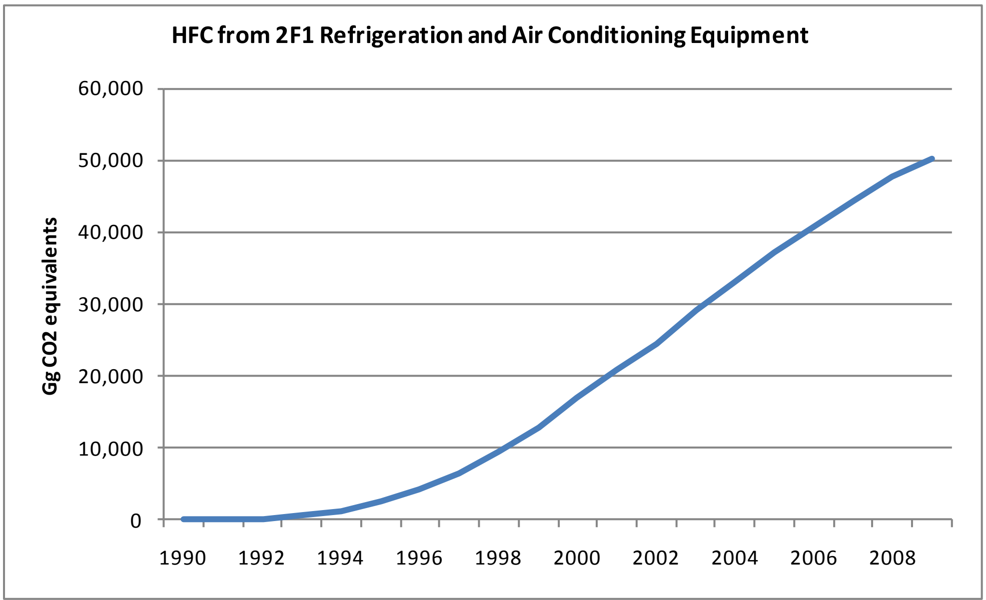



**Table 4.63** **2F3 Fire extinguishers: Member States' contributions to HFC emissions and information on method applied, activity data and emission factor**

| Member State | HFC (Gg $CO_2$ equivalents) | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg CO2 equivalents) | (%) | (Gg CO2 equivalents) | (%) | | |
| Austria | NO | 10 | 10 | 0.4% | 0 | 2% | - | - | 0.0 | 0.0 |
| Belgium | 1 | 12 | 12 | 0.5% | 0 | 1% | 12 | 2231% | 0.0 | 0.0 |
| Denmark | NO | NO | NO | - | - | - | - | - | NA | NA |
| Finland | NO | C,NO | C,NO | - | - | - | - | - | NA | NA |
| France | NO | 126 | 128 | 5.0% | 2 | 2% | - | - | CR,T2 | CS |
| Germany | NO | 12 | 14 | 0.2% | 2 | 13% | - | - | CS | CS,D |
| Greece | NA,NO | 35 | 39 | 0.5% | 3 | 9% | - | - | CS | D |
| Ireland | 0 | 20 | 23 | 0.9% | 3 | 14% | 23 | 10405% | T3 | CS |
| Italy | NO | 131 | 146 | 5.7% | 15 | 12% | - | - | CS | CS |
| Luxembourg | NO | NO | NO | - | - | - | - | - | NA | NA |
| Netherlands | NO | NO | NO | - | - | - | - | - | NA | NA |
| Portugal | NE | 6 | 6 | 0.2% | 0 | 0% | - | - | 0.0 | 0.0 |
| Spain | NA | 1,837 | 1,980 | 77.2% | 143 | 8% | - | - | T1,T2 | D |
| Sweden | NA | 8 | 6 | 0.2% | -2 | -26% | - | - | CS | CS |
| UK | NO | 200 | 202 | 7.9% | 2 | 1% | - | - | T2 | CS |
| **EU-15** | **1** | **2,396** | **2,564** | **100.0%** | **169** | **7%** | **2,564** | **348667%** | | |

In 2009, HFC emissions from 2F3 Table 4.63 increased by 7% compared to 2008 – and by 348 667% compared to 1990. The biggest contributors to this sector are Spain (77%), France (5%), and Italy (5.7%), those three countries account for 87.5% of the share in EU15 emissions in this sector. Only Sweden reported a decrease in emissions (-26%) compared to 2008.

**Table 4.64** **2F4 Aerosols/ Metered Dose Inhalers: Member States' contributions to HFC emissions and information on method applied, activity data and emission factor**

| Member State | HFC (Gg $CO_2$ equivalents) | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg CO2 equivalents) | (%) | (Gg CO2 equivalents) | (%) | | |
| Austria | 22 | 23 | 19 | 0.3% | -4 | -15% | -3 | -12% | CS | D |
| Belgium | 39 | 72 | 72 | 0.9% | 1 | 1% | 33 | 85% | T1,T2 | D |
| Denmark | NA,NE,NO | 19 | 18 | 0.2% | -1 | -5% | 18 | - | M,CS | M,CS |
| Finland | NA,NO | 77 | 80 | 1.0% | 2 | 3% | 80 | - | T2 | D |
| France | NO | 3,523 | 3,433 | 44.8% | -90 | -3% | 3,433 | - | CR,T2 | CS |
| Germany | C,NO | 492 | 452 | 5.9% | -40 | -8% | 452 | - | CS,T2 | CS,D |
| Greece | NO | 142 | 139 | 1.8% | -3 | -2% | 139 | - | T2 | D |
| Ireland | 0 | 93 | 94 | 1.2% | 1 | 1% | 94 | 1456481% | T1,T2 | CS |
| Italy | NO | 341 | 398 | 5.2% | 57 | 17% | 398 | - | CS | CS |
| Luxembourg | 2 | 3 | 3 | 0.0% | 0 | 7% | 1 | 76% | 0.0 | 0.0 |
| Netherlands | NO | IE | IE | - | - | - | - | - | NA | NA |
| Portugal | NE | 1 | 1 | 0.0% | 0 | -19% | 1 | - | RA | CS |
| Spain | NA | 138 | 139 | 1.8% | 1 | 1% | 139 | - | D | D |
| Sweden | 1 | 26 | 25 | 0.3% | 0 | -1% | 24 | 1852% | CS,T2 | D |
| UK | 12 | 2,876 | 2,784 | 36.4% | -92 | -3% | 2,772 | 23455% | T2 | CS |
| **EU-15** | **76** | **7,824** | **7,657** | **100.0%** | **-167** | **-2%** | **7,581** | **9975%** | | |

In 2009, HFC emissions from 2F4 were more than 100 times higher than in 1990 (Figure 4.14). France and UK are responsible for 81 % of total EU-15 emissions from this source. Between 2008 and 2009 EU-15 emissions decreased by 2 %. The relative decrease between these years was largest in Austria and Portugal, the biggest increase was reported in Italy (Table 4.66).

**Figure 4.14** **2F4 Aerosols/Metered Dose Inhalers: EU-15 HFC emissions**

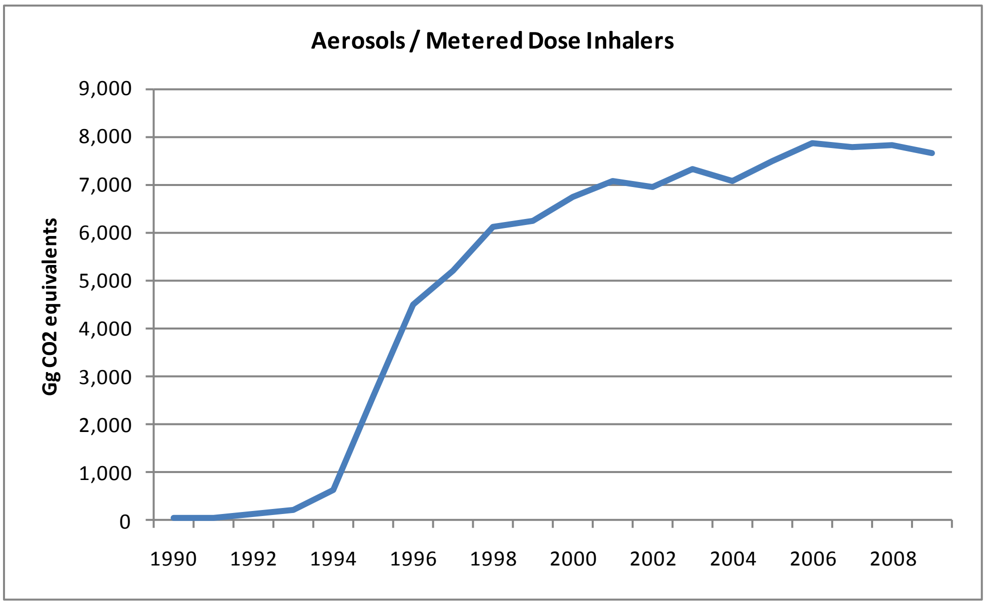


Table 4.65 provide descriptions on methods used for estimating HFC, PFC and $SF_6$ emissions from 2F Consumption of Halocarbons and $SF_6$.

Table 4.65 **2F Consumption of halocarbons and $SF_6$: General description of national methods used for estimating emissions**

| Member States | Description of methods |
|---|---|
| *Austria* | A study was contracted out to determine the consumption data and emissions from 1990–2000 for all uses of FCs (UMWELTBUNDESAMT 2001b). In this study, bottom up data for consumption per sector were compared with top-down data from importers and retailers of FCs as well as with data from the national statistics (import/export statistics). The sub-category 2.F.2 Foam blowing was re-evaluated in a new contracted study (OBERNOSTERER et al 2004). Austrian estimates of emissions from the sources 2.F.4 Aerosols and 2.F.5 solvents are based on a European evaluation of emissions from this sector (HARNISCH & SCHWARZ 2003), subsequently disaggregated to provide a top-down Austrian estimate. For the years 2000-2008 a second study (LEISEWITZ & SCHWARZ 2010) was contracted in order to conduct a complete survey of all F-gas uses and emission sources. In this study equally a combined bottom-up top-down approach was used. Data about consumption of HFC, PFC and $SF_6$ were determined from the following sources:<br>data from national statistics<br>data from associations of industry<br>direct information from importers and end users<br>Since 2004 there is also a reporting obligation under the Austrian FC-regulation for users of FCs in the following applications: refrigeration and air-conditioning, foam blowing, semiconductor manufacture, electrical equipment, fire extinguishers and aerosols.<br>Emissions for all subcategories were estimated using a country specific methodology, emission factors are based on information of experts from the respective industries. For most sources emissions are calculated from annual stocks using emission factors. |
| *Belgium* | Emissions of fluorinated greenhouse gases are mainly estimated on the basis of the consumption of the different substances for each application, the consumption of products containing such substances, figures on external trade in substances or products containing substances, as well as on emission modelling by application and assumptions on leakage rates. |
| *Denmark* | The data for emissions of HFCs, PFCs, and $SF_6$ has been obtained in continuation on work on inventories for previous years. The determination includes the quantification and determination of any import and export of HFCs, PFCs, and $SF_6$ contained in products and substances in stock form. This is in accordance with the IPCC-guideline (IPCC (1997), vol. 3, p. 2.43ff) as well as the relevant decision trees from the IPCC Good Practice Guidance (GPG, IPCC (2000) p. 3.53ff).<br>For the Danish inventories of F-gases basically a Tier 2 bottom up approach is used. As for verification using import/export data a Tier 2 top down approach is applied. In an annex to the F-gas inventory report 2008 (DEPA, 2010), there is a specification of the approach applied for each sub-source category. The following sources of information have been used:<br>Importers, agency enterprises, wholesalers, and suppliers<br>Consuming enterprises, and trade and industry associations<br>Recycling enterprises and chemical waste recycling plants<br>Statistics Denmark<br>Danish Refrigeration Installers' Environmental Scheme (KMO)<br>Previous evaluations of HFCs, PFCs, and $SF_6$<br>Suppliers and/or producers provide consumption data of F-gases. Emission factors are primarily defaults from GPG, which are assessed to be applicable in a national context. |
| *Finland* | Detailed sector-specific approach. Emissions from each category are quantified using 2 or 3 different methods given in IPCC GPG (2000). |
| *France* | IPCC Tier 2 |
| *Germany* | Detailed CS approach (Tier 2). |
| *Greece* | In order to obtain a reliable estimation of F-gases emissions, collection of detailed data for all activities mentioned above (e.g. number of refrigerators, type and amount of refrigerant used by each market label, substitutions of refrigerants that took place the late years etc.) is required. The availability of official data in Greece is limited and, therefore, the estimations presented hereafter involve the application of country specific methodologies. In order to resolve any remaining completeness issues, and given the fact that there has not been<br>any opposite indication for the use of the PFCs in Fire Extinguishers and f-gases in Solvent Uses<br>up to now,in September 2010 Greece has decided to use information from inventories of<br>neighbouring countries. To this end, the inventory of Italy has been used, on the grounds that the<br>climatic and socio-economic conditions between Greece and Italy are quite similar. |
| *Ireland* | Emission calculation based on special studies by sub-contractors |
| *Italy* | Methodology used is IPCC Tier 2a, except for $SF_6$ emissions from electrical equipment (2F7), where it is IPCC |

| Member States | Description of methods |
|---|---|
| | Tier 3c. The IPCC Tier 1a method has been used to calculate potential emissions, using production, import, export and destruction data provided by the national producer (Solvay, several years; ST Microelectronics, several years; MICRON, several years). As regard PFC potential emissions, since no production occurs in Italy, export has been reasonably assumed negligible, whereas import correspond to consumption of PFCs by semiconductor manufactures, that use these substances. |
| *Luxembourg* | Emission estimates for the years 1996 to 1999, 2001 to 2004 and 2006 have been calculated with the respective trends 1995-2000, 2000-2005 and 2005-2010. The emissions from 1990 to 1994 are assumed to be equal to 1995 emissions since trend calculations are not possible for those years (it would actually lead to negative values). A re-evaluation of the emission sources and the emissions of HFCs, PFCs and $SF_6$, taking into account the 2000 IPCC-GPG Guidelines as well as country specific considerations, is ongoing. [NIR 2008] |
| *Netherlands* | To comply with the IPCC Good Practice Guidance (IPCC, 2001) IPCC Tier 2 methods are used to estimate emissions of the sub-sources Stationary refrigeration, Mobile airconditioning, Aerosols, Foams and Semiconductor manufacturing. The country-specific method for the source Electrical equipment is equivalent to the IPCC Tier 3 method and the country-specific methods for the sources Sound-proof windows and Electron microscopes are equivalent to IPCC Tier 2 methods. |
| *Portugal* | For those sources with sufficient available data, actual emissions where estimated with a Tier 2 (advanced or actual method) approach which is considered Good Practice in accordance with GPG. This approach allows the quantification of emissions in the year in which they actually occurred accounting for the time lag between consumption and emissions. On the contrary, the Tier 1, or potential approach, allocates emissions in the year that the chemical is sold into a particular end-user. As a general rule, bottom-up methodologies were used, and thus overall methodology should be classified as Tier 2a. This approach departs from the knowledge of the number of equipments using Fluorinated compounds and estimates emissions to atmosphere from charge (amount of chemical used in the equipment), service life, emission rate during the various periods of the equipment life and possible recovery of emissions. Whenever possible emission estimates include:<br>- assembly emissions - when equipment is first filled76; - operation emissions - occurring during equipment lifetime or usage and resulting mainly from leaks; - disposal emissions - the remaining charge that is released to the atmosphere at end of equipment life and where the remaining charge is neither recycled or destroyed. |
| *Spain* | No general description, see sub-category specific descriptions |
| *Sweden* | In estimating the actual emissions, as far as possible, a Tier 2 approach has been used. A model is used for calculating the actual emissions. Changes in accumulated amounts each year resulting from additional amounts of HFC, PFC and $SF_6$ imported and used within the country, as well as the decline in accumulated stock caused by exports or emissions from operating systems, have been taken into consideration.<br>Potential emissions: Data on bulk imports and exports are obtained from the Products register hosted by the Swedish Chemicals Inspectorate, which did not register these substances until 1995. Estimates of potential emissions for imports and exports were, however, made for all years in the time series, 1990-2004 in a special study in 2005. The method of estimating potential emissions for 2005 was made accordingly. |
| *United Kingdom* | No general description, see sub-category specific descriptions |

*Source: NIR 2011 unless stated otherwise*

Table 4.66 provide descriptions on methods used for estimating HFC emissions from 2F1 Refrigeration and Air-Conditioning Equipment.

**Table 4.66 2F1 Refrigeration and Air-conditioning equipment: Description of national methods used for estimating HFC emissions**

| Member States | Description of methods |
|---|---|
| *Austria* | See also General description of national methods used for estimating emissions from Consumption of halocarbons and $SF_6$.<br>Refrigeration and Air Conditioning: Consumption data was obtained directly from the most important importers, retailers and service companies of refrigerants. The stocks of the different subcategories were estimated using information from the most important refrigerant retailers/ importers and experts from the refrigeration branch. |
| *Belgium* | For the refrigeration sector, emissions have been estimated separately for the following source categories: industrial and commercial installations, household refrigerators, air conditioning of private cars, air conditioning of buses and coaches, and refrigerated transport. In accordance with the IPCC guidelines, the assembly emissions, the operation emissions and the disposal emissions are being determined separately. The assembly emissions are calculated as a function of the estimated amount charged into new systems and the percentage assembly losses, the operation emissions as a function of the amount stocked in existing systems and assumptions on annual leakage rates, and the disposal emissions in function of the amount in systems at time of disposal and the estimated recovered fraction.<br>An annual inquiry is made on the consumption of the major F-gas containing product manufacturers, among which the 4 car manufacturers. These data are used for calculating the potential emissions as well as the assembly emissions. |

| Member States | Description of methods |
|---|---|
| | Industrial and commercial "installations" represent all on-site assembled systems for industrial & commercial refrigeration as well as stationary air-conditioning applications, which is the largest single source of F-gas emissions. The consumption and emission of refrigerants are modelled on the basis of an annual inquiry among refrigerant distributors on their national supply by refrigerant mixture, as well as on assumptions on average loss rates, from which the estimated supply for refilling vehicles is subtracted. No distinction is made between industrial refrigeration, commercial refrigeration and air conditioning installations, as it is not possible to disaggregate the consumption data between these sub-sectors, because of the presence of intermediary wholesalers, and the fact that no inventory of installations is available.<br><br>The refrigerant consumption and emissions of the transportation sector are estimated by modelling the evolution of the vehicle stock, on the basis of the number of new vehicle registrations and of the percentage of new vehicles equipped with air conditioning., by category of vehicles (cars, buses and coaches).<br><br>The emissions from refrigerated transport are calculated on the basis of the annual number of new registrations of refrigerated trucks and trailers by gross / net weight categories, the average quantity of refrigerant (by type of refrigerant) contained in each vehicle (by vehicle category) and emission factors taken from the literature. |
| *Denmark* | See General description of national methods used for estimating emissions from Consumption of halocarbons and $SF_6$.<br><br>In case of commercial refrigerants and Mobile Air Condition (MAC), national emission factors are defined and used. Import/export data for sub-source categories where import/export is relevant (MAC, fridge/freezers for household) are quantified on estimates from import/export statistics of products + default values of the amount of gas in the product. The estimates are transparent and described in the annex to the report referred to above. |
| *Finland* | Refrigeration and air conditioning (CRF 2.F.1)<br><br>Top-down Tier 2, Tier 1a, Tier 1b<br><br>The Tier 2 top-down method is used for all sources in this category, both stationary and mobile. Data are not collected for separate subcategories because such statistics are either not available or the preparation of such statistics would entail a very high reporting burden on companies. There is also some evidence that simpler questionnaires lead to better response activity. HFC-23 emissions from this source are not reported separately due to confidentiality. |
| *France* | IPCC Tier 2. Les émissions de HFC sont déterminées à l'aide du modèle « RIEP » développé par l'Ecole des Mines de Paris qui utilise une méthode de rang 2 du GIEC avancée. |
| *Germany* | IPCC Tier 2a. This category is divided into the sub-categories of household refrigeration, commercial refrigeration, transport refrigeration, industrial refrigeration, stationary air-conditioning systems and room air-conditioners, and mobile air-conditioning systems. In Germany, the leading pure-HFC refrigerants are HFC-134a and the mixtures 404A and 507A.<br><br>For calculation of HFC emissions from the sub-categories of refrigeration and stationary airconditioning systems, individual data are collected, or refrigerant models used. Any refrigerant models used are described in connection with the relevant method. The emission factors used are the result of surveys of experts. The emission factors for waste disposal are the standard values from the IPCC Guidelines of 1996. For some sub - source categories, disposal emissions occurred for the first time in 2003. |
| *Greece* | Refrigeration and air-conditioning:<br><br>F-gases emissions are estimated according to the Tier 2a methodology described in the IPCC Good Practice Guidance. It is a bottom-up approach based on detailed equipment data and emission factors representing various types of leakage per equipment category. It should be noted that the application of the Tier 1 methodology (calculation of potential emissions based on imports, exports and domestic consumption of each gas) and Tier 2b is not possible, as the available information is not reported in the way required by these methodologies.<br><br>Total emissions are calculated as the sum of assembly emissions, operation emissions that include annual leakage from equipment stock in use as well as servicing emissions and disposal emissions that include the amount of refrigerant released from scrapped systems. |
| *Ireland* | In terms of stationary refrigeration data on the quantities of industrial gases supplied to the refrigeration sector is obtained from chemical suppliers and manufacturers of refrigeration units. Sales data is provided for a range of HFCs and blends corresponding to the individual HFC species. A bottom-up approach is not feasible for estimating actual emissions from stationary refrigeration and air conditioning in Ireland due to the lack of data available on equipment types and HFC sales data into equipment sub-categories. Therefore emissions are estimated using a top-down approach based on reported sales data and information on market shares, which are applied to calculate estimates of total HFC sales into the Irish stationary refrigeration and air-conditioning sectors.<br><br>Emissions of HFCs from sub-category 2.IIA.F.1.6 Mobile Air-Conditioning are estimated using a Tier 3b bottom-up analysis which utilises national vehicle fleet statistics from the Department of the Environment, Heritage and Local Government and assumed rates of airconditioning unit penetration in the national vehicle fleet. The methodology used takes account of vehicle lifetime, the percentage of vehicles having HFC in their air-conditioning systems, average charge per unit, product manufacturing emissions, effective lifetime leakage rates (incorporating emissions from normal operating losses and accidental releases arising from collision damage) and decommissioning losses. |
| *Italy* | Refrigeration and air-conditioning: IPCC Tier 2a<br><br>Basic data and have been supplied by industry: specifically, for the mobile air conditioning equipment the na- |

| Member States | Description of methods |
| --- | --- |
| | tional motor company and the agent's union of foreign motor-cars vehicles have provided the yearly consumptions; for the other air conditioning equipment the producer supply detailed table of consumption data by gas.<br><br>Losses rates have been checked with industry and they are distinguished by domestic equipment, small and large commercial equipment, industrial chillers, mobile air conditioning equipment. Refrigeration activities, such as commercial, transport, industrial and other stationary, are all reported under domestic refrigeration because no detailed information is available to split consumptions and emissions in the different sectors. Anyway appropriate losses rates have been applied for each gas taking in account the equipment where refrigerants are generally used. Therefore implied product life factors, especially for HFC 134a, result from the weighted average of different losses rates, from 0.7% for domestic refrigeration to 10% for large chillers. |
| *Luxembourg* | Emissions from stationary refrigeration and the mobile air conditioning are based on a new study, but no information for stationary refrigeration is provided in the NIR. The refrigerant consumption and emissions of the transportation sector are estimated by modelling<br><br>the evolution of the vehicle stock, on the basis of the number of new vehicle registrations and<br><br>of the percentage of new vehicles equipped with air conditioning., by category of vehicles (cars,<br><br>buses and coaches). Emissions from refrigerated transport are calculated using reported emissions by Germany expressed per capita with the relative population in Luxembourg. [NIR 2011] |
| *Netherlands* | See General description of national methods used for estimating emissions from Consumption of halocarbons and $SF_6$. |
| *Portugal* | CFC, HCFC and F-Gases emissions from operation and disposal of Domestic Refrigeration Equipments, Commercial Refrigeration (non domestic Refrigeration Equipments), transport refrigeration equipments, Stationary and Industrial Air conditioning equipments and Mobile Air Conditioning were estimated using the bottom-up approach (Tier 2a or actual method) as proposed in chapter 3.7.4 of the GPG. F-Gases emissions for each particular compound were estimated from total Refrigeration Fluid emissions and considering the percentage of F-Gas use in total Refrigeration Fluid use in each year.<br><br>The stock of domestic refrigeration equipments was estimated from the number of households and from the percentage of households with refrigeration equipments, available for years 1990, 1995 and 2000, according to an unpublished report from INE.From year 2000 onward the percentage of equipments per household was forecasted by APA based on gross domestic product behaviour. The number of households refers to INE-Family Survey.<br><br>There are no available national statistics concerning the number and dimension of non-domestic refrigeration equipments used in commerce, industry, tourism, services and institutional activities. A survey to Hotels, Hostels and Camping Parks was conducted with the support of "Turismo de Portugal, ip" and "AHP – Associação da Hotelaria de Portugal", in order to obtain real data concerning the number and dimension of non-domestic refrigeration equipments. Data pertaining to other commerce and services activities was estimated with the technical support of APIRAC, Importers and DGE (Enterprise and Industry General Directorate). Calculations for Hypermarkets were made separately.<br><br>Estimates for Road Transportation and Railways were made separately. The number of light vehicles with MAC was estimated from the total number of light vehicles sold each year, using the same information used to establish the time series of car sales and fleet in chapter 1A3, and the percentage of new cars sold with MAC at each yearwas estimated according to data provided by manufacturers. |
| *Spain* | Para estos sectores se ha contado con información suministrada para algunos años por las asociaciones empresariales del frío y climatización y, por lo que respecta a su uso en la industria de automoción, con información obtenida vía cuestionario a las plantas de fabricación de automóviles. Para los equipos estacionarios de refrigeración y climatización, el equipo de trabajo del inventario ha extendido las tasas de variación interanual para<br><br>completar los últimos años de la serie al no haberse podido disponer de otra información en esta edición del inventario. La información para el desglose según tamaños (pequeños o stand-alone y medios/grandes) de los equipos de refrigeración comercial, se ha tomado de un estudio sectorial sobre equipamiento de las superficies comerciales, clasificadas según tipología y tamaño, y que contenía datos sobre metros lineales de equipos de refrigeración. Los factores de emisión son, por lo que respecta a la producción nacional de automóviles, datos derivados de la información de cuestionarios a las plantas fabricantes, y para los demás sub-sectores se han tomado de las guías de IPCC. |
| *Sweden* | See also General description of national methods used for estimating emissions from Consumption of halocarbons and $SF_6$.<br><br>Refrigeration and air conditioning equipment: Input data for the calculation of actual emissions consists of information from various sources. For heat pumps, air conditioning, mobile air conditioning, refrigeration and freezing equipment, the equipment producers and importers were contacted and have provided information of varying quality. Estimates have been checked with trade associations (KYS and SVEP) and with experts at the Swedish EPA (Ujfalusi, Bernekorn, Björsell). The information on refrigerant-related imported amounts of fluorinated gases from the Products register is compared to calculations made in the model, based on assumptions and information from other sources. |
| *United Kingdom* | The calculation methodology within the model is considered to provide a relatively conservative approach to the estimation of emissions.The bank of fluid is estimated by considering the consumption of fluid in each sector, together with corrections for imports, exports, disposal and emissions.Once the size of the bank in a given year is known, the emission can be estimated by application of a suitable emission factor.Emissions are also estimated from the production stage of the equipment and during disposal.The methodology corresponds to the IPCC Tier |

| Member States | Description of methods |
|---|---|
| | 2 -'bottom-up'- approach.Data are available on the speciation of the fluids used in these applications; hence estimates were made of the global warming potential of each fluid category.<br><br>Emissions from the domestic refrigeration sector were estimated based on a bottom-up approach using UK stock estimates of refrigerators, fridge-freezers, chest-freezers and upright freezers from the UK Market Transformation Programme (MTP, 2002). For the commercial and industrial refrigeration sub-sectors, emission estimates are now based on refrigerant fluid sales data, from the British Refrigeration Association. This allowed the previous estimates within the model to be verified against real data, and adjusted accordingly. Emissions of HFCs from mobile air conditioning systems were also derived based on a bottom-up analysis using UK vehicle statistics obtained from the UK Society of Motor Manufacturers and Traders, and emission factors determined in consultation with a range of stakeholders. A full account of the assumptions and data used to derive emission estimates for the MAC sub-sector is in AEAT (2004) and AEA (2008). |

*Source: NIR 2011 unless stated otherwise*

Table 4.67 provides an overview of all sources reported under 2F9 Other by EU-15 Member States for the year 2009. The largest contributor to emissions is Germany with 54 %. Most Member States report emissions from double glaze windows in this source category.

**Table 4.67 2F9 Other: Overview of sources reported under this source category for 2009**

| Member State | 2.F.9 Other | HFC emissions [Gg $CO_2$ equivalents] | PFC emissions [Gg $CO_2$ equivalents] | $SF_6$ emissions [Gg] | Total emissions [Gg $CO_2$ equivalents] | Share in EU-15 Total |
|---|---|---|---|---|---|---|
| Austria | Double glaze windows, Research and other use | NA,NO | NA,NO | 0.0103 | 246.7 | 6.0% |
| Belgium | Double glaze windows | NA,NO | NA,NO | 0.0035 | 83.4 | 2.0% |
| Denmark | Double glaze windows, Laboratories, Fibre optics | 2.8 | 6.3 | 0.0009 | 31.2 | 0.8% |
| Finland | Grouped confidential data | 2.3 | 1.1 | 0.0012 | 31.8 | 0.8% |
| France | Shoes application, Closed application, Open application | NA,NO | 187.3 | NO | 187.3 | 4.6% |
| Germany | Car Tyres, Shoes, Trace gas, Double glaze windows, Coating, AWACS maintenance, Optical Glass Fibre, Solar Technology, Welding | C,NA,NO | C,NA,NO | 0.0936 | 2,237.4 | 54.4% |
| Greece | NA,NO | NA,NO | NA,NO | NO | - | 0.0% |
| Ireland | Medical Applications, Tracer in Leak Detection, Double glaze windows, Sporting goods | NA,NO | NA,NO | 0.0004 | 8.9 | 0.2% |
| Italy | NA,NO | NA,NO | NA,NO | NO | - | 0.0% |
| Luxembourg | Noise reduction windows | NA,NO | NA,NO | 0.0002 | 5.8 | 1,801.6 |
| Netherlands | No specific allocation due to confidentiality of data | 308.9 | 125.2 | 0.0073 | 609.3 | 14.8% |
| Portugal | NA,NO | NA,NO | NA,NO | NO | - | 0.0% |
| Spain | NA | NA | NA | NA | - | 0.0% |
| Sweden | Shoes, Double glaze windows | NA,NO | NA,NE,NO | 0.0003 | 7.7 | 0.2% |
| UK | Semiconductors, Electrical and production of trainers, One Component Foams, Gibraltar F Gas Emissions | 6.0 | 72.3 | 0.0244 | 661.6 | 16.1% |
| **EU-15 Total** | | **320** | **392** | **0.1422** | **4,111** | **100.0%** |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

Table 4.68 summarise information by Member State on emission trends, methodologies, emission factors and activity data for the key source $SF_6$ from 2F9 Other sources of $SF_6$. The emission trend is mainly driven by the emission trend in Germany.

**Figure 4.15** **2F9 Other: EU-15 $SF_6$ emissions**

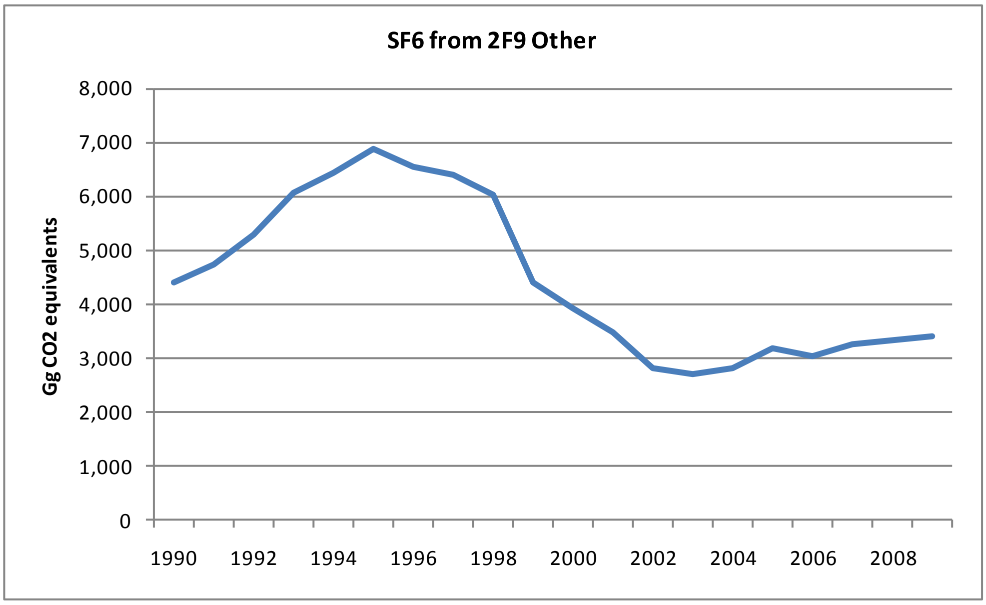



**Table 4.68** **2F9 Other: Member States' contributions to $SF_6$ emissions and information on method applied, activity data and emission factor**

| Member State | SF6 emissions (Gg CO2 equivalents) | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg CO2 equivalents) | (%) | (Gg CO2 equivalents) | (%) | | |
| Austria | 127 | 250 | 247 | 7.3% | -3 | -1% | 120 | 95% | CS | CS |
| Belgium | 84 | 76 | 83 | 2.5% | 7 | 9% | 0 | 0% | 0.0 | 0.0 |
| Denmark | 12 | 15 | 22 | 0.7% | 7 | 43% | 10 | 85% | 0.0 | 0.0 |
| Finland | 8 | 26 | 29 | 0.8% | 2 | 8% | 21 | 262% | T1,T2 | D |
| France | 118 | NO | NO | - | - | - | -118 | - | NA | NA |
| Germany | 3,211 | 2,136 | 2,237 | 65.8% | 101 | 5% | -974 | -30% | CS | CS,D |
| Greece | NO | NO | NO | - | - | - | - | - | NA | NA |
| Ireland | 13 | 9 | 9 | 0.3% | 0 | 1% | -5 | -34% | NA | NA |
| Italy | NO | NO | NO | - | - | - | - | - | NA | NA |
| Luxembourg | 1 | 5 | 6 | 0.2% | 0 | 7% | 5 | 909% | 0.0 | 0.0 |
| Netherlands | 217 | 186 | 175 | 5.2% | -11 | -6% | -42 | -19% | CS,T2 | D,PS |
| Portugal | NE | NO | NO | - | - | - | - | - | NA | NA |
| Spain | NA | NA | NA | - | - | - | - | - | NA | NA |
| Sweden | 2 | 8 | 8 | 0.2% | 0 | 0% | 5 | 211% | CS | CS,D,PS |
| United Kingdom | 604 | 623 | 583 | 17.2% | -39 | -6% | -21 | -3% | OTH,T3 | CS,OTH |
| **EU-15** | **4,396** | **3,335** | **3,399** | **100.0%** | **64** | **2%** | **-997** | **-23%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

Table 4.69 provide descriptions on methods used for estimating $SF_6$ emissions from 2F Consumption of Halocarbons and $SF_6$.

**Table 4.69** **2F6-2F9 Consumption of halocarbons and $SF_6$: Description of national methods used for estimating $SF_6$ emissions**

| Member States | Description of methods |
|---|---|
| *Austria* | Semiconductors: All consumption data and data about actual emissions from semiconductor manufacture are based on direct information from industry. Because of the confidentiality claimed for consumption data in this industry emissions are reported in the CRF only for the sum of HFC and PFC. Emissions are calculated according to the formula presented below:<br><br>Emissions = Consumption*(1-emission control technology) * efficiency factor * uptime<br><br>Typical ranges of these parameters are: for emission control technology 0.01 – 0.95, for efficiency factor 0.75-0.95, and for uptime 0.9. The emission control technology applied is high temperature combustion and elution of HF with typical efficiencies of 65-95% for latest years..<br><br>Electrical Equipment: Information on $SF_6$ stocks in electrical equipment in 2003-2007 was obtained from energy suppliers and industrial facilities. The EFop of HV- and MV-GIS correspond to the default emission factors of the IPCC GL 2006 with 0.7% (HV) and 0.1% (MV) per year, respectively. Manufacturing emissions from first filling were estimated to 1% according to reported data, the EFdisp is assumed to equal 2%.<br><br>Noise insulating windows: Activity data were estimated based upon information from experts from industry. Approximately one-third of the total amount of $SF_6$ used for filling of the double glass windows is released during assembly. For the stock of gas remaining inside the window (bank), an annual leakage rate of 1 percent is assumed. At the end of the lifetime, about 75% of the initial stock remains and is lost by disposal. As of 2003, the Austrian F-gas regulation stopped by legal prohibition the usage of $SF_6$ as filling gas for soundproof glazing.. Emissions at disposal became relevant in 2005, because the average life time is estimated to be 25 years and the first $SF_6$ filled windows were introduced in Austria in 1980. They are calculated by assuming that the remaining quantity of $SF_6$ in windows produced in 1980 is emitted this year.<br><br>Tyres: $SF_6$ used as filling gas for tyres was supplied by only one $SF_6$ importer, who reported on the amount of $SF_6$ sold to the Austrian tyre and automotive trade. Due to the Austrian F-gas regulation this use has been legally prohibited. According to IPCC GL 2006 it is assumed that $SF_6$ completely emits from car tyres with their disposal three years after filling. Filling emissions are regarded to be insignificant. Consumption of $SF_6$ and disposal emissions three years later are identical.<br><br>Shoes: Shoes with F-gas cusions are not manufactured in Austria but imported. As no import data for Austria are available, 10% of the German market were taken for estimation, due to the comparability of the market and the size of the country. Operating emissions during the use of the footwear are not considered. The lifetime of shoes is estimated to be 3 years. At disposal, 100% of the initial filling is released to the atmosphere (i.e. EFdisp= 100%). Emissions of year 3 are treated to be equal to the amount of F-gas in sport shoes put on the market the year n-3.<br><br>Research: Manufacturers and operators provided the number of devices operating in Austria. Data on filling<br><br>volume and refilling have been collected from the institutions and companies operating the equipment, from manufacturers and from service companies. The annual F-gas consumption (first filling of new products) is very small (order of kg) and reached about 400 kg only during one year. The stock is for all years below 1 t. The implied EF is in the order of 6%, but there is a wide difference between the several types of equipment. |
| *Belgium* | The $SF_6$ emissions originating from the production and the stock of soundproof double-glazing are calculated from the $SF_6$ consumption data, which have been obtained from the main manufacturers. The stock of $SF_6$ contained in existing glazing in Belgium is evaluated on the basis of a balance between production, import and export of this glazing , as well as emissions from the stock, over the years. From information obtained from the double glazing producers we assessed a specific export rate for each of them. The import of acoustic double glazing was estimated to be around 10% of the Belgian consumption. The emission rate of glazing from the bank is assumed to be 1% /year, as previously. The emission from production of acoustic double glazing is assumed to be 33% of the $SF_6$ consumption. The disposal emissions are based on an assumed unique lifetime of 25 years.<br><br>$SF_6$ emissons from the electricity sector are based on stock and emission factor data obtained from the SYNERGRID association. |
| *Denmark* | See also General description of national methods used for estimating emissions from Consumption of halocarbons and $SF_6$. |
| *Finland* | Electrical equipment (CRF 2.F. 8) Tier 3c (country-level mass-balance), Tier 1b<br><br>Tier 1a estimates can not be calculated for this source because of lack of historical data. Tier 1b estimates have been calculated, however, based on survey and emissions data, cf. section 3.1 of Oinonen (2003).<br><br>Running shoes (CRF 2.F. 9) Method for adiabatic property applications, Tier 1b<br><br>Tier 1a is not applicable to this category because all $SF_6$ used is imported not in bulk, but in products (i.e. shoes). Emissions from this source are not reported separately due to confidentiality. The emissions from running shoes ended in 2007. |
| *France* | IPCC Tier 2.<br><br>Fabrication de semi-conducteurs (2F7) : Les émissions de PFC, HFC-23 et $SF_6$ sont calculées selon la méthode de rang 2c du GIEC à partir des consommations de gaz déclarées par les sites.<br><br>Equipements électriques (2F8) : La méthode de calcul distingue les émissions à la charge des équipements à |

| Member States | Description of methods |
|---|---|
| | l'usine selon les quantités déclarées par les industriels à leur syndicat et les émissions du parc installé estimées par EDF qui distingue les fuites à l'usage, la maintenance et la fin de vie. |
| *Germany* | Semiconductor manufacture: The emissions cannot be determined solely on the basis of input quantities (sales by gas vendors), because the difference between consumption and emissions depends on a number of factors, including only partial chemical transformation in plasma reactors and the effects of downstream exhaust-gas-scrubbing systems. Furthermore, a residue of approximately 10 % per gas bottle must be taken into account as non-consumption. During the etching process, only about 15 % of the added CF4 react chemically. The emission factor, an inverse reaction quota, thus amounts to 85 % of the CF4 consumption.<br><br>Electrical equipment: The emissions figures are based largely on a mass balance. Increasingly, they are also being combined with emission factors for sub-areas in which the technical measurement limits for mass-balancing have been reached or in which mass-balancing would necessitate unreasonably high costs. The methods used are based on the new "2006 IPCC Guidelines for National Greenhouse Gas Inventories; Volume 3", Chapter 8. For further information, the reader is referred to "Tier 3, Hybrid Life-Cycle Approach" in sub-chapter 8.2.<br><br>Noise insulating windows: The EF production is 33 %, with respect to new annual consumption. The emission factor Euse of 1 % with respect to the average $SF_6$ stocks that have accumulated since 1975 and that are in place in year n. Disposal losses are incurred at the end of windows' service lifetimes (utilization periods), or an average of 25 years after being filled.<br><br>Tyres and Shoes: The emissions are calculated using equation 3.23 of IPCC-GPG (2000). |
| *Greece* | Electrical equipment<br><br>The available information is not sufficient in order to apply the methodologies suggested by the IPCC Good Practice Guidance. In the context of the present inventory emissions are estimated on the basis of information provided by PPC regarding losses in the transmission and in the distribution system. The data provided cover the period 1995 – 2008. Emissions estimates are being performed on the basis of the quantity of $SF_6$ consumed during the year, by the Directorate of Strategy and Planning of the PPC. Emissions for the period 1990 – 1994 are estimated (by the inventory team) by mean of a linear extrapolation. |
| *Ireland* | Semiconductor manufacture: There are two main semiconductor manufacturers in Ireland, both of which provide data on the annual use and estimated emissions of HFCs, PFCs and $SF_6$ in their plants over the full time series 1990-2008<br><br>Electrical equipment: The Electricity Supply Board (ESB) is the owner of both the high and low voltage distribution systems and the owner and operator of the medium and lower voltage distribution systems in Ireland. The company has supplied an estimate of $SF_6$ emissions from their equipment using a Tier 1 approach based on an analysis of opening and closing stocks of $SF_6$.<br><br>Other Emission Sources (2.F.9): This category includes emissions of $SF_6$ from minor uses within Ireland including emissions from double glazed windows, medical applications, sporting goods and as a gas-air tracer in leak detection. |
| *Italy* | $SF_6$ emissions from electrical equipment have been estimated according to the IPCC Tier 2a approach from 1990 to 1994, and IPCC Tier 3c from 1995. $SF_6$ leaks from installed equipment have been estimated on the basis of the total amount of sulphur hexafluoride accumulated and average leakage rates; leakage data published in environmental reports have also been used for major electricity producers (ANIE, several years). Additional data on $SF_6$ used in high voltage gas insulated transmission lines have been supplied by the main energy distribution companies. |
| *Luxembourg* | F7 – Electrical Equipment: A country specific methodology is applied: Emissions= EF● AR; The activity rate (AR) is the estimated installed capacity with the total nameplate capacity from the largest operator in Luxembourg. The yearly emissions are assumed to be 1% of the activity rate, i.e. EF=0.01.<br><br>F8 – Noise reduction windows: A country specific methodology is applied: Emissions= EF● AR; The activity rate (AR) is the calculated $SF_6$ stock on the basis of the estimated installed noise reduction windows. The yearly emissions are assumed to be 1% of the activity rate, i.e. EF=0.01. [NIR 2008] |
| *Netherlands* | See General description of national methods used for estimating emissions from Consumption of halocarbons and $SF_6$. |
| *Portugal* | $SF_6$ emissions from electrical equipment: different estimates methodologies for electricity distribution at:<br><br>(a) Very High Voltage (>110 kV): a methodology based on "Correspondent States Principle" was used<br><br>(b) distribution at Low (≤1 kV), Medium (>1 kV and ≤45 kV) and High Voltage (>45 kV and ≤110 kV): estimated with a tier T3b, based on data provided by "EDP Distribuição", excluding the details in life-cycle and using a country-specific emission factor. Separate estimates were made for Gas Circuit Breakers; Outdoor Gas Insulated Switchgears; Gas Insulated Switchgears; High and Medium Voltage Sectioning Posts; |
| *Spain* | Tier 2. Category 2F8 includes the $SF_6$ emissions from electrical equipment. In the case of Spain, this is the only source generating emissions of this gas.<br><br>De una forma general, las emisiones se pueden generar en cada uno de los siguientes puntos del ciclo de vida de los equipos eléctricos que incorporan $SF_6$ como aislante:<br><br>1) En la fase de fabricación del equipo (lo que incluye las operaciones de prueba y la carga de los equipos).<br><br>2) Durante la instalación en el lugar de funcionamiento del equipo. |

| Member States | Description of methods |
|---|---|
| | 3) Durante la fase de funcionamiento del equipo.<br><br>4) En la retirada de funcionamiento del equipo.<br><br>Estos cuatro puntos o fases del ciclo vida que dan origen a las emisiones se corresponden con los respectivos cuatro términos que figuran en el segundo miembro de la ecuación siguiente, y que es la trascripción de la Ecuación 3.16 de la Guía de Buenas Prácticas de IPCC correspondiente al método de nivel 2a, que es el que se ha adoptado para la estimación de las emisiones de esta actividad:<br><br>ET = EF + EI + EO + ERdonde:<br><br>ET = Emisiones totales; EF = Emisiones en fabricación; EI = Emisiones en instalación; EO = Emisiones en operación de los equipos; ER = Emisiones en la retirada de los equipos |
| *Sweden* | Semiconductor manufacture: Information concerning the annually used amounts of various fluorinated substances has been provided by the company, and as far as possible been compared to information from the Products register at the Swedish Chemicals Agency. Emissions are calculated by using the IPCC Good practice Guidance Tier 1 method.<br><br>Electrical equipment: The $SF_6$ emissions from production have decreased in later years due to measures taken at the production facility. These estimates, obtained from industry, are of medium to high quality, with better quality in later years. For the early 1990s, assumptions on the emitted amounts of $SF_6$ from GIS manufacture were made in cooperation with industry. Industry has also provided information concerning the used amount of $SF_6$ for GIS manufacture, as well as the share of products that are exported from the country, which exceeds 90 % of the production. Emissions from installed amounts of $SF_6$ for insulation purposes in operating systems have previously contributed less to the actual annual emissions. In 2001- 2002, a questionnaire was sent out to power companies from the trade association Swedenergy102 (Svensk Energi) asking for the installed amounts of $SF_6$ in operating equipment, and the replaced amounts of $SF_6$ during service. The results showed an installed accumulated amount of approximately 80 Mg and an annual leakage rate of 0.6 % (equals the amount replaced from the questionnaire) and these were used as input data in the inventory. For later years, data on replaced amounts of $SF_6$ in operating systems results in a calculated annual leakage rate of 0.5 % (Swedenergy and power distribution companies).<br><br>For jogging shoes, a more or less rough estimate has been made. It has not been possible to obtain any national data, so a Norwegian estimate was scaled to the Swedish population. According to the results from a study performed in early 2004 a phasing out of $SF_6$ and replacement with PFC-218 was started in 2003.<br><br>Manufacturers of windows have provided data on the amount of $SF_6$ used in the manufacture of barrier gas windows. The manufacturers have also provided estimates of the share of $SF_6$ emitted in production. These estimates vary considerably between manufacturers, from 5-50%. Calculating a weighted average of the emission factor at production results in a national figure in the order of 30%, which is in line with the point estimate of 33% given in the IPCC Good Practice Guidance. |
| *United Kingdom* | Emissions of $SF_6$ from semiconductor manufacturing and from electrical equipment are combined with emissions from training shoes in source category 2F8b for reasons of commercial confidentiality.<br><br>$SF_6$ emission from electrical transmission and distribution were based on industry data from BEAMA (for equipment manufacturers) and the Electricity Association (for electricity transmission and distribution), who provided emission estimates based on Tier 3b, but only for recent years. Tier 3a estimates were available for the electricity distribution and transmission industry for 1995. In order to estimate a historical time series and projections, these emission estimates together with fluid bank estimates provided by the utilities were extrapolated using the March study methodology (March, 1999).This involved estimating leakage factors based on the collected data and using the March model to estimate the time series. Emissions prior to 1995 used the March $SF_6$ consumption data to extrapolate backwards to 1990 from the 1995 estimates.<br><br>Emissions of PFC and $SF_6$ emissions from electronics are based on data supplied by UK MEAC – the UK Microelectronics Environmental Advisory Committee.UK MEAC gave total PFC consumption for the UK electronics sector based on purchases of PFCs as reported by individual companies. Emissions were then calculated using the IPCC Tier 1 methodology, which subtracts the amount of gas left in the shipping container (10%), the amount converted to other products (between 20% and 80% depending on the gas) and the amount removed by abatement (currently assumed to be zero).Emissions for previous years were extrapolated backwards assuming an annual 15% growth in the production of semiconductors in the UK up until 1999. |

*Source: NIR 2011 unless stated otherwise*

Table 4.70 summarizes the recommendations from the latest UNFCCC review of the inventory report in relation to the category 2F Consumption of Halocarbons. The overview shows that some recommendations have been implemented.

**Table 4.70 2F Consumption of halocarbons and $SF_6$: Findings of the latest UNFCCC review of the inventory report and responses in 2011 inventory submissions**

| Member State | Review findings and responses related to 2.F. Consumption of halocarbons and $SF_6$ | |
|---|---|---|
| | Comment in the latest UNFCCC review report | Status in 2011 submission |

| Member State | Review findings and responses related to 2.F. Consumption of halocarbons and $SF_6$ | |
|---|---|---|
| | **Comment in the latest UNFCCC review report** | **Status in 2011 submission** |
| *Austria* | No recommendation for improvement for this source category in the latest review report.. | No follow-up necessary |
| *Belgium* | The ERT noted that Belgium does not include HFC emissions from the disposal of domestic refrigeration equipment, as recommended by the previous review report. Responding to a question of clarification, Belgium indicated that emissions of HFC-134a from the disposal of household refrigerators are mistakenly reported as "NE" instead of 0, because the use of refrigerators with that gas only started in 1995, and lifetime of the equipment is not yet over. The ERT recommends that Belgium explain this in its next NIR and change the notation key in the CRF tables accordingly. | Resolved |
| *Denmark* | Emissions are estimated using a complex model that was made available to the ERT during the review. The NIR does not provide sufficient information regarding AD, EFs, quantity of gas in equipment and basic assumptions. The ERT recommends that Denmark improve the background information for this model in future NIRs. | Not resolved |
| | The F-gases report indicates that the comparison between potential and actual emission estimates has been only partly completed. To this end, data from importers (topdown) are assessed against data from users (bottom-up) to ensure that import and consumption correspond. The consumption reported from users is always adjusted in line with the import of substances, which are the data with a lower degree of uncertainty. In 2008, the ratio of potential to actual data for HFC-134a is 0.69 and for all species together this ratio is 0.88, indicating an underestimation of potential emissions or an overestimation of actual emissions. There are no explanations about these figures in the F-gases report or in the NIR. The ERT recommends that the Party improve transparency with regard to this particular key category, as well as for the F-gases in general, by providing more detailed information in the NIR and completing the documentation of the model. | Not resolved |
| | According to the F-gases report, no specific QA/QC plan for the F-gas calculation has been developed, although some QC procedures are carried out in the model. The ERT recommends that Denmark improve QA/QC for F-gases. | Not resolved |
| | Figures in the NIR (table 4.16) do not reflect those in the CRF tables from the 2010 submission, except for the year 2008. The ERT recommends that Denmark check its reporting in the NIR and CRF tables for consistency in the next submission. | Resolved |
| *Finland* | Electrical Equipment-$SF_6$:<br>The NIR indicated that $SF_6$ emissions from 2003 to 2007 were recalculated due to the use of the modified IPCC tier 3c model. The data for the years prior to 2003 are not detailed enough to use the tier 3c method and Finland concluded that a recalculation would not result in improved emission estimates | Resolved;<br>Historical activity data will be collected, and a recalculation of the time series will be considered with the 2010 inventory. |
| *France* | No 2010 review report available at the time of the compilation of this NIR | |
| *Germany* | No 2010 review report available at the time of the compilation of this NIR. | |
| *Greece* | The ERT noted that the emissions from product use were estimated using an EF (product life factor (PLF)) based on expert judgement and that the | Resolved |

| Member State | Review findings and responses related to 2.F. Consumption of halocarbons and $SF_6$ | |
|---|---|---|
| | Comment in the latest UNFCCC review report | Status in 2011 submission |
| | actual source (rather than the provider) of AD was not always provided. The ERT recommends that Greece provide more information on the country-specific EF used and clarify the sources of the AD used (type and quality), in particular for commercial refrigeration and mobile airconditioning. | |
| | The ERT observed a discrepancy between the PLF value for transport refrigeration reported in the NIR (12.5 per cent) and that provided in the CRF tables (10 per cent). The ERT recommends that Greece correct this error in its next annual submission. | Resolved |
| | Emissions of $SF_6$ from electrical equipment are reported in CRF table 2(II), but there are no further details provided in CRF table 2(II).F. The ERT noted that, although there is no manufacturer of switchgear equipment in Greece, there are emissions from installation losses for high-voltage switchgear used in the country, which should preferably be reported under emissions from manufacturing. The ERT recommends that Greece complete its reporting of these emissions in CRF table 2(II).F in order to improve transparency. | Not resolved |
| *Ireland* | | Not resolved |
| | The ERT noted that Ireland is not presenting transparent information on the time series of AD and EFs for each category separately as appropriate. The ERT considers that the aggregated approach adopted by Ireland impairs transparency, and recommends that the Party increase the level of disaggregation of the information in its next annual submission by providing additional information for this sector. | |
| | The ERT noted that in CRF table 2(II).F the Party appears to have inconsistently used the notation key for included elsewhere ("IE") and the notation key "NA" to report AD and the corresponding estimates of emissions of HFCs from refrigeration and airconditioning equipment: estimated emissions from manufacturing and from disposal for commercial refrigeration are reported as "IE" and included under "stock", and AD are reported as "NA". The Party explained to the ERT during the review that the use of a bottom-up approach is not appropriate for estimating actual emissions from stationary refrigeration and air conditioning in Ireland, owing to the lack of data available on equipment types and sales of HFCs for each equipment subcategory. Emissions are therefore estimated using a top-down approach based on reported sales data and information on market shares. These are used to allocate the estimates of total HFC sales between stationary refrigeration and air conditioning. Therefore, Ireland is not in a position to provide AD but only estimates of actual emissions from stocks. The ERT recommends that Ireland investigate this matter further for its next annual submission and improve the transparency of its reporting by reviewing its use of the notation keys for this category. | Not resolved |
| | The ERT also recommends that the Party provide more information on the share of newvehicles equipped with air conditioning (the NIR states that 75 per cent of new or imported vehicles are equipped with air conditioning) and the average filling amount (0.8 kg for private cars and 1.2 kg for commercial vehicles) of new vehicles that were used to estimate emissions for this category. | Not resolved |
| *Italy* | No recommendation for improvement for this source category in the latest review report. | No follow-up necessary |

| Member State | Review findings and responses related to 2.F. Consumption of halocarbons and $SF_6$ | |
|---|---|---|
| | **Comment in the latest UNFCCC review report** | **Status in 2011 submission** |
| *Luxembourg* | The ERT noted that Luxembourg has continued not to estimate actual HFC emissions from fire extinguishers and from solvent use. In response to questions raised by the ERT during the review, Luxembourg stated that no HFCs are used in the country in fire extinguishers or as solvents and it changed the notation key in the CRF tables from "NE" to "NO". The ERT considered the response from Luxembourg satisfactory and recommends that the Party include this information in its next NIR. | Not resolved; |
| | The ERT noted that Luxembourg continues to report estimates of actual HFC emissions based on projections rather than on actual data, on the basis of a report produced in 1999, which includes projections for up to 2010. The ERT reiterates the recommendation of previous ERTs that Luxembourg recalculate its emission estimates for the whole time series, using actual values and not projections or other proxy data. | Resolved |
| *Netherlands* | No 2010 review report available at the time of the compilation of this NIR. | |
| *Portugal* | Actual emissions of PFCs for refrigeration and air conditioning are reported as "NO". However, potential emissions for this category are reported in the CRF tables. The ERT recommends that Portugal investigate whether PFCs are used in refrigeration and air conditioning. If they are, the ERT recommends that Portugal estimate actual emissions of PFCs and if not, change the notation key to "NO" for potential emissions in its next annual submission. However, the ERT recommends that the Party ensure that all potential emissions are covered in its inventory. | Resolved |
| *Spain* | No 2010 review report available at the time of the compilation of this NIR. | |
| *Sweden* | No 2010 review report available at the time of the compilation of this NIR. | |
| *UK* | The ERT recommends that the United Kingdom enhance the transparency and comparability of its reporting by including a table with EFs (product manufacturing factors, product life factors (PLFs) and disposal loss factors) by application over time in its next annual submission. In addition, the ERT recommends that the United Kingdom check the model used for calculating emissions from refrigeration and the AD, emissions and PLFs reported in the CRF sectoral background data table 2(II).F for refrigeration, and correct them if necessary. | Not resolved |

*Sources: Review Report 2010 unless stated otherwise; NIR 2011 unless stated otherwise*

### 4.2.6 Other (CRF Source Category 2G) (EU-15)

Table 4.71 shows that only three Member States reports GHG emissions under 2G Other for the year 2008. The Netherlands include $CO_2$, $CH_4$ and $N_2O$ emissions from fireworks and candles, degassing drinkwater from groundwater and process emissions in other economic sectors; Germany reports due to confidentiality reasons aggregated $SF_6$ emissions from shoes, AWACS maintainance and welding; and Denmark include $CO_2$ emissions from lubricants in this category.

**Table 4.71 2G Other: Overview of sources reported under this source category for 2009**

| Member State | 2.G Other | $CO_2$ emissions [Gg] | $CH_4$ emissions [Gg] | $N_2O$ emissions [Gg] | HFC emissions [Gg $CO_2$ equivalents] | PFC emissions [Gg $CO_2$ equivalents] | $SF_6$ emissions [Gg] | Total emissions [Gg CO2 equivalents] | Share in EU-15 Total | Information from NIR-2008 |
|---|---|---|---|---|---|---|---|---|---|---|
| Austria | NA | NA | NA | NA | NA | NA | NA | - | 0.0% | |
| Belgium | NA,NE | NA | NA | NA | NA | NA | NA | - | 0.0% | |
| Denmark | Lubricants | 31.2 | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | 31.2 | 5.4% | |
| Finland | NA | NA | NA | NA | NA | NA | NA | - | 0.0% | |
| France | NA,NO | NO | NO | NO | NA,NO | NO | NO | - | 0.0% | |
| Germany | Other non-specified | NO | NO | NO | 21.0 | 3.9 | 0.0080 | 217 | 37.4% | For reasons of confidentiality, SF6 emissions from production of SF6 (2.E), from use in sport shoes (2.F.8 Other – sport shoes) and from use in AWACS maintenance (2.F.8 Other – AWACS maintenance) are reported under 2.G. |
| Greece | NA,NO | NO | NO | NO | NA,NO | NO | NO | - | 0.0% | |
| Ireland | NA,NO | NO | NO | NO | NA,NO | NA,NO | NO | - | 0.0% | |
| Italy | NA | NA | NA | NA | 1.6 | NA,NO | NO | 1.6 | 0.3% | |
| Luxembourg | NA | NA | NA | NA | NA | NA | NA | - | 0.0% | |
| Netherlands | Fireworks and candles, Degassing drinkwater from groundwater, Process emissions in other economic sectors | 284.2 | 1.7 | 0.03 | NA,NO | NA,NO | NO | 330 | 56.9% | |
| Portugal | NA,NO | NO | NO | NO | NA,NO | NO | NO | - | 0.0% | |
| Spain | NA | NA | NA | NA | NA | NA | NA | - | 0.0% | |
| Sweden | NA | NO | NO | NO | NA,NO | NO | NO | - | 0.0% | |
| UK | NA | NA | NA | NA | NA | NA | NA | - | 0.0% | |
| **EU-15 Total** | | **315** | **2** | **0** | **23** | **4** | **0.0080** | **580** | **100.0%** | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

## 4.3 Methodological issues and uncertainties (EU-15)

The previous section presented for each EU-15 key source in CRF Sector 2 an overview of the Member States' contributions to the key source in terms of level and trend, information on methodologies, emission factors, completeness and qualitative uncertainty estimates. Detailed information on national methods and circumstances is available in the Member States' national inventory reports.

Table 4.72 shows the total EU-15 uncertainty estimates for the sector 'Industrial processes' and the uncertainty estimates for the relevant gases of each source category. The highest level uncertainty was estimated for $N_2O$ from 2C (118 %) and the lowest for $CO_2$ from 2C5 (3 %). With regard to trend HFC from 2F9 shows the highest uncertainty estimates, $CO_2$ from 2C5 and $CH_4$ from 2B1 the lowest. For a description of the Tier 1 uncertainty analysis carried out for the EU-15 see Chapter 1.7.

**Table 4.72 Sector 2 Industrial processes: Uncertainty estimates for the EU-15**

| Source category | Gas | Emissions 1990 | Emissions 2009 | Emission trends 1990-2009 | Level uncertainty estimates based on MS uncertainty estimates | Trend uncertainty estimates based on MS uncertainty estimates |
|---|---|---|---|---|---|---|
| 2.A.1 Cement production | $CO_2$ | 80,174 | 79,401 | -1% | 5.5% | 0.6 |
| 2.A.2 Lime production | $CO_2$ | 17,194 | 17,358 | 1% | 7.9% | 1.3 |
| 2.A.3 Limestone and dolomite use | $CO_2$ | 7,444 | 7,644 | 3% | 7.2% | 2.0 |
| 2.A.4 Soda ash production and use | $CO_2$ | 1,874 | 1,954 | 4% | 21.8% | 6.6 |
| 2.A.5 Asphalt roofing | $CO_2$ | 0 | 0 | 33% | 25.5% | 4.5 |
| 2.A.6 Road paving with asphalt | $CO_2$ | 25 | 9 | -66% | 15.3% | 9.3 |
| 2.A.7 Other | $CO_2$ | 4,894 | 5,317 | 9% | 10.6% | 2.9 |
| 2.B.1 Ammonia production | $CO_2$ | 19,450 | 17,022 | -12% | 3.4% | 1.7 |
| 2.B.3 Adipic Acid production | $CO_2$ | 10 | 13 | 31% | 22.4% | 13.3 |
| 2.B.4 Carbide Production | $CO_2$ | 794 | 195 | -75% | 9.5% | 10.7 |
| 2.B.5 Other | $CO_2$ | 10,406 | 14,331 | 38% | 16.2% | 4.7 |
| 2.C.1 Iron and Steel Production | $CO_2$ | 47,287 | 42,352 | -10% | 5.1% | 2.3 |
| 2.C.2 Ferroalloys | $CO_2$ | 2,688 | 1,805 | -33% | 9.7% | 13.8 |
| 2.C.3 Aluminium Production | $CO_2$ | 3,884 | 3,848 | -1% | 13.5% | 3.9 |
| 2.C.5 Other | $CO_2$ | 302 | 418 | 38% | 7.1% | 1.0 |
| 2.D.2 Food and Drink | $CO_3$ | 77 | 36 | -53% | 7.1% | 4.0 |
| 2.G Other | $CO_2$ | 282 | 350 | 24% | 18.8% | 3.8 |
| 2.A.7 Other | $CH_4$ | 24 | 16 | -30% | 102.0% | 78.1 |
| 2.B.1 Ammonia production | $CH_4$ | 1 | 2 | 41% | 5.4% | 0.2 |
| 2.B.4 Carbide Production | $CH_4$ | 20 | 19 | -4% | - | - |
| 2.B.5 Other | $CH_4$ | 680 | 449 | -34% | 27.1% | 14.9 |
| 2.C.1 Iron and Steel Production | $CH_4$ | 105 | 154 | 47% | 38.8% | 15.5 |
| 2.C.2 Ferroalloys | $CH_4$ | 1 | 0 | -100% | - | 0.0 |
| 2.B.2 Nitric Acid production | $N_2O$ | 35,772 | 14,742 | -59% | 24.3% | 17.3 |
| 2.B.3 Adipic Acid production | $N_2O$ | 58,927 | 8,617 | -85% | 16.8% | 59.9 |
| 2.B.5 Other | $N_2O$ | 4,587 | 1,399 | -69% | 14.7% | 9.7 |
| 2.C Metal production | $N_2O$ | 40 | 29 | -29% | 118.0% | 65.3 |
| 2.G Other | $N_2O$ | 3 | 9 | 186% | 70.7% | 162.2 |
| 2.C.1 Iron and Steel Production | HFC | 0 | 0 | - | - | - |

| | | | | | | |
|---|---|---|---|---|---|---|
| 2.E.1 By-product Emissions | HFC | 21,158 | 1,009 | -95% | 16.0% | 11.9 |
| 2.E.2 Fugitive Emissions | HFC | 6,301 | 870 | -86% | 5.8% | 4.8 |
| 2.E.3 Other | HFC | 0 | 18 | - | 13.2% | - |
| 2.F.1 Refrigeration and Air Conditioning Eqipment | HFC | 166 | 47,717 | 28632% | 10.9% | 1974.0 |
| 2.F.2 Foam Blowing | HFC | 336 | 2,752 | 718% | 5.3% | 68.4 |
| 2.F.3 Fore Extinguishers | HFC | 1 | 2,396 | 325717% | 54.6% | 92594.2 |
| 2.F.4 Aerosols/ Metered Dose Inhalers | HFC | 76 | 7,824 | 10195% | 16.7% | 1312.7 |
| 2.F.5 Solvents | HFC | 0.5 | 416 | 89520% | 28.3% | - |
| 2.F.6 Other applications using ODS sustitutes | HFC | 0 | 0 | - | - | - |
| 2.F.7 Semiconductor Manufacture | HFC | 65 | 50 | -23% | 4.5% | 2.3 |
| 2.F.8 Electrical Eqipment | HFC | 0 | 0 | - | - | - |
| 2.F.9 Other | HFC | 0.01 | 322 | 2806830% | 49.7% | 1029699.3 |
| 2.C.3 Aluminium Production | PFC | 13,347 | 1,051 | -92% | 8.2% | 10.7 |
| 2.E.1 By-product Emissions | PFC | 1,454 | 111 | -92% | - | - |
| 2.E.2 Fugitive Emissions | PFC | 1,364 | 182 | -87% | - | - |
| 2.F.1 Refrigeration and Air Conditioning Eqipment | PFC | 0 | 347 | - | 55.2% | - |
| 2.F.3 Fore Extinguishers | PFC | 0 | 5 | - | 58.3% | - |
| 2.F.7 Semiconductor Manufacture | PFC | 327 | 708 | 117% | 31.0% | 45800.1 |
| 2.C.4 Aerosols/Metered Dose Inhalers | $SF_6$ | 1,294 | 459 | -65% | 27.6% | 11.8 |
| 2.C.5 Other | $SF_6$ | 426 | 88 | -79% | - | - |
| 2.E.1 By-product Emissions | $SF_6$ | 1,559 | 0 | -100% | - | - |
| 2.E.2 Fugitive Emissions | $SF_6$ | 239 | 100 | -58% | 10.0% | 5.9 |
| 2.E.3 Other | $SF_6$ | 136 | 0 | -100% | - | - |
| 2.F.7 Semiconductor Manufacture | $SF_6$ | 249 | 203 | -19% | 12.4% | 9.3 |
| 2.F.8 Electrical Eqipment | $SF_6$ | 2,434 | 1,946 | -20% | 6.9% | 5.1 |
| 2.F.9 Other | $SF_6$ | 4,396 | 3,335 | -24% | 9.0% | 2.0 |
| Total | all | 352,882 | 306,369 | -13% | 4.8% | 13.6 |

*Note: Emissions are in Gg $CO_2$ equivalents; trend uncertainty is presented as percentage points; the sum of the source category emissions may not be the total sector emissions because uncertainty estimates are not available for all source categories; uncertainty estimates for Portugal are not included.*

## 4.4 Sector-specific quality assurance and quality control (EU-15)

There are two main activities for improving the quality of GHG emissions from industrial processes: (1) Before and during the compilation of the EU GHG inventory several checks are made of the Member States data in particular for time series consistency of emissions and implied emission factors, comparisons of implied emission factors across Member States and checks of internal consistency. (2) In the second half of the year the EU internal review is carried out for selected source categories. In 2006 the following source categories have been reviewed by Member States experts: 2A Mineral Products, 2B Chemical Industry, 2C Iron and Steel Production and Fluorinated Gases, 2E Production of Halocarbons and $SF_6$ and 2F Consumption of Halocarbons and $SF_6$. In 2008, completeness and allocation issues have been reviewed by Member States experts for all source categories in Industrial Processes.

For the inventory 2005 for the first time plant-specific data was available from the EU Emission Trading Scheme (EU ETS). This information has been used by EU Member States for quality checks and as input for calculating total $CO_2$ emissions for the sectors Energy and Industrial Processes in this report (see Section 1.4.2).

## 4.5 Sector-specific recalculations (EU-15)

Table 4.73 shows that in the industrial processes sector the largest recalculations in absolute terms were made for $CO_2$ in 1990 and 2008.

**Table 4.73 Sector 2 Industrial processes: Recalculations of total GHG emissions and recalculations of GHG emissions for 1990 and 2008 by gas (Gg $CO_2$ equivalents) and percentage)**

| 1990 | $CO_2$ | | $CH_4$ | | $N_2O$ | | HFCs | | PFCs | | $SF_6$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Gg | percent | Gg | percent | Gg | percent | Gg | percent | Gg | percent | Gg | percent |
| Total emissions and removals | -17,295 | -0.6% | 13,980 | 3.2% | 8,543 | 2.2% | 47 | 0.2% | 6 | 0.0% | 11 | 0.1% |
| Industrial Processes | -21,970 | -10.0% | 0 | 0.0% | 10 | 0.0% | 47 | 0.2% | 6 | 0.0% | 11 | 0.1% |
| **2008** | | | | | | | | | | | | |
| Total emissions and removals | -21,852 | -0.7% | 14,673 | 4.9% | 9,128 | 3.2% | 660 | 1.1% | 77 | 2.7% | -2,603 | -29.0% |
| Industrial Processes | -21,781 | -10.2% | -12 | -1.7% | 1,403 | 6.0% | 660 | 1.1% | 77 | 2.7% | -2,603 | -29.0% |

Table 4.74 provides an overview of Member States' contributions to EU-15 recalculations.

**Table 4.74 Sector 2 Industrial processes: Contribution of Member States to EU-15 recalculations for 1990 and 2008 by gas (difference between latest submission and previous submission Gg of $CO_2$ equivalents)**

| | 1990 | | | | | | 2008 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $CO_2$ | $CH_4$ | $N_2O$ | HFCs | PFCs | $SF_6$ | $CO_2$ | $CH_4$ | $N_2O$ | HFCs | PFCs | $SF_6$ |
| Austria | 0 | 0 | 0 | 0 | 0 | 0 | 42 | 0 | 0 | 0 | 0 | 0 |
| Belgium | 481 | 0 | 9 | 0 | NO | 0 | 448 | 0 | 19 | -108 | 5 | 0 |
| Denmark | 0 | 0 | 0 | 0 | NO | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Finland | 0 | 0 | 0 | 0 | NO | 0 | 21 | 0 | 18 | -1 | 0 | 0 |
| France | 707 | 0 | -31 | 0 | 0 | 0 | 154 | -7 | 0 | 72 | 0 | -13 |
| Germany | -23,722 | 0 | 28 | 0 | 0 | 0 | -21,707 | 3 | 1,381 | 4 | 2 | -2,030 |
| Greece | 537 | 0 | 0 | 0 | 6 | 0 | 169 | 0 | 55 | 397 | 2 | 0 |
| Ireland | 0 | 0 | 0 | 0 | NO | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Italy | 165 | 0 | 0 | 0 | 0 | 0 | 46 | 0 | 0 | 155 | -1 | 0 |
| Luxembourg | 0 | 0 | 0 | 0 | NA,NO | 0 | 0 | 0 | 0 | -26 | 0 | 2 |
| Netherlands | 0 | 0 | 0 | 0 | 0 | 0 | -204 | -8 | 2 | -25 | 0 | -34 |
| Portugal | 91 | 0 | 0 | 0 | NE | 0 | 55 | 2 | -71 | 9 | 0 | 0 |
| Spain | -312 | 0 | 0 | 0 | 0 | 0 | -546 | 0 | 0 | 502 | 49 | 0 |
| Sweden | 50 | 0 | 4 | 0 | 0 | 0 | 49 | 0 | 0 | 0 | 0 | 0 |
| UK | 32 | 0 | 0 | 0 | 0 | 0 | -305 | -2 | 0 | -433 | 0 | 0 |
| **EU-15** | **-21,970** | **0** | **10** | **0** | **6** | **0** | **-21,781** | **-12** | **1,403** | **547** | **57** | **-2,074** |

# 5 SOLVENT AND OTHER PRODUCT USE (CRF SECTOR 3)

This chapter provides sections on emission trends, methods and on recalculations in CRF Sector 3 Solvent and Other Product Use. In response to the UNFCCC review findings this report for the second time includes more detailed descriptions of methods used by Member States.

The use of solvents manufactured using fossil fuels as feedstock can lead to evaporative emissions of various non-methane volatile organic compounds (NMVOC), which are subsequently further oxidised in the atmosphere. Fossil fuels used as solvent are notably white spirit and kerosene (paraffin oil). White spirit is used as an extraction solvent, as a cleaning solvent, as a degreasing solvent and as a solvent in aerosols, paints, wood preservatives, lacquers, varnishes and asphalt products. White spirit is the most widely used solvent in the paint industry.

A comprehensive methodology for estimating NMVOC emission for all sources is provided neither in the IPCC guidelines nor in the EMEP/EEA Air pollutant emission inventory guidebook 2009. The current methodology for estimating NMVOC from solvents determinates comparability between countries, shows lack in transparency and uncertainty quantification.[29]

The EMEP/EEA Air pollutant emission inventory guidebook 2009 is structured according to the Nomenclature for Reporting (NFR), which is the reporting format of the Guidelines for Reporting Emission Data under the Convention on Long-range Transboundary Air Pollution (LRTAP). This nomenclature closely resembles the IPCC source nomenclature developed for reporting under the UN Framework Climate Change Convention. Cross-referencing to the Selected Nomenclature for reporting of Air Pollutants (SNAP) 97 developed by the EEA's European Topic Centre (ETC/AE) is presented in the following overview.

| **CRF** | **SNAP** | **Description** | **CRF** | **SNAP** | **Description** |
|---|---|---|---|---|---|
| 3 A | 0601 | Paint application | 3 B | 0602 | Degreasing, dry cleaning and electronics |
| | 060101 | Paint application: manufacture of automobiles | | 060201 | Metal degreasing |
| | 060102 | Paint application: car repairing | | 060202 | Dry cleaning |
| | 060103 | Paint application: construction and buildings | | 060203 | Electronic components manufacturing |
| | 060104 | Paint application: domestic use (except 060107) | | 060204 | Other industrial cleaning |
| | 060105 | Paint application: coil coating | 3 D | 0604 | Other use of solvents and related activities |
| | 060106 | Paint application: boat building | | 060401 | Glass wool enduction |
| | 060107 | Paint application: wood | | 060402 | Mineral wool enduction |
| | 060108 | Other industrial paint application | | 060403 | Printing industry |
| | 060109 | Other non industrial paint application | | 060404 | Fat, edible and non edible oil extraction |
| 3 C | 0603 | Chemical products manufacturing or processing | | 060405 | Application of glues and adhesives |
| | 060301 | Polyester processing | | 060406 | Preservation of wood |
| | 060302 | Polyvinylchloride processing | | 060407 | Underseal treatment and conservation of vehicles |
| | 060303 | Polyurethane processing | | 060408 | Domestic solvent use (other than paint applicat.) |
| | 060304 | Polystyrene foam processing | | 060409 | Vehicles dewaxing |
| | 060305 | Rubber processing | | 060411 | Domestic use of pharmaceutical products |
| | 060306 | Pharmaceutical products manufacturing | | 060412 | Other (preservation of seeds,...) |
| | 060307 | Paints manufacturing | | 0605 | Use of HFC, $N_2O$, NH3, PFC and $SF_6$ |
| | 060308 | Inks manufacturing | | 060501 | Anaesthesia |
| | 060309 | Glues manufacturing | | 060505 | Fire extinguishers |

29 See http://www.tfeip-secretariat.org/MeetingReport_CI_Workshop_17Feb2010_final.pdf

| | | | | | |
|---|---|---|---|---|---|
| | 060310 | Asphalt blowing | | 060506 | Aerosol cans |
| | 060311 | Adhesive, magnetic tapes, films &photographs | | 060508 | Other |
| | 060312 | Textile finishing | NOT included in this sector | | |
| | 060313 | Leather tanning | 2 F 1 | 060502 | Refrigeration and air conditioning equipments |
| | 060314 | Other | 2 G | 060503 | Refrigeration and air conditioning equipments using other products than halocarbons |
| | | | 2 F 2 | 060504 | Foam blowing (except 060304) |
| | | | 2 F 6 | 060507 | Electrical equipments (except 060203) |

## 5.1 Overview of sector (EU-15)

CRF Sector 3 Solvent and Other Product Use contributes 0.25 % to the total EU-15 GHG emissions in 2009 (Table 5.4). The EU-15 Member states jointly achieved a emissions reduction of about 28 % from 13.5 Tg in 1990 to 9.8 Tg in 2009 (Figure 5.1 and Table 5.1).

As it is shown in Table 5.1 and Figure 5.2, in the period 1990 to 2009 an emission reduction in this sector could be achieved by

- Germany (2 664 Gg $CO_2$eq; -59 %);
- France (761 Gg $CO_2$eq; -37 %);
- The Netherlands (335 Gg $CO_2$eq; -62 %);
- Italy (457 Gg $CO_2$eq; -19 %);
- Austria, Finland, Denmark, Sweden, Luxembourg, Ireland and Portugal (together 392 Gg $CO_2$eq;
  -10 %).

The Member State with the high increase in emissions in this sector is Spain with 868.7 Gg $CO_2$eq (+48 %) from 1990 to 2009. The GHG emission of the Member States Belgium and Greece increased slightly (together 6.5 Gg $CO_2$eq; 2.2 %) in the same period.

**Figure 5.1 Sector 3 Solvent and Other Product Use: EU-15 GHG emissions for 1990–2009 in $CO_2$ equivalents (Tg)**

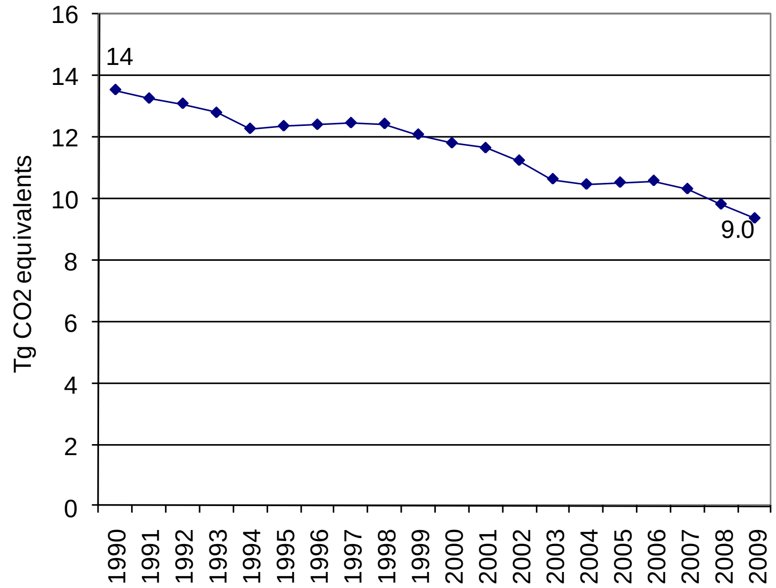
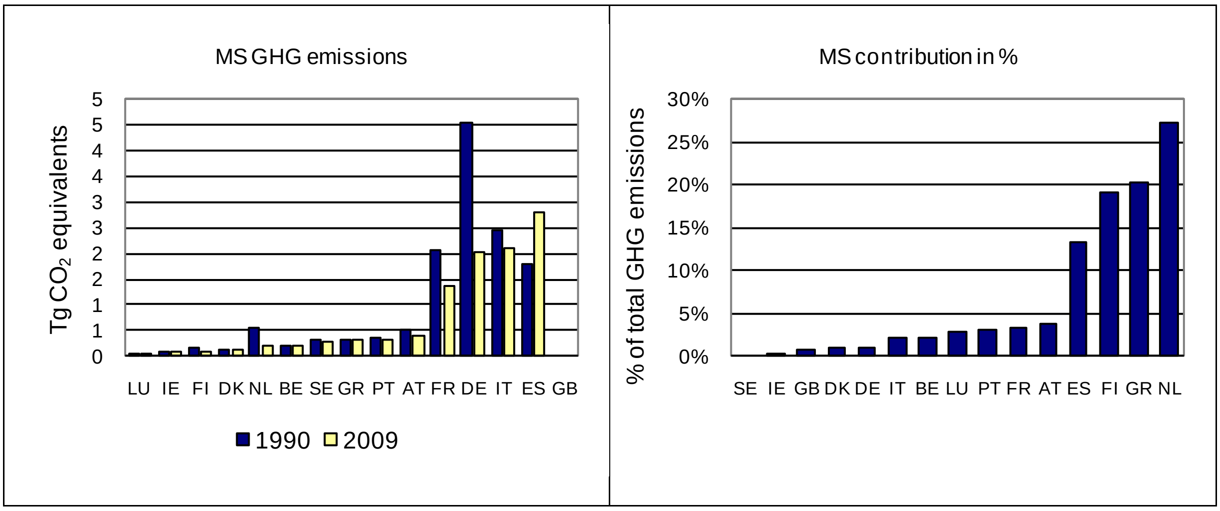


**Figure 5.2** **Sector 3 Solvent and Other Product Use: GHG emissions of EU-15 MS for 1990 and 2009 as well as Member States' contributions to GHG emissions for 2009 in percentage**




In 2009, the emissions decreased by 5 % compared to 2008 (Table 5.1). In this period the highest emission reduction in absolute terms was achieved by Germany (-137 Gg $CO_2$eq; -7 %), Spain (-114 Gg $CO_2$eq; -4 %), Italy (-106 Gg $CO_2$eq; -5 %), France (-75 Gg $CO_2$eq; -5 %), and Portugal (-36,7 Gg $CO_2$eq; -12 %). In the Member States Greece and Sweden a slight increase compared to 2008 could be noted (together 10.5 Gg $CO_2$eq).

As it is shown in Table 5.1 the Member States Spain, France, Germany and Italy are jointly responsible for 80 % of the total EU-15 GHG emissions in this sector in 2009. The remaining 20 % of GHG emissions of this sector emanate in 2009 from all other EU-15 Member States each with shares of 4 % or even less.

**Table 5.1** **Sector 3 Solvent and Other Product Use: Member States' contributions to GHG emissions**

| Member State | Greenhouse gas emissions (Gg CO2 equivalents) | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | |
|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg CO2 equivalents) | (%) | (Gg CO2 equivalents) | (%) |
| Austria | 512 | 389 | 367 | 3.7% | -21.6 | -5.6% | -144.6 | -28% |
| Belgium | 213 | 214 | 214 | 2.2% | -0.2 | -0.1% | 0.7 | 0% |
| Denmark | 136 | 103 | 95 | 1.0% | -8.3 | -8.0% | -41.2 | -30% |
| Finland | 178 | 97 | 87 | 0.9% | -10.3 | -10.6% | -91.6 | -51% |
| France | 2,063 | 1,376 | 1,302 | 13.3% | -74.6 | -5.4% | -761.0 | -37% |
| Germany | 4,539 | 2,011 | 1,874 | 19.1% | -136.7 | -6.8% | -2,664.3 | -59% |
| Greece | 308 | 313 | 314 | 3.2% | 0.7 | 0.2% | 5.8 | 2% |
| Ireland | 80 | 76 | 74 | 0.8% | -1.3 | -1.7% | -5.7 | -7% |
| Italy | 2,455 | 2,104 | 1,998 | 20.4% | -106.2 | -5.0% | -456.9 | -19% |
| Luxembourg | 24 | 17 | 17 | 0.2% | -0.6 | -3.3% | -7.0 | -29% |
| Netherlands | 541 | 209 | 207 | 2.1% | -1.9 | -0.9% | -334.6 | -62% |
| Portugal | 346 | 318 | 282 | 2.9% | -36.7 | -11.5% | -64.7 | -19% |
| Spain | 1,809 | 2,792 | 2,678 | 27.3% | -113.8 | -4.1% | 868.7 | 48% |
| Sweden | 332 | 286 | 295 | 3.0% | 9.8 | 3.4% | -37.1 | -11% |
| United Kingdom | NE | NE | 0 | 0.0% | 0.0 | - | 0.0 | - |
| **EU-15** | **13,537** | **10,306** | **9,804** | **100.0%** | **-502** | **-4.9%** | **-3,733.47** | **-28%** |

**This sector does not contain a key source.**

In the Sector 3 Solvent and Other Product Use in addition to $CO_2$ emission NMVOC and $N_2O$ emission are identified. The most important GHG from Solvent and Other Product Use is $CO_2$. In 2008 the $CO_2$ emissions have a share of 0.19 % of the 'Total EU-15 $CO_2$ Emissions and Removals' and a share of 0.15 % of the 'Total EU-15 GHG emissions' (Table 5.2). In 2009 the $N_2O$ emissions have a share of 1.28 % of the 'Total EU-15 $N_2O$ emissions' and a share of 0.10 % of the 'Total EU-15 GHG emissions' (Table 5.3).

**Table 5.2 Sector 3 Solvent and Other Product Use: EU-15 $CO_2$ emissions as well as their share**

| | Unit | 1990 | 2009 |
|---|---|---|---|
| **CO2 emission in 'Solvent and Other Product Use'** | [Gg] | 8,803 | 5,755 |
| **Total GHG emission in 'Solvent and Other Product Use'** | [Gg $CO_2$ eq] | 13,537 | 9,347.9 |
| *Share of CO2 emission in Total GHG in 'Solvent and Other Product Use'* | | *65%* | *62%* |
| **Total National CO2 Emissions and Removals (excluding net CO2 from LULUCF)** | [Gg] | 3,359,400 | 3,063,226 |
| *Share of CO2 emission from 'Solvent and Other Product Use' in Total CO2 Emissions and Removals* | | *0.26%* | *0.19%* |
| **Total National GHG Emissions and Removals (without LULUCF)** | [Gg $CO_2$ eq] | 4,264,911 | 3,723,714 |
| *Share of CO2 emission from 'Solvent and Other Product Use' in Total GHG Emissions and Removals (without LULUCF)* | | *0.21%* | *0.15%* |

**Table 5.3 Sector 3 Solvent and Other Product Use: EU-15 $N_2O$ emissions as well as their share**

| | Unit | 1990 | 2009 |
|---|---|---|---|
| **N2O emission in 'Solvent and Other Product Use'** | [Gg] | 15.3 | 11.6 |
| **Total GHG emission in 'Solvent and Other Product Use'** | [Gg $CO_2$ eq] | 13,537 | 9,348 |
| *Share of N2O emission in Total GHG* in 'Solvent and Other Product Use' | | *35%* | *38%* |
| **Total National N2O Emissions** | [Gg] | 1,299 | 904 |
| *Share of N2O emission from 'Solvent and Other Product Use' in Total National N2O Emissions* | | *1.18%* | *1.28%* |
| **Total National GHG Emissions and Removals (without LULUCF)** | [Gg $CO_2$ eq] | 4,264,911 | 3,723,714 |
| *Share of N2O emission from 'Solvent and Other Product Use' in Total GHG Emissions and Removals (without LULUCF)* | | *0.11%* | *0.10%* |

**Table 5.4 Sector 3 Solvent and Other Product Use: EU-15 GHG emissions as well as their share**

| | Unit | 1990 | 2009 |
|---|---|---|---|
| **GHG emission in 'Solvent and Other Product Use'** | [Gg $CO_2$ eq] | 13,537 | 9,348 |
| **Total National GHG Emissions and Removals (without LULUCF)** | [Gg $CO_2$ eq] | 4,264,911 | 3,723,714 |
| *Share of GHG emission from 'Solvent and Other Product Use' in Total GHG Emissions and Removals (without LULUCF)* | | *0.32%* | *0.25%* |

In Table 5.5 the emission of $CO_2$, $N_2O$ and NMVOC as well as the Total GHG emission for the EU-15 and for all EU-15 Member States are listed as recommended in IRR 2007 (para 78).

**Table 5.5** Sector 3 Solvent and Other Product Use: EU-15 emissions of $CO_2$, $N_2O$, NMVOC and GHG

| | | $CO_2$ | $N_2O$ | NMVOC | Total emissions | | $CO_2$ | $N_2O$ | NMVOC | Total emissions |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Gg | | | Gg $CO_2$ eq | | Gg | | | Gg $CO_2$ eq |
| AT | A. Paint Application | 47.85 | | 18.00 | 47.85 | B. Degreasing and Dry Cleaning | 23.28 | NA | 8.81 | 23.28 |
| BE | | NA | | 19.58 | NA | | NA | NA | 3.14 | NA |
| DK | | 8.64 | | 3.32 | 8.64 | | 0.00 | NA | 0.00 | 0.00 |
| FI | | 23.27 | | 10.58 | 23.27 | | 1.31 | NO | 0.60 | 1.31 |
| FR | | 479.20 | | 153.75 | 479.20 | | 19.54 | NA | 6.27 | 19.54 |
| DE | | 589.35 | | 267.89 | 589.35 | | 100.60 | NO | 45.73 | 100.60 |
| GR | | 35.56 | | 11.41 | 35.56 | | 8.89 | NA | 2.85 | 8.89 |
| IE | | 19.45 | | 6.24 | 19.45 | | 3.67 | NA | 1.18 | 3.67 |
| IT | | 639.63 | | 205.21 | 639.63 | | 64.86 | NA | 20.81 | 64.86 |
| LU | | 2.66 | | 1.21 | 2.66 | | 3.21 | NA | 1.08 | 3.21 |
| NL | | 51.21 | | 18.07 | 51.21 | | 1.96 | NO | 3.45 | 1.96 |
| PT | | 53.58 | | 17.19 | 53.58 | | 8.22 | NO | 2.64 | 8.22 |
| ES | | 401.76 | | 128.91 | 401.76 | | 80.94 | NA | 25.97 | 80.94 |
| SE | | 35.64 | | 12.85 | 35.64 | | 0.15 | NA | 0.13 | 0.15 |
| GB | | NE | | 81.04 | NE | | NE | NE | 30.17 | NE |
| ***EU15*** | | 2,387.80 | | 955.24 | 2,387.80 | | 316.63 | 0.00 | 152.81 | 316.63 |
| AT | C. Chemical Products, Manufacture and Processing | 10.26 | | 5.44 | 10.26 | D. Other | 71.66 | 0.47 | 31.86 | ***217.36*** |
| BE | | NA | | 2.57 | NA | | NA | 0.69 | 26.69 | ***214.00*** |
| DK | | 12.22 | | 4.90 | 12.22 | | 43.77 | 0.12 | 19.13 | ***80.78*** |
| FI | | 5.26 | | 2.39 | 5.26 | | 15.89 | 0.08 | 7.22 | ***40.67*** |
| FR | | 92.56 | | 29.70 | 92.56 | | 530.55 | 0.28 | 170.23 | ***617.05*** |
| DE | | 118.52 | | 53.87 | 118.52 | | 662.75 | 1.21 | 301.25 | ***1039.31*** |
| GR | | NA | | IE | NA | | 116.92 | 0.50 | 39.97 | ***271.15*** |
| IE | | 7.89 | | 2.53 | 7.89 | | 40.78 | NA,NE | 13.09 | ***40.78*** |
| IT | | NA | | 73.54 | NA | | 486.10 | 2.16 | 155.95 | ***1157.11*** |
| LU | | 1.46 | | 0.56 | 1.46 | | 4.00 | 0.02 | 1.86 | ***8.69*** |
| NL | | NA | | IE | NA | | 67.21 | 0.24 | 35.26 | ***142.18*** |
| PT | | 60.00 | | 19.25 | 60.00 | | 90.93 | 0.28 | 29.17 | ***176.43*** |
| ES | | NA | | 91.76 | NA | | 474.85 | 5.15 | 152.36 | ***2070.19*** |
| SE | | 1.27 | | 0.50 | 1.27 | | 135.32 | 0.40 | 66.22 | ***258.36*** |
| GB | | NE | | 12.07 | NE | | NE | NE,NO | 231.79 | ***0.00*** |
| ***EU15*** | | 309.45 | | 299.09 | 309.45 | | 2,740.72 | 11.59 | 1,282.05 | ***6334.06*** |
| *AT* | *Total Solvent and Other Product Use* | *153.05* | 0.47 | *64.10* | *298.75* | | | | | |
| *BE* | | *NA* | 0.69 | *51.98* | *214.00* | | | | | |
| *DK* | | *64.63* | 0.12 | *27.35* | *101.64* | | | | | |
| *FI* | | *45.72* | 0.08 | *20.78* | *70.51* | | | | | |
| *FR* | | *1,121.85* | 0.28 | *359.95* | *1,208.35* | | | | | |
| *DE* | | *1,471.22* | 1.21 | *668.73* | *1,847.77* | | | | | |
| *GR* | | *161.38* | 0.50 | *54.24* | *315.60* | | | | | |
| *IE* | | *71.80* | NA,NE | *23.04* | *71.80* | | | | | |
| *IT* | | *1,190.58* | 2.16 | *455.51* | *1,861.59* | | | | | |
| *LU* | | *11.33* | 0.02 | *4.70* | *16.02* | | | | | |
| *NL* | | *120.38* | 0.24 | *56.77* | *195.36* | | | | | |
| *PT* | | *212.73* | 0.28 | *68.25* | *298.23* | | | | | |
| *ES* | | *957.56* | 5.15 | *399.00* | *2,552.90* | | | | | |
| *SE* | | *172.38* | 0.40 | *79.71* | *295.41* | | | | | |
| *GB* | | *NE* | NE,NO | *355.07* | *0.00* | | | | | |
| ***EU15*** | | *5,754.59* | 11.59 | *2,689.19* | *9,347.93* | | | | | |

## 5.2 Methodological issues and uncertainties (EU-15)

This sector does not contain any key source. An overview information on methodologies used by the Member States is given in Table 5.6. For estimation the emission in this sector the methodologies used by the Member States are very different and based on:

- Methodology provided by IPPC Guidelines and CORINAIR Guidebook;
- Bottom up and top down approach / consumption-based emissions estimating;
- Chemical approach
- mass balance for single substances or groups of substances
- plant specific surveys / expert judgment.

No additional overview information on qualitative uncertainty estimates is provided. Altogether it can be noted that very high uncertainties are reported because of lack of information and rough assumptions.

**Table 5.6 Sector 3 Solvent and Other product use: Methodological issues for estimation of emissions**

**Sector 3 Solvent and Other product use: Methodological issues for estimation of emissions**

**Austria (NIR AT 2011)**

**GHG & pollutant:** $CO_2$, NMVOC, $N_2O$ — **GHG Key Category:** $CO_2$

**Time series consistency:** yes — **Sector specific QA/QC and verification**: provided

**Methodology ($CO_2$ emissions):**

$CO_2$ emissions from solvent use were calculated from NMVOC emissions of this sector. As a first step the quantity of solvents used and the solvent emissions were calculated. To determine the quantity of solvents used in Austria in the various applications, a bottom up and a top down approach were combined. The top down approach provided total quantities of solvents used in Austria. The share of the solvents used for the different applications and the solvent emission factors have been calculated on the basis of the bottom up approach. By linking the results of bottom up and top down approach, quantities of solvents annually used and solvent emissions for the different applications were obtained. Emission estimates only based on the top down approach overestimated emissions because a large amount of solvent substances is used for "non-solvent-applications" (applications where substances usually are used as feed stock in chemical, pharmaceutical or petrochemical industry). However, there might be emissions from the use of the produced products, such as ETBE or MTBE which are used as fuel additive and finally combusted, these emissions for example are considered in the transport sector.

**Activity:**

The top-down approach is based on (A) import-export statistics, (B) production statistics on solvents in Austria, (C) survey on non-solvent-applications in companies, (D) survey on the solvent content in products and preparations at producers & retailers. The bottom up approach is based on an extensive survey on the use of solvents in the year 2000 and 2008. In this survey data about the solvent content of paints, cleaning agents etc. and on solvents used (both substances and substance categories) like acetone or alcohols were collected. Information about the type of application of the solvents was gathered, divided into the three categories 'final application', 'cleaner' and 'product preparation' as well as the actual type of waste gas treatment, which was divided into the categories 'open application', 'waste gas collection' and 'waste gas treatment'.

**Emission factor:**

For every category of application and waste gas treatment an emission factor was estimated to calculate solvent emissions in the year 2000. In a second step a survey in 1800 households was made for estimating the domestic solvent use. Also, solvent use in the context of moonlighting besides commercial work and do-it-yourself was calculated.

**Methodology, Activity & Emission factor ($N_2O$ Emissions):**

$N_2O$ Emissions in CRF 3: 3 D 1 Use of $N_2O$ for anaesthesia and 3 D 3 Use of $N_2O$ in aerosol cans: A specific methodology for these activities has not been prepared yet. 100 % of $N_2O$ used for anaesthesia/ aerosol cans is released into atmosphere, which means that activity data = emission (1.00 Mg $N_2O$ / Mg product use)

**Sector 3 Solvent and Other product use: Methodological issues for estimation of emissions**

**Belgium (NIR BE 2011)**

**GHG & pollutant:** NMVOC, $N_2O$ **GHG Key Category**: no

**Time series consistency:** yes **Sector specific QA/QC and verification:** not provided

**Methodology ($CO_2$ emissions):**

In Belgium the emissions of NMVOC in this source category include paint application, production of medicines, paints, inks and glues, domestic use of other products, coating processes, printing industry, wood conservation, treatment of rubber, storage and handling of products, recuperation of solvents and extraction of oil, cleaning and degreasing and dry cleaning. No estimation of the $CO_2$ equi. emissions of the solvent consumption is carried out in Belgium; except in the Flemish region (from non-energy use of lubricants and solvents wich are reported under category 2.G).

The regions in Belgium are using comparable methodologies to estimate the emissions of solvent and other product use in their region.

The emissions of NMVOC in Flanders are estimated by using the results of a study started by the University of Gent in 1998 and continued by the Flemish Environment Agency (VMM). In Wallonia, the calculation is based on a methodology established by Econotec.

In the Brussels region, the emissions are calculated by using the results of research projects.

Because of the less importance of these emissions in the greenhouse gas story, only a general view of how these emissions are calculated in Belgium is given below.

- All emissions of category 3A (NMVOC emissions for Paint Application…) as well as some of category 3.D (other domestic use, wood coating, wood conservation, recovery of solvents, treatment of rubber, coating of synthetic material and paper) are estimated based on production figures that are given by the specific industry or professional federations. The emission factors used are mainly the solvent content of the product.
- The remaining emissions of categories 3C (production of paints, inks and glues) and 3D (storage and handling of products and assembly of automobiles, extraction of oil seeds, textile coating and printing industry) are estimated based on information gathered in the industrial databases mainly originating from the yearly reporting obligations of the industrial companies.
- There is no estimation carried out in Belgium of the $CO_2$ equivalents calculated out of the emissions of NMVOC of the solvent consumption because of the unreliability of this factors proposed in literature.

**Methodology, Activity & Emission factor ($N_2O$ Emissions):**

The emission calculation for the emission of $N_2O$ from anaesthesia (3D) is based on the number of hospital beds in Belgium and the average consumption of anaesthetics per bed. The emission factor is 10,3 kg $N_2O$/bed/year. This factor was determined by inquiries carried out in 1995 by an independent consultant agency Econotec. It has been assumed that all of the nitrous oxide used for anaesthetics will eventually be released to the atmosphere. The number of beds used for the emissions calculations was obtained from the DGASS (General Directorate for Health and Social Action) and from the Health Public Federal Service.

**Denmark (NIR DK 2010)**

**GHG & pollutant:** $CO_2$, NMVOC, $N_2O$ **GHG Key Category:** no
**Sectorspecific QA/QC and verification**: yes **Recalculation:** yes

**Uncertainties: Tier 2 uncertainty analysis:** Overall uncertainty (2009): -9.2%; +11%), Trend uncertainty 1990–2009: -1.2%; +5.0%

**Methodology ($CO_2$ emissions):**

Until 2002 the Danish solvent emission inventory was based on questionnaires, which were sent to selected industries and sectors requiring information on solvent use. In 2003 it was decided to implement a method that is more complete, accurate and transparent with respect to including the total amount of used solvent, attributing emissions to industrial sectors and households and establishing a reliable model that is readily updated on a yearly basis. Emission modelling of solvents can basically be done in two ways: (1) By estimating the amount of (pure) solvents consumed, or (2) By estimating the amount of solvent containing products consumed, taking account of their solvent content (EMEP/CORINAIR, 2004). In (1) all relevant solvents must be estimated, or at least those together representing more than 90 % of the total NMVOC emission, and in (2) all relevant source categories must be inventoried or at least those together contributing more than 90 % of the total NMVOC emission. The detailed method (1) is used in the Danish emission inventory for solvent use, thus representing a chemicals approach, where each chemical (NMVOC) is estimated separately. The sum of emissions of all estimated NMVOCs used as solvents equals the NMVOC emission from solvent use.

NMVOC is the most important chemical group especially in relation to the CLRTAP. The definitions of solvents and VOC that are used in the Danish inventory (Nielsen et al., 2009) are as defined in the solvent directive (Directive 1999/13/EC) of the EU legislation: "Organic solvent shall mean any VOC which is used alone or in combination with other agents, and without undergoing a chemical change, to dissolve raw materials, products or waste materials, or is used as a cleaning agent to dissolve contaminants, or as a dissolver, or as a dispersion medium, or as a viscosity adjuster, or as a surface tension adjuster, or a plasticiser, or as a preservative". The definition implies that some chemicals, e.g. ethylenglycol, that have vapour pressures just around 0.01 kPa at 20 oC, may only be defined as VOCs at use conditions with higher temperature. However, use conditions under elevated temperature are typically found in industrial processes. Here the capture of solvent fumes is often efficient, thus resulting in small emissions (communication with industries). The Danish list of chemicals comprises 33 chemicals or chemical groups representing more than 95 % of the total NMVOC emission from solvent use of the known NMVOCs. $CO_2$ conversion factors, where all C-molecules in a NMVOC molecule are converted to $CO_2$, are provided.

**Activity**

For each chemical a mass balance is formulated: Consumption = (production + import) – (export + destruction/disposal + hold-up) (Eq. 1). Data concerning production, import and export amounts of solvents and solvent containing products are collected from StatBank DK (2008), which contains detailed statistical information on the Danish society. Manufacturing and trading industries are committed to reporting production and trade figures to the Danish Customs & Tax Authorities in accordance with the Combined Nomenclature. Import and export figures are available on a monthly basis from 1995 to present and contain trade information from 272 countries world-wide. Production figures are reported quarterly as "industrial commodity statistics by commodity group and unit" from 1995 to present. Destruction and disposal of solvents lower the NMVOC emissions. In principle this amount must be estimated for each NMVOC in all industrial activity and for all uses of NMVOC containing products. At present the solvent inventory only considers destruction and disposal for a limited number of NMVOCs. For some NMVOCs it is inherent in the emission factor, and for others the reduction is specifically calculated from information obtained from the industry or literature. Hold-up is the difference in the amount in stock in the beginning and at the end of the year of the inventory. No information on solvents in stock has been obtained from industries. Furthermore, the inventory spans over several years so there will be an offset in the use and production, import and export balance over time.

In some industries the solvents are consumed in the process, e.g. in the graphics and plastic industry, whereas in the production of paints and lacquers the solvents are still present in the final product. These products can either be exported or used in the country. In order not to double count consumption amounts of NMVOCs it is important to keep track of total solvent use, solvents not used in products and use of solvent containing products. Furthermore some chemicals may be represented as individual chemicals and also in chemical groups, e.g. "o-xylene", "mixture of xylenes" and "xylene". Some chemicals are better inventoried as a group of NMVOCs rather than individual NMVOCs, due to missing information on use or emission for the individual NMVOCs. The Danish inventory considers single NMVOCs, with a few exceptions. Activity data for chemicals are thus primarily calculated from Equation 1 with input from StatBank DK (2008). When StatBank (2008) holds no information on production, import and export or when more reliable information is available from industries, scientific reports or expert judgements the data can be adjusted or even replaced.

**Emission factor**

For each chemical the emission is calculated by multiplying the consumption with the fraction emitted (emission factor), according to: Emission = consumption * emission factor. The present Danish method uses emission factors that represent specific industrial activities, such as processing of polystyrene, dry cleaning etc. or that represent use categories, such as paints and detergents. Some

chemicals have been assigned emission factors according to their water solubility. Higher hydrophobicity yields higher emission factors, since a lower amount ends in waste water, e.g. ethanol (hydrophilic) and turpentine (hydrophobic).

Emission factors are categorised in four groups in ascending order: (1) Lowest emission factors in the chemical industry, e.g. lacquer and paint manufacturing, due to emission reducing abatement techniques and destruction of solvent containing waste, (2) Other industrial processes, e.g. graphic industry, have higher emission factors, (3) Non-industrial use, e.g. auto repair and construction, have even higher emission factors, (4) Diffuse use of solvent containing products, e.g. painting, where practically all the NMVOC present in the products will be released during or after use. For a given chemical the consumed amount can thus be attributed with two or more emission factors; one emission factor representing the emissions occurring at a production or processing plant and one emission factor representing the emissions during use of a solvent containing product. If the chemical is used in more processes and/or is present in several products more emission factors are assigned to the respective chemical amounts. Emission factors can be defined from surveys of specific industrial activities or as aggregated factors from industrial branches or sectors. Furthermore, emission factors may be characteristic for the use pattern of certain products. The emission factors used in the Danish inventory also rely on the work done in the joint Nordic project (Fauser et al. 2009).

**Methodology, Activity & Emission factor ($N_2O$ Emissions):**

Five companies sell $N_2O$ in Denmark and only one company produces $N_2O$. $N_2O$ is primarily used in anaesthesia by dentists, veterinarians and in hospitals and in minor use as propellant in spray cans and in the production of electronics. Due to confidentiality no data on produced

amount are available and thus the emissions related to $N_2O$ production are unknown. An emission factor of 1 is assumed for all uses, which

equals the sold amount to the emitted amount. Sold amounts are obtained from the respective companies and the produced amount is estimated from communication with the company. Total sold and estimated produced NO2 for sale in Denmark, which is equal the emissions.

Fireworks Methodology, Activity & Emission factor ($N_2O$ Emissions):

Emissions from fireworks are calculated by multiplying the activity data with selected emission factors. Emissions are calculated for the compounds $CH_4$, $CO_2$ and $N_2O$.

Activity data for the years 1990-2009 are collected from Statistics Denmark, these data are based on information on import and export.

Emission factor: Letting off fireworks (2008), which is based on Brouwer et al. (1995), is chosen as the source for $CH_4$, $CO_2$ and $N_2O$ emission factors. No other sources were found to provide emission factors for these compounds: $CO_2$ Mg/Mg 0.043 Letting off fireworks (2008), $CH_4$ kg/Mg 0.825 Letting off fireworks (2008), $N_2O$ kg/Mg 1.935.

**Finland (NIR FI 2011)**

**GHG & pollutant:** $CO_2$, NMVOC, $N_2O$ **GHG Key Category:** no
**Sector specific QA/QC and verification: yes**
**Overall uncertainty:** NMVOC: -30% - +30%, $N_2O$:-34%-+39%

**Methodology ($CO_2$ emissions):**

3.A – 3.D.: Indirect $CO_2$ emissions from solvents and other product use have been calculated from NMVOC emissions for the time series 1990-2008. Indirect $CO_2$ emissions were calculated using the equation below. It was assumed that the average carbon content is 60% by mass for all categories under the sector of solvents and other products use according to the 2006 IPCC Guidelines. As described in the Guidelines, the used fossil carbon content fraction of NMVOC is based on limited published national analyses of speciation profile.

$\text{Emissions}CO_2 = \text{EmissionsNMVOC} * \text{Percent carbon in NMVOCs by mass} * 44/12$

Paint application is the biggest source of NMVOC emissions of this sector. Emissions have been calculated from the use of paint and varnish in industry and households. Most Finnish paint producers or importers are members of the Association of Finnish Paint Industry and the use of paint is calculated in the Association using amount and solvent content of sold paint and varnish. The rest of emissions from use of paint and varnish have been estimated using a questionnaire sent to non-members of this association and emission data from the VAHTI system (detailed information in Annex 2). Detailed data of these calculations are included in the report to the UNECE: Air pollutant emissions in Finland 1990-2008, Informative Inventory Report (Finnish Environment Institute, 2010)

Degreasing and dry cleaning is a minor source of NMVOCs. Chlorinated organic solvents are used in the metal and electronics industries to clean surfaces of different components and in dry cleaners and emissions are based on import statistics of pure chlorinated solvents, amount of products containing chlorinated organic solvents and amounts of solvent waste processed in the hazardous waste treatment plant.

The NMVOC emissions are also emitted from the use of solvents in different industrial processes. In Finland there are these kinds of processes in the pharmaceutical industry, leather industry, plastic industry, textile industry, rubber conversion and manufacture of paints and inks. The emissions are foremost from the emission data of the VAHTI system. Questionnaires are also sent to companies in the textile, plastic and paint industry in which they report either the amount of used solvent or the emissions of their production processes.

**Methodology ($N_2O$ Emissions):**

The $N_2O$ emissions are calculated by Statistics Finland. The country-specific calculation method is consistent with a Tier 2 method. In the estimation of the $N_2O$ emissions sales data are obtained from the companies delivering $N_2O$ for medical use and other applications in Finland. For the years 1990 to 1999 the emissions have been assumed constant based on activity data obtained for the years 1990 and 1998. Since 2000 annual and more precise data have been received from the companies. The emission estimation is based on the assumption that all used $N_2O$ is emitted to the atmosphere in the same year it is produced or imported to Finland. A very small part of emissions is estimated due to non-response.

**Activity**

For the estimation of $N_2O$ emissions production or importation data are obtained from companies for the years 1990, 1998 and all years starting from 2000. In 2008 one company reported that they have continued to export and that has been also taken into account in the calculations.

**France (NIR FR 2011)**

**GHG & pollutant:** NMVOC, $N_2O$ **GHG Key Category:** no

**Time series consistency**: yes **Sectorspecific QA/QC and verification:** not provided

**Methodology ($CO_2$ emissions):**

Les émissions de $CO_2$ traduisent la transformation du carbone contenu dans les émissions de COVNM en $CO_2$ ultime. Cette conversion se fait sur la base d'un contenu moyen en carbone de 85%. Au total pour cette catégorie, les émissions ultimes de $CO_2$ ont été réduites de 1990 Gg à 1194 Gg de 1990 à 2008. Les principales réductions ont eu lieu dans le secteur de l'application de peinture (grâce à une baisse de l'activité et une réduction de la teneur en solvant des peintures), du dégraissage et du nettoyage à sec (amélioration du recyclage et renouvellement des matériels). Les émissions de $N_2O$ sont occasionnées par l'utilisation de ce gaz comme analgésique médical (environ 260 tonnes chaque année).

**3A Approche méthodologique**:

Activity: Mix top-down (provenant des statistiques du secteur) et bottum-up lorsque les informations par usine sont disponibles

Facteurs d'émission: Estimés au niveau national en concertation avec la profession dans le cas general. Recalculés partir des facteurs d'émission spécifiques chaque installation si ceux-ci sont disponibles

**3B Approche méthodologique**

Activité: Estimation des consommations totales de solvants

Facteurs d'émission: Pour le dégraissage des métaux, directement déduits des émissions de COVNM. Pour le nettoyage à sec, estimés à partir des données des industriels

**3C Approche méthodologique**

Activité: Traitement des statistiques de consommation au niveau national ou bottom-up suivant les secteurs.

Facteurs d'émission: Spécifiques aux secteurs. Valeurs nationales par défaut ou spécifiques chaque installation si elles sont disponibles

**3C Approche méthodologique**

Activité: Traitement des statistiques de consommation au niveau national ou bottom-up suivant les secteurs Population pour l'utilisation domestique de solvants et de produits pharmaceutiques

Facteurs d'émission: Spécifiques aux secteurs. Valeurs nationales par défaut ou informations par installation lorsqu'elles sont disponibles

**Methodology, Activity & Emission factor ($N_2O$ Emissions):**

Le $N_2O$ est également, du fait de son usage comme gaz analgésique, émis par ce secteur.

The emission calculation for the emission of $N_2O$ from anaesthesia (3D) is based on the number of population and the use of N20 from anaesthesia in Europe.

**Germany (NIR DE 2011)**

**GHG & pollutant:** $CO_2$, NMVOC, $N_2O$ **GHG Key Category: no** **Completeness:** yes

**Time series consistency:** yes **Sector specific QA/QC and verification:** yes

**Methodology ($CO_2$ emissions):**

NMVOC emissions are calculated in keeping with a product-consumption-oriented approach. In this approach, the NMVOC input quantities allocated to these source categories, via solvents or solvent-containing products, are determined and then the relevant NMVOC emissions (for each source category) are calculated from those quantities via specific EFs. This method is explicitly listed, under "consumption-based emissions estimating", as one of two methods that are to be used for emissions calculation for this source category. Use of this method is possible only with valid input figures – differentiated by source categories – in the following areas:

1. Quantities of VOC-containing (pre-) products and agents used in the report year,
2. The VOC concentrations in these products (substances and preparations),
3. The relevant application and emission conditions (or the resulting specific EF).

4. To take account of the highly diverse structures throughout the sub-categories 3A – 3D, these input figures are determined on the level of 37 differentiated source categories, and the calculated NMVOC emissions are then aggregated. The product/substance quantities used are determined at the product-group level with the help of production and foreign-trade statistics. Where possible, the so-determined domestic-consumption quantities are then further verified via cross-checking with industry statistics.
5. The values used for the average VOC concentrations of the input substances, and the EFs used, are based on experts' assessments (expert opinions and industry dialog) relative to the various source categories and source-category areas. Not all of the necessary basic statistical data required for calculation of NMVOC emissions for the most current relevant year are available in final form; as a result, the data deter-mined for the previous year are used as an initial basis for a forecast for the current report. The forecast for NMVOC emissions from solvent use for the relevant most current year is calculated on the basis of specific activity trends. As soon as the relevant basic statistical data are available for the relevant most current year, in their final form, the inventory data for NMVOC emissions from solvent use will be recalculated.
6. Since 1990, so the data, NMVOC emissions from use of solvents and solvent-containing products have decreased by nearly 38 %. The main emissions reductions have been achieved in the years since 1999. This successful reduction has occurred especially as a result of regulatory provisions such as the 31st Ordinance on the execution of the Federal Immissions Control Act, the 2nd such ordinance (and the TA Luft. The German "Blauer Engel" ("Blue Angel") environmental quality seal, which is used to certify a range of products, including low-solvent paints, lacquers and glues, has also played an important role in this development.
7. While product sales increased in some areas – even over periods of several years –thereby adding to emissions, the above-described measures offset this trend. These successes, which have occurred especially in recent years, are reflected in the updated emissions calculations – which, thanks to methods optimisation, now feature greater differentiation of VOC concentrations and EFs.

For the 2011 report, indirect $CO_2$ emissions from NMVOC have been calculated. The following relationship was used for pertinent conversion: EMindirect $CO_2$ = EMNMVOC * molar mass $CO_2$ / molar mass C * 60%

**Methodology, Activity & Emission factor ($N_2O$ Emissions):**

$N_2O$ in medical application, $N_2O$ use in the food industry, $N_2O$ in technical applications: With regard to development of $N_2O$-emissions time series for product use, to date only $N_2O$ emissions from medical applications have actually been determined. At the same time, this approach is justified, since this sector is the main source of $N_2O$ emissions in the area of product use, accounting for 90 % of such emissions (SCHÖN et al., 1993). The remaining 10 % can be broken down into technical applications (less than 10 %) and food technology applications (less than 5 %). From this information, the pertinent share for the food-technology industry is estimated at 3 %, and thus the corresponding share for the "technical applications" area is estimated at 7 %, the difference between the total remaining share (10 %) and the 3 % for foods. The $N_2O$-applications distribution in 2001 is 90 % for medical applications and 10 % for food technology and technical applications. In the time-series trend, a constant $N_2O$-emissions level is assumed in the "other" area, since no detailed figures on trends in this sector are available. In product use (medical and other applications), the input nitrous oxide escapes into the air directly and completely. As a result, the emission factor for this sector is 1 t/t, for all years in question.

$N_2O$ for production of semiconductor: All information from German association of electrical and electronics industry (ZVEI - Zentralverband Elektrotechnik- und Elektronikindustrie e.V): AD: amount of used $N_2O$, EF expert judgement 1990: 100% and 2008: 40 %

$N_2O$ formation in detonation of explosives with ammonium nitrate: According to the Federal Office for Material Research and Testing (BAM), levels of explosives use in Germany remained constant from 1990 to 2005. The $N_2O$-emissions amount estimated above represents only the theoretically maximum emittable amount. No information is available as to distribution, i.e. as to the number of detonations that would be required to emit this maximum amount of $N_2O$. For this reason, it is also assumed here that detonations are carried out primarily as "controlled" detonations, and that thus the maximum $N_2O$-emissions levels are seldom attained. No figures are available to permit determination of the amounts of $N_2O$ emissions actually emitted upon detonations. The figure (68 g $N_2O$ per kg AN) is a theoretical one, and it could be far off the actual value. When a 5 % emissions rate is assumed the $N_2O$ amount is 3.4 g. This figure is of the same order as the maximum emissions rate (2 g) given by BENNDORF (1999, page 4), a figure that corresponds to about 3 % of the above-determined theoretical maximum $N_2O$ emissions level. For a "worst-case scenario", the time-series trend in this project is calculated using the higher value (3.4 g). To determine the relevant emission factors in kg/t, the explosives amounts involved are used.

**Greece (NIR GR 2011)**

**GHG & pollutant:** $CO_2$, NMVOC **GHG Key Category**: no

**Time series consistency:** yes **Sector specific QA/QC and verification:** not provided

**Methodology (NMVOC, $CO_2$ emissions):**

The calculation of NMVOC emissions requires a very detailed analysis of the use of solvents and other products containing volatile organic compounds. There are two basic approaches for the estimation of emissions from Solvent and Other Product Use, which depend on the availability of data on the activities producing emissions and the emission factors.

- Production-based. In cases that solvent or coating use is associated with centralised industrial production activities (e.g. automobile and ship production), it is generally possible to develop NMVOC emission factors based on unit of product output. Next, annual emissions are estimated on the basis of production data.
- Consumption-based. In many applications of paints, solvents and similar products, the end uses are too small-scale, diverse, and dispersed to be tracked directly. Therefore, emission estimates are generally based on total consumption (i.e. sales) of the solvents, paints, etc. Used in these applications. The assumption is that once these products are sold to end users, they are applied and emissions generate relatively rapidly. Emission factors developed on the basis of this assumption can then be applied to data from sales for the specific solvent or paint products.

The application of both approaches needs detailed activity data, concerning either e.g. the amount of pure solvent consumed or the amount of solvent containing products consumed. The availability of such activity data in Greece is limited and as a result the default CORINAIR methodology is applied for the estimation of NMVOC emissions. It should be mentioned that evaporative emissions of GHG arising from other types of product use (e.g. $N_2O$ emissions from medical use), are not estimated since appropriate methodologies have not been developed yet. Carbon dioxide emissions are calculated from NMVOC emissions, assuming that the carbon content of NMVOC is 85%.

Paint application: Data availability concerning the use of products containing solvents for "Vehicle manufacture and Vehicle refinishing" is limited and as a result the respective emissions are not estimated. Emissions from "Domestic use and construction" are estimated on the basis of population figures and default emission factors from CORINAIR (0.5 kg / capita).

Metal Degreasing and Dry Cleaning: Emission estimates are given only for the dry cleaning sector. These estimates are based on population figures and default emission factors from CORINAIR (0.25 kg /capita) that is applicable to all types of dry cleaning equipment.

Other Use of Solvents and Related Activities: The emission factors used for some of the activities defined in CORINAIR and for which it was possible to obtain the corresponding activity data from the National Statistical Service of Greece, are: (a) Production and processing of PVC: 40 kg / t of product produced or processed. (b) Production of pharmaceutical products: 14 g /capita. (c) Ink production: 30 kg / t of product. (d) Glue production, applied emission factor: 20 kg /t of product (e) For the wood preservation: 24 kg / t of wood preserved (f) For fat edible and non edible oil extraction: 14 kg NMVOC/ t of seed processed (g) For domestic solvent use (except paint application): 2.6 kg NMVOC/capita/year.

In the case of printing industry, the estimation of emissions was based on the consumption of ink. Printing ink is mostly used for the publishing of newspapers, books and various leaflets. According to the estimations of one publishing organisation, the amount of ink used for the printing of a daily newspaper is approximately 3.7 g of ink. The quantity of ink used for printing books etc. Was calculated by subtracting the total quantity used for the newspapers from the total ink consumed. The emission factor applied (260 kg / t ink) is the average of emission factors for newspaper printing (54 kg /t ink) and for books and other leaflets printing (132-800 kg / t ink).

**Methodology, Activity & Emission factor ($N_2O$ Emissions):**

Not provided.

**Ireland (NIR IE 2011)**

**GHG & pollutant:** $CO_2$, NMVOC **GHG Key Category:** no

**Time series consistency:yes** **Sectorspecific QA/QC and verification:** not provided

**Methodology ($CO_2$ emissions):**

The inventory agency commissioned a project to carry out in-depth analysis of the specified NMVOC source categories (CTC, 2005) in order to compile the best possible estimates of emissions in 2004 as a follow-up to the earlier commissioned work and to revise the inventories for the years 1998-2003 as necessary in the light of new information. The revised estimates for these target years indicated lower NMVOC emissions than had been previously reported and used as the basis for $CO_2$ in the sector Solvent and Other Product Use.

A bottom-up approach was possible for activities subject to IPC licensing in the four source categories. Relevant data on emissions and solvent use were extracted from their electronic or paper Annual Environmental Reports (AERs) or Pollution Emissions Registers (PERs). Where such information was not available, European PERs were assessed. Top-down methods were used for activities not covered by the IPC licensing system. These included the use of paints and the use of domestic solvents, the two principal source categories. Input, usage and emissions data for each individual activity was collated into IPC and non-IPC spreadsheets and emissions were estimated by applying EMEP/CORINAIR methods, default emission factors and general guidance as appropriate. Scaling up to national level was applied where necessary.

**Activity data**

The activity data used for computing estimates of $CO_2$ emissions in Solvent and Other Product Use are the mass emissions of NMVOC computed for the relevant source categories (3.A, 3.B, 3.C and 3.D). The Irish data used for this purpose are the VOC emissions compiled according to the CORINAIR methodology for reporting to UNECE under the UNECE/LRTAP Convention. As part of the work on recalculations for the 2002 submission, Ireland produced a revised and consistent timeseries of such NMVOC emissions estimates based on the results of detailed analysis and investigations for 1998 (Finn et al, 2001).

**Emission factor**

The $CO_2$ emissions are derived by assuming that 85 percent of the mass emissions of NMVOC in the four categories is converted to $CO_2$.

**Italy (NIR IT 2011)**

**GHG & pollutant:** $CO_2$, NMVOC, $N_2O$ **GHG Key Category:** yes **Completness:** yes

**Uncertainty:** $CO_2$: 58% - AD 30%, EF 50%; $N_2O$: 51% - AD 50%, EF 10%

**Time series consistency:**yes **Sectorspecific QA/QC and verification:** provided

**Methodology, Activity data & Emission factor ($CO_2$ emissions):**

Emissions of NMVOC from solvent use have been estimated according to the methodology reported in the EMEP/CORINAIR guidebook, applying both national and international emission factors (Vetrella, 1994; EMEP/CORINAIR, 2005). Country specific emission factors provided by several accredited sources have been used extensively, together with data from the national EPER Registry; in particular, for paint application (Offredi, several years; FIAT, several years), solvent use in dry cleaning (ENEA/USLRMA, 1995), solvent use in textile finishing and in the tanning industries (TECHNE, 1998; Regione Toscana, 2001; Regione Campania, 2005; GIADA 2006). Basic information from industry on percentage reduction of solvent content in paints and other products has been applied to EMEP/CORINAIR emission factors in order to evaluate the reduction in emissions during the considered period. Emissions from domestic solvent use have been calculated using a detailed methodology, based on VOC content per type of consumer product. As regards household and car care products, information on VOC content and activity data has been supplied by the Sectoral Association of the Italian Federation of the Chemical Industry (Assocasa, several years) and by the Italian Association of Aerosol Producers (AIA, several years). As regards cosmetics and toiletries, basic data have been supplied by the Italian Association of Aerosol Producers too (AIA, several years) and by the national Institute of Statistics and industrial associations (ISTAT, several years; UNIPRO, several years); emission factors time series have been reconstructed on the basis of the information provided by the European Commission (EC, 2002). The conversion of NMVOC emissions into $CO_2$ emissions has been carried out considering that carbon content is equal to 85% as indicated by the European Environmental Agency for the CORINAIR project (EEA, 1997), except for $CO_2$ emissions from the 3C sub-sector which are not calculated to avoid double-counting. These emissions are, in fact, already accounted for in sectors 1A2c and 2B.

**Methodology, Activity data & Emission factor ($N_2O$ emissions):**

Emissions of $N_2O$ have been estimated taking into account information available by industrial associations. Specifically, the manufacturers and distributors association of $N_2O$ products has supplied data on the use of $N_2O$ for anaesthesia from 1994 to 2008 (Assogastecnici, several years). For previous years, data have been estimated by the number of surgical beds published by national statistics (ISTAT, several years ). Moreover, the Italian Association of Aerosol Producers (AIA, several years) has provided data on the annual production of aerosol cans. It is assumed that all $N_2O$ used will eventually be released to the atmosphere, therefore the emission factor for anaesthesia is 1 Mg $N_2O$/Mg product use, while the emission factor used for aerosol cans is 0.025 Mg $N_2O$/Mg product use, because the $N_2O$ content in aerosol cans is assumed to be 2.5% on average (Co.Da.P., 2005). $N_2O$ emissions have been calculated multiplying activity data, total quantity of $N_2O$ used for anaesthesia and total aerosol cans, by the related emission factors.

**Luxembourg (NIR LU 2011)**

**GHG & pollutant:** $CO_2$, NMVOC, $N_2O$ **GHG Key Category:** no

**Time series consistency:**yes **Sectorspecific QA/QC and verification:** not provided

**Methodology, Activity data & Emission factor ($CO_2$ emissions):**

The total amount of NMVOC emissions from solvents and other product use has been taken as a basis to calculate resulting $CO_2$ emissions. The following VOC emission estimates from this source categroy were done for 1990. Part of these data are based on estimations of various solvent application activities in Luxembourg as they were at the beginning of the 1990ies. In some sub-sectors, no statistical data on consumption of solvent containing products were available. Therefore part of the estimations are based on typical consumption estimates of products containing solvents for the neighbour countries of Luxembourg and/or for Europe. An update of these estimations of VOC emissions from solvents could lead to an improvement of the emission data.

**Netherlands (NIR NL 2011)**

**GHG & pollutant:** $CO_2$, NMVOC, $N_2O$ **GHG Key Category:** no

**Time series consistency:yes** **Sectorspecific QA/QC and verification**: not provided

**Methodology ($CO_2$ emissions):**

Country-specific carbon contents of the NMVOC emissions from 3A, 3B and 3D are used to calculate indirect $CO_2$ emissions. The monitoring of NMVOC emissions from these sources differs per source. Most of the emissions are reported by branch organizations (e.g. paints, detergents and cosmetics). The indirect $CO_2$ emissions from NMVOC are calculated from the average carbon contents of the NMVOC in the solvents: C-content NMVOC 3A: 0.72, 3B: 0.16 3D: 0.69. The carbon content of degreasing and dry cleaning is very low due to the high share of chlorinated solvents (mainly tetrachloroethylene used for dry cleaning). The emissions are then calculated as follows:

$CO_2$ (in Gg) = $\Sigma${NMVOC emission in subcategory i (in Gg) x C-fraction subcategory i} x 44/12.

The fraction of organic carbon (i.e. of natural origin) in the NMVOC emissions is assumed to be negligible.

***Activity data***

Consumption data and NMVOC contents of products are mainly provided by trade associations, such as the VVVF (for paints), the NCV (for cosmetics) and the NVZ (for detergents). The consumption of almost all solvent-containing products has increased since 1990. However, the general NMVOC content of products (especially paints) has decreased over the past years, resulting in a steady decline in NMVOC emissions since 1990. Due to the increased sales of hairspray and deodorant sprays NMVOC emissions have increased slightly in recent years.It is assumed that the NMVOC contents of these products have remained stable.

***Emission factors***

It is assumed that all NMVOC in the product is emitted (with the exception of some cleaning products and methylated spirit, which are partly broken down in sewerage treatment plants after use, or used as fuel in BBQs or fondue sets (methylated spirit). The carbon contents of NMVOC emissions are documented in a monitoring protocol.

**Methodology ($N_2O$ emissions):**

Country-specific methodologies are used for the $N_2O$ sources in Sector 3. Since the emissions in this source category are from non-key sources for $N_2O$, the present methodology complies with the IPCC Good Practice Guidance (IPCC, 2001).

Activity data: The major hospital supplier of $N_2O$ for anesthetic use reports the consumption data of anesthetic gas in the Netherlands annually. The Dutch Association of Aerosol Producers (NAV) reports data on the annual sales of $N_2O$-containing spray cans. Missing years are then extrapolated on the basis of this data. Domestic sales of cream in aerosol cans have shown a strong increase since 2000. The increase is reflected in the increased emissions in these years.

***Emission factors***

The emission factor used for $N_2O$ in anesthesia is 1 kg/kg. Sales and consumption of $N_2O$ for anesthesia are assumed to be equal each year. The emission factor for $N_2O$ from aerosol cans is estimated to be 7.6 g/can (based on data provided by one producer), and is assumed to be constant over time.

**Portugal (NIR PT 2011)**

**GHG & pollutant:** $CO_2$,NMVOC, $N_2O$ **GHG Key Category:** 3A, 3B 3D

**Planned improvements:** yes

**Methodology, Activity data & Emission factor ($CO_2$ emissions):**

NMVOC emissions estimates must be converted in $CO_2$ emissions whenever the carbon that is present in organic compounds has fossil fue origin (originated from feed-stocks from petroleum, coal or natural gas), and being assumed that NMVOC compounds are fully oxidized in air to carbon dioxide contributing thence to the atmospheric pool. Therefore, in general terms in except for the cases where a specific methodology is presented, emission of ultimate $CO_2$ were calculated assuming that 85 percent of the mass emissions of NMVOC is carbon and it is converted to carbon dioxide in the atmosphere. All solvents are assumed to have fossil origin and hence all ultimate $CO_2$ emissions are included in the inventory as $CO_2$e. With $UCO_2$=44/12 * NMVOC*0.85, where $UCO_2$-Ultimate $CO_2$ (ton/yr); NMVOC-emissions of NMVOC (ton/yr).

***Paint Application (CRF 3A): Methodology:***

NMVOC emissions from use of coating materials are estimated in a simple manner using the following formulation:

EmiNMVOC(a,p,y) =ΣaΣp[EF(p) * CoatingCONS(a,p,y)] * 10-3; where EmiNMVOC(y) – NMVOC emissions resulting from use/application of coating substances during year y; CoatingCONS(a,p,y) – Use of coating substance p in economic activity a during year y; EF(p) – NMVOV EF (solvent content) resulting from application of substance p.

For specific sectors were more detailed activity data and emissions factores were available a product base methodology was used. This is the case for: (a) Cars manufacturing; (b) Truck cabin coating; (c) Leather finishing. The product based methodology can be described as following: EmiNMVOC(p,y) = ΣaΣp [EF(p) * CoatingCONS(a,p,y)] * 10-3

Where EmiNMVOC(p,y) – NMVOC emissions resulting the production of product p during year y (t/yr); Product(p,y) – Production units of product p during year y (cars/yr, truck cabins/yr, kg leather/yr); EF(p) – NMVOV emission factor for production of product p (kg/car, kg/truck cabin, kg/kg leather) p – product (cars, truck cabin, leather).

Emission factors were taken from EMEP/CORINAIR guidebook 2009. Control strategies were obtained from GAINS model developed by IIASA. Default emission factors and abatment technologies were obtained from EMEP/CORINAIR, then the control strategy suggested by IIASA was applied in the following manner.

Activity data: For most activities there is no available and reliable statistical information concerning the use of paints. From IAIT and IAPI industrial surveys, from INE, it is only possible to determine consumption of paint in industrial activities, but the remaining, and larger part of consumption, is not known. Therefore total consume of paint and varnish in Portugal had first to be estimated from internal production, importation and exportation according to: TotalCons(y,p)=Production(y,p)+Imports(y,p)–Exports(y,p); Where: TotalCons(y)- Consumed paint and varnish of type p in year y; Production(y,p) - National Produced paint and varnish of type p in year y; Imports(y,p) - Imported paint and varnish of type p in year y; Exports(y,p) - Exported paint and varnish of type p in year y. The most detailed level desegregation per paint type that was possible to achieve was dependent, however on the fact that the statistical classes available for production data were dissimilar from the classes that are used for external trade. Information of annual production of paints by paint type are collected in IAIT and IAPI surveys.

***Degreasing and dry cleaning (CRF 3B) - Methodology:***

Assuming that all solvents consumed during degreasing and dry-cleaning evaporate, NMVOC emission will be equal to the amount of solvents used. If it is considered that annual consumption of solvents in an economic activity is used to replenish the quantity of solvent that was lost, then annual NMVOC emissions may be estimated from the annual consumption of solvent. This methodology overcomes the need of being aware of the portion of solvent that is recovered.

In the case of the dry-cleaning activity it was assumed that either the solvent is lost directly to atmosphere, or if it is conveyed to water or retained in clothes, but it will eventually reach atmosphere by evaporation. For the dry cleaning sector other methodologies, based on quantities of washed cloths, are recommended by several sources (USEPA, 1981; EMEP/CORINAIR). However, in Portugal there is no sufficient information to use this other approach.

Emission factors: Updated emissions factors from EMEP/CORINAIR were used.

Activity data: Statistical information concerning total solvent use, from the National Statistics Institute (INE), was used to estimate VOC emissions. Consumption of solvents, presented in Table 5.29, was based on consumption of volatile organic materials in the metal and plastic industries, from IAIT statistical survey. There is no available statistical information concerning consumption of solvents and other materials in dry-cleaning activity, because this activity is not included under IAIT and IAPI industrial surveys. Therefore, it was assumed that all PER (Tetra-chloro-ethylene)86 imported to Portugal is used in dry-cleaning87 activity and that all PER used is imported (no national production). Annual importation, which is available from INE’s statistical databases on external trade from 1990 to 2002, was therefore assumed as equal to solvent use.

***Chemical products, manufacture and processing (CRF 3C): Methodology:***

Emissions were estimated by the use of EF that are multiplied by the quantity of material produced: EmiNMVOC=EF*ActivityRate*10-3

Where EmiNMVOC - annual emission of NMVOC; ActivityRate - Indicator of activity in the production process. Quantity of product produced per year as a general rule for this emission source. It was assumed that NMVOC result mostly from solvents with fossil origin, therefore contributing fully to ultimate carbon dioxide emissions.

Processing of polymers-Activity data: Information about activity data for this sector is scarce and limited to year 1990, from National Statistics Institute (INE). However, because some polymers and fibbers are produced in a restricted number of industrial units, confidentiality constraints avoid their publication in NIR.

Emission factors applied to polymer processing and fibber production were set from AP42 (US-EPA), and from CORINAIR/EMEP.

Rubber Processing-Methodology: Emissions from rubber processing was estimated according with EMEP/CORINAIR Guidebook. Rubber processed for tyre production is not included in this sector.

Emission factor: The emission factor used for rubber processing was obtained from EMEP/CORINAIR guidebook. The same emission factor was used for year 1990 to 2008.

Activity data: Production data of rubber artefacts, incl. tires and tire reconstruction, was available from the IAIT and IAPI industrial surveys.

Paints Manufacturing- Activity data: Production of paints and varnish as described in Paint Application.

Emission factor: The USEPA (1983) EF was used - 15 kg for each tone of paint or varnish manufactured, that includes emissions during cleaning of installations and applies to production of all coating materials. This EF was applied to the total value of paint and varnish produced in Portugal irrespective of type.

Inks Manufacturing- Activity data: Statistical data of annual production of inks in Portugal is available from IAIT and IAPI industrial surveys (INE), for years 1990 through 2000. Linear forecast values were considered for subsequent years. Use of pigments in ink production was also available from INE's database.

Emission factor: The NMVOC EF that was used, 60 kg for each tone of ink manufactured, refers to vehicle coking and applies to general ink type, is from USEPA (1983).

Glues Manufacturing-Activity data: Production of glues and adhesives in Portugal is available in Portugal for years 1990 and 1991 from INE. Average values were considered for subsequent years. Production of glues and adhesives is reported in chapter 5.5.

Emission factor: The CORINAIR EF was adopted - 20 kg for each tone of glues and adhesives manufactured, which is applied to all kind of glues and adhesives, with or without solvents in their composition, and includes the cleaning of industrial installations.

Tyre manufacturing - Methodology: Emissions from tyre manufacturing were estimated according with EMEP/CORINAIR Guidebook. Statistical information for year 2008 was not yet available, therefore emissions were estimated according with a forecast based on historical emissions from the last five year period. NMVOC emissions were estimated from the number of tyres produced according to:

EmiNMVOC(y) = EFNMVOC (y) x Tyres(y) x 10-6; Where: EmiNMVOC(y) – NMVOC emissions from manufacturing of tyres during year y (t/yr); EFNMVOC(y) – NMVOC emission factor for manufacturing of tyres in year y (g/tyre); Tyres(y) – Number of tyres produced in year y (n./yr); y – year

Emission factor: were taken from EMEP/CORINAIR guidebook 2009. Control strategies were obtained from GAINS model developed by IIASA (http://gains.iiasa.ac.at). Default emission factors and abatment technologies were obtained from EMEP/CORINAIR, then the control strategy suggested by IIASA was applied

Activity data: Production data for tyres was available from the IAIT and IAPI industrial surveys from INE

**Other use of solvents and related activities (CRF 3D**

In this sector are included emission calculations for different activities, such as: 1) printing; 2) edible and non edible oil extraction; 3) use of glue and adhesives; 4) preservation of wood; 5) other solvents use; 6) use of perfume; 7) use of waxes and polishing products; 8) use of soaps and detergents.

Printing-Methodology: Emissions from printing industry was estimated according with Tier 1 methodologly from EMEP/CORINAIR Guidebook.With EmiNMVOC(a,p,y) = ΣpΣtΣi[EF(i) * INKCONS(p.i,t,y)] * 10-3. Where EmiNMVOC(y) – NMVOC emissions resulting from printing activities during year y; InkCONS(p,i,t,y)–Use of ink i for printing product p using technology t during year y; EF(p)–EF(solvent content) of ink i.

Emission factor: The emission factor used for printing activities was obtained from EMEP/CORINAIR guidebook. The same emission factor was used for year 1990 to 2008.

Activity data: Consumption of inks in printing industry according to printing product is available from the INE's statistical database. Original data allows that total consumption of inks – but not its type – be divided by printing products. Data printing activities in other economic activities – metallic industry, plastic industry, ceramic and - is also included. Some assumptions were made concerning what technology was used for each press product, i.e.: a) newspapers are printed using web letterpress or web offset lithography, according to national sales of ink; b) books printing uses lithography; c)Magazines and other publications use rotogravure; d) Packages and metallic, plastic and other artefacts use flexography; e) serigraphy technology is used in textile processes. For years in the period from 1990-1994, consumption of inks had to be estimated from national production and external trade and according to: TotalCons(y) = Production(y) + Imports(y) – Exports(y) Where: TotalCons(y)- Total consumption of inks in year y; Production(y,p) - National Produced inks in year y; Imports(y,p) - Imported inks in year y; Exports(y,p) - Exported quantity of inks in year y. Because external trade classifies inks in a single class, the more detailed desegregation of inks, available for production of inks, could not be used, and only total ink consumption could be assessed. The same proportion of technologies/products in 1995 was used to separate total inks consumption for the years 1990-1994.

Edible and non edible oil extraction - Methodology: Emissions of NMVOC were estimated considering that the annual hexane consumption by the industrial plant, hexane make-up, is due to losses to the air, and hence: EmiNMVOC(y) = MakeUpSolvents(y)Where: EmiNMVOC(y) - Emissions of NMVOC; MakeUpSolvents(y) - annual consumption ofsolvent in edible and non-edible oil industry, to replenish looses.

Ultimate $CO_2$ emissions are calculated assuming that 85.71 percent of the mass emissions of NMVOC is carbon and is converted to carbon dioxide in the atmosphere. All solvents are assumed to have fossil origin and hence all ultimate $CO_2$ emissions are included in the inventory. $UCO_2$ = 44/12 * NMVOC * 0.8571Where: $UCO_2$ - Ultimate $CO_2$ (ton/yr); NMVOC - Global emissions of NMVOC.

Emission factor: The national EF for NMVOC was calculated as the ratio of the amount of solvents consumed during manufacture processes to the quantities of edible and non edible oil manufactured. However, from the available data from INE, this EF could be only estimated from IAIT industrial survey because solvent consumption is not available from IAPI survey. Because in IAPI survey (1992-2000) it was not possible to distinguish production of edible oils from production of non-edible soils, it was decided just to use a global EF.

Activity data: Oil production data was available from INE's industrial surveys: IAIT for 1990 and 1991 and IAPI thereafter until 2000. Production data for 2001-2006 was forecasted by APA from previous years. All annual values are reported in Table 5.23, together with olive oil production, although that product does not cause NMVOC emissions.

Glues and adhesives - Methodology: NMVOC = ConsNat x FENat + Imp x FEimp Where: NMVOC = Global emissions of NMVOC (ton); ConsNat = Consumption of Glues and Adhesives produced in Portugal (ton); FENat = EF for Glues and Adhesives produced in Portugal; Imp = Importation of Glues and Adhesives (ton); FEimp = EF associated to the use of imported Glues and Adhesives. And ConsNat = ProdNat – ExpWhere: ConsNat = Consumed Glues and Adhesives produced in Portugal (ton); ProdNat= National Produced Glues and Adhesives (ton); Exp = Exported Glues and Adhesives (ton)

Emission factor: To estimate the EF applied for the use of national glues and adhesives, the ratio of the amount of solvents consumedduring manufacture processes with the amount of glues and adhesives manufactured was computed, and an average EF obtained. The EF for VOC emission from the manufacture of glue and adhesives was subtracted from this value to obtain the EFs for use of national produced glue and adhesives. For non-natural imported glues and adhesives the CORINAIR90 Default EF was used: 600 kg/ton. It is considered that natural based glue does not contribute to NMVOC emission.

Wood Preservation - Methodology: EmiNMVOC (y) = Consumption(y)* FEConsumptionwhere: EmiNMVOC(y) - Emissions of NMVOC associated to consumption of wood preservation products (ton); Consumption(y) - Consumption of wood preservation products (ton); FEConsumption - EF associated to the consumption of wood preservation products.

Emission factor: CORINAIR90 EF Handbook proposes three EFs for VOC emission from wood preservation, depending on the type of product used. The EF is 100 kg/ton of product applied for creosote; 900 kg/ton for solvent based products and 0 for water based products. The available data do not discriminate the share of the several types of preservation products, therefore, it was assumed that the main product used in Portugal is creosote.

Perfumes and Cosmetics Use - Methodology: Perfumes, personal hygiene and cosmetic products. Lipsticks, brilliantine, beauty creams and milks, depilatories, deodorants, hair sprays, sun lotions, tanner products, shampoos, tooth-cleaning, hair coloration and nail varnishes, among others, were considered in perfume, personal hygiene or cosmetic product. Emissions are estimated from:NMVOC = Use * FEProd+usewhere: NMVOC - Emissions of NMVOC associated to the production and use of perfumes (ton); use - Use of perfumes (ton); FEProd+use - EF associated to the production and use of perfumes (ton)

Emission factor: Since there are no available VOC EF for this activity an EF for VOC emission during the production and the use of these products was calculated. It was estimated by the ratio of the amount of solvents consumed during the manufacture process with the amount of perfumes, personal hygiene and cosmetic products manufactured.With FEProd+use = Solvents / National Production where: FEProd+use = Emissions of NMVOC associated to consumption of perfume and cosmetics use (ton); Solvents = Solvent content of perfumes (ton); National Production = National production values of perfumes (ton)

Waxes and polishing products / Soaps and Detergents: The Methodology is similar to the one that was used for Perfume Use.

Uses of solvents from biomass: There are two organic substances used as solvents: ethanol and rosin derivatives that may be emitted to atmosphere when used. Emissions may be estimated from consumption of these substances. However, in some activities, such as beverage and food industry, use of alcohol does not contribute to air emissions because it is ingested, and it is not included in emissions.

Methodology: Emissions are therefore estimated from: NMVOC = TotalConsumption – ConsNONEMIWhere NMVOC – Emission; TotalConsumption – Total consumption of biological solvent in all activities; ConsNONEMI – Consumption of biological solvents in activities where solvents are not emitted to atmosphere. For rosin derivatives total consumption is obtained from industrial production corrected from imports and exports: TotalConsumption = IndustrialProduction + Imports – Exports. Because these two compounds have a biological origin NMVOC emissions are not added to ultimate carbon dioxide emissions accounting.

Other uses of synthetic solvents from fossil fuels - Methodology: NMVOC = Produced Solventswhere: NMVOC = Emissions of NMVOC (ton); Consumed Solvents = quantity of produced solvents(ton). The calculation of Global $CO_2$ emissions is made according to:$UCO_2$ = 44/12 * NMVOC * 0.85where: $UCO_2$ - Ultimate $CO_2$ (ton/yr); NMVOC - Global emissions of NMVOC (ton/yr).

**Spain (NIR ES 2011)**

**GHG & pollutant:** $CO_2$,NMVOC, $N_2O$ **GHG Key Category:** no

**Time series consistency:** yes **Sector specific QA/QC and verification:** yes

**Methodology, Activity data & Emission factor ($CO_2$ emissions):**

Para los COVNM, la metodología aplicada para la estimación de las emisiones es esencialmente la de EMEP/CORINAIR, complementada con aportaciones y consultas realizadas con IIASA y EGTEI2. Como especificidades cabe destacar que, para algunas fuentes emisoras de especial relevancia, la información se ha recabado y procesado a nivel de planta individualizada (caso de las plantas de fabricación de automóviles). Para las restantes fuentes emisoras, la información sobre las variables de actividad procede en su inmensa mayoría de las

asociaciones empresariales correspondientes, entre las que cabe destacar las siguientes: Asociación Española de Fabricantes de Pinturas y Tintas de Imprimir (ASEFAPI); Federación Empresarial de la Industria Química Española (FEIQUE); Confederación Española de Empresarios de Plástico (ANAIP); Asociación Técnica del Poliuretano Aplicado (ATEPA); Asociación Nacional de Poliestireno Expandido (ANAPE); Asociación de la Industria del Poliuretano Rígido (IPUR); Consorcio Nacional de Industriales del Caucho (COFACO); Asociación Nacional de Empresas para el Fomento de las Oleaginosas y su Extracción (AFOEX); Asociación Nacional de Empresas de Protección de la Madera (ANEPROMA). Asimismo, se ha utilizado en el caso de algunas actividades información de estadísticas generales, tales como la población del Instituto Nacional de Estadística (INE), la Encuesta Industrial (INE) o la publicación “La Industria Química en España” del Ministerio de Industria, Turismo y Comercio (MITYC).

En cuanto a los factores de emisión, la metodología utilizada trata de cuantificar el contenido de COVNM en los disolventes y otros productos que contienen estas sustancias. En su caso, se incorporan los coeficientes reductores correspondientes a las distintas técnicas de aplicación y de abatimiento de las emisiones resultantes. En particular, y para el caso de aplicación de pinturas, es especialmente relevante la diferenciación entre los distintos tipos de pinturas (al agua, al disolvente, etc.). En la medida que se dispone de información de la evolución de estas técnicas en el tiempo, los factores aparecen anualizados.

Especial mención merece el caso de las fábricas de automóviles, para las cuales se ha realizado un tratamiento individualizado en cada planta, recabando la información sobre cantidades de concentrado y disolvente utilizadas y sus contenidos en COV en las distintas fases de las líneas de pintado del proceso productivo, así como de los procesos de recuperación y eliminación implantados en cada centro, de manera que la emisión se estima por balance de masas.

Una vez que se han determinado las emisiones inmediatas de COVNM su conversión a $CO_2$ final se realiza utilizando el siguiente algoritmo: Emisión $CO_2$ = Emisión COVNM · 0,85 · 44/12; donde 0,85 es el coeficiente para pasar la masa de COVNM a masa de carbono, y 44/12 para expresar la masa de carbono en masa de $CO_2$.

**Methodology, Activity data & Emission factor ($N_2O$ emissions):**

Por lo que al $N_2O$ se refiere, las emisiones consideradas en el inventario se circunscriben, tal y como se ha mencionado anteriormente, al uso de este gas con fines anestésicos. El óxido nitroso, con su característica de mayor solubilidad en grasas que en el agua, es transportado en forma gaseosa por la sangre hasta el sistema nervioso central a través de los líquidos contenidos en este último, donde se produce un estado de completa inconsciencia o narcosis. Como muchos otros productos anestésicos volátiles, el $N_2O$ sale del organismo sin experimentar cambios, es decir, es refractario al catabolismo de los procesos biológicos. Debido a esta propiedad la emisión de $N_2O$ se considera igual al consumo que de dicho gas se hace para este uso. Dicho consumo se ha estimado a partir de la información facilitada por una de las grandes empresas del sector para el periodo 1990-2003, y de información facilitada por el Ministerio de Sanidad y Política Social para los años 2006-2008, habiéndose estimado los consumos correspondientes a los años 2004 y 2005 mediante procedimientos de interpolación.

**Sweden (NIR SE 2011)**

**GHG & pollutant:** $CO_2$,NMVOC, $N_2O$ **GHG Key Category:** no

**Time series consistency:**yes **Sectorspecific QA/QC and verification**: no

**Methodology ($CO_2$ emissions):**

In 2005 a new method for estimating emissions from Solvent and Other Product Use was developed by SMED in cooperation with the Swedish Chemicals Agency. The method is more complete, accurate and transparent, and data can easily be updated on a yearly basis. The Swedish method is consumption-based with a product-related approach. With the new method emissions are calculated with activity data from the Products Register hosted by the Swedish Chemicals Agency, and country specific emissions factors. The Products Register is a register over chemical products imported to or manufactured in Sweden. Official statistics from the Products Register is only available with a two years delay.

A list of substances defined as NMVOCs, and found in the Products Register in quantities over 100 tonnes, has been compiled. The threshold of 100 tonnes is based on the fact that substances found in the Products Register in quantities less than 100 tonnes are equivalent to 0.03 % of the total solvent sales of 400 000 tonnes. The following definition of NMVOC has been used: “Volatile organic compounds (VOC) mean any organic compound having a vapour pressure of 0.01 kPa or more at 293.15 K, or having a corresponding volatility under the particular conditions of use. The fraction of creosote which exceeds this value of vapour pressure at 293.15 K shall be considered a VOC.” The list includes 382 substances, and was used for extracting quantities of NMVOC and C in substances found in the Products Register for year 2007. The carbon share (C) for each substance defined as NMVOC has been calculated based on the molecular formula. In some cases a mixture of substances are included in the substance list, and for the mixtures the carbon content has been estimated by the Swedish Chemicals Agency as 85 % of NMVOC, based on information in the Products Register. In those cases when the carbon content cannot be derived from the Products Register, the default value, given in the 2006 IPCC guidelines, of 60 % has been used.

***Activity data:*** The sold amount of solvents and solvent based products, (production + import – export), is derived from the Products Register at the Swedish Chemicals Agency. When a company is reporting to the Products Register it should be stated, among other things, to which industrial sectors the product is sold, and the intended use of the product. The substance list has been used to extract quantities of NMVOC and C in substances found in the Products Register. Due to confidentiality, data cannot be delivered on substance level. Consequently, data are delivered on product and industrial category level. An advantage of making a more targeted selection like this on product and industry category, is that the risk that chemicals are double-reported in the Products Register is minimized. Hence it is highly unlikely that the same

chemical will appear in a particular product that is sold twice to the same industrial sector.

Data extractions have been made for each year from 1995 to 2007, since reliable activity data, for this purpose, can only be obtained from 1995. The extractions show for each year: (A) The intended use of the product and the type of product (product code); (B) Industry to which the product is sold (industry category); (C) Quantity NMVOC; (D) Quantity C.

The extractions from the Products Register for 1995-2007 have been used in order to compile a connection diagram with all combinations of "product codes" and "industry categories". For all combinations, decisions whether to include or exclude from reporting are based on expert judgements in order to avoid doublecounting of reported emissions within other sectors. The industries that are excluded in the extractions from the Products Register are considered to be reported in CRF 1, 2 or 6. If the combination should be included, its specific CRF code has

been decided. Furthermore, it has to be determined if the product is used as raw material or not. The quantities of NMVOC used as raw material in processes have been identified and treated separately from remaining quantities for each CRF code, due to that most of the solvents used as raw material will not be emitted. An Excel macro has been written in order to compile time series with quantities of

NMVOC and C for each sub-code within CRF sector 3.

The sold amount of solvent is not always identical to the amount of solvent used, i.e. stock of solvents. Therefore activity data has been recalculated using a running average over three years. This leads to the need for updating of reported emissions for the latest three years in the time series in every new submission.

***Emission factor:*** Country specific emission factors for solvents used as raw material and for remaining solvents were developed for each reported activity within each CRF code The emission factors have been based on the old emission time series 1988-2001, which were developed by SMED in 2002109. The old time series were mostly based on information in earlier national reports, investigations and estimations of national NMVOC emissions. These investigations were dedicated specific emission inventories focusing on NMVOC, which is why they are still to be considered as reliable. The emission factors have been developed also considering the application techniques, the reported emissions presented in environmental reports for specific industries, as well as other pathways of release (e.g. waste or water).

The emission factors for raw material are set very low, since most of the solvents will not be emitted during production, but will end up in the product.

**Methodology, Activity data & Emission factor ($N_2O$ emissions):**

Due to confidentiality, data for 3D1-Use of $N_2O$ for Anaesthesia and 3D3 – $N_2O$ from Aerosol cans cannot be reported separately.

**Sector 3 Solvent and Other product use: Methodological issues for estimation of emissions**

**United Kingdom (NIR GB 2011)**

**GHG & pollutant:** NMVOC **GHG Key Category**: no

**Time series consistency:**yes **Sectorspecific QA/QC and verification:** not provided

**Methodology, Activity data & Emission factor ($CO_2$ emissions):**

3.A.: Emission estimates for most types of coatings are based on annual consumption data and emission factors provided by the British Coatings Federation (BCF, 2009). Emission estimates for drum coatings, metal packaging and OEM coatings are estimated instead using a combination of consumption data and emission factors and estimates made on a plant by plant basis using information supplied by the Metal Packaging Manufacturers Association (MPMA, 2000) and the regulators of individual sites.

3.B.: Emission estimates for surface cleaning processes are based on estimates of annual consumption and emission factors. Consumption estimates are based on data from UK industry sources and UK and European trade associations, together with some published data. Some extrapolation of data is necessary, using Index of Output data produced annually by the Office for National Statistics (ONS, 2009), although this is not expected to introduce significant uncertainty into the estimates. Emission factors assume that all hydrocarbon and oxygenated solvent is emitted, while emission factors for chlorinated solvents are lower, reflecting the fact that some solvent is sent for disposal rather than emitted.

Emission estimates for dry cleaning are based on estimates of solvent consumption by the sector. Industry-sourced data are available for some years and estimates for the remaining years are based on a model of the sector, which takes account of changes in the UK population and the numbers of machines of different types and with different emission levels.

Emission estimates for leather degreasing are based on a single estimate of solvent use extrapolated to all years using the Index of Output for the leather industry, which is produced annually by the ONS.

3.C.: Emission estimates for coating of film, leather, and textiles as well as estimates for tyre manufacture are based on plant-by-plant emission estimates, made on the basis of information available from regulators.

Emissions from coating manufacture are calculated from the solvent contained in coatings produced in the UK, by assuming that an additional 2.5% of solvent was lost during manufacture.

Emissions from the manufacture of rubber goods other than tyres are based on solvent consumption estimates provided by the British Rubber Manufacturers Association (BRMA, 2001), which are extrapolated to other years on the basis of the Index of Output figures for the rubber industry which are published each year by the ONS.

3.D.: Emission estimates are based on one of three approaches: (1) Estimates are made based on activity data and emission factors supplied by industry sources (printing processes, consumer products, wood preservation); (2) Estimates are made for each process in a sector based on information provided by regulators or process operators (seed oil extraction, pressure sensitive tapes, paper coating); (3) Estimates are based on estimates of solvent consumption supplied by industry sources (adhesives, aerosols, agrochemicals, miscellaneous solvent use).

## 5.3 Sector-specific quality assurance and quality control (EU-15)

There are no sector-specific QA/QC procedures for this sector.

## 5.4 Sector-specific recalculations (EU-15)

Table 5.7 shows that in the solvent sector recalculations were made for $CO_2$ and $N_2O$.

**Table 5.7 Sector 3 Solvent and Other Product Use: Recalculations of total GHG emissions and recalculations of GHG emission for 1990 and 2008 by gas (Gg$CO_2$-equivalents and %)**

| 1990 | $CO_2$ | | $CH_4$ | | $N_2O$ | | HFCs | | PFCs | | $SF_6$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | percent | Gg | percent | Gg | percent | Gg | percent | Gg | percent | Gg | percent |
| Total emissions and removals | -17,295 | -0.6% | 13,980 | 3.2% | 8,543 | 2.2% | 47 | 0.2% | 6 | 0.0% | 11 | 0.1% |
| Solvent and other product | -743 | -7.8% | 0 | 0.0% | 227 | 5.0% | NO | NO | NO | NO | NO | NO |
| **2008** | | | | | | | | | | | | |
| Total emissions and removals | -21,852 | -0.7% | 14,673 | 4.9% | 9,128 | 3.2% | 660 | 1.1% | 77 | 2.7% | -2,603 | -29.0% |
| Solvent and other product | -673 | -9.8% | 0 | 0.0% | 0 | 0.0% | NO | NO | NO | NO | NO | NO |

*Abbreviations explained in the Chapter ‘Units and abbreviations’.*

Table 5.8 provides an overview of Member States’ contributions to EU-15 recalculations. Germany and Spain had larger recalculations for 1990 and/or 2008.

**Table 5.8** **Sector 3 Solvent and Other Product Use: Contribution of Member States to EU-15 recalculations for 1990 and 2008 by gas (difference between latest submission and previous submission Gg of $CO_2$ equivalents)**

| | 1990 | | | | | | 2008 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $CO_2$ | $CH_4$ | $N_2O$ | HFCs | PFCs | $SF_6$ | $CO_2$ | $CH_4$ | $N_2O$ | HFCs | PFCs | $SF_6$ |
| Austria | 0 | 0 | 0 | NO | NO | NO | -21 | 0 | 0 | NO | NO | NO |
| Belgium | NA | 0 | -33 | NO | NO | NO | NA | 0 | 0 | NO | NO | NO |
| Denmark | 0 | 0 | 1 | NO | NO | NO | 0 | 0 | 0 | NO | NO | NO |
| Finland | 0 | 0 | 0 | NO | NO | NO | 1 | 0 | 0 | NO | NO | NO |
| France | -3 | 0 | 2 | NO | NO | NO | 25 | 0 | 0 | NO | NO | NO |
| Germany | -756 | 0 | -164 | NO | NO | NO | -671 | 0 | 0 | NO | NO | NO |
| Greece | 0 | 0 | 0 | NO | NO | NO | 0 | 0 | 0 | NO | NO | NO |
| Ireland | 1 | 0 | 0 | NO | NO | NO | -12 | 0 | 0 | NO | NO | NO |
| Italy | 0 | 0 | 0 | NO | NO | NO | -1 | 0 | 0 | NO | NO | NO |
| Luxembourg | 0 | 0 | 0 | NO | NO | NO | 1 | 0 | 0 | NO | NO | NO |
| Netherlands | 0 | 0 | 0 | NO | NO | NO | 3 | 0 | 0 | NO | NO | NO |
| Portugal | 14 | 0 | 0 | NO | NO | NO | -1 | 0 | 0 | NO | NO | NO |
| Spain | 0 | 0 | 421 | NO | NO | NO | 0 | 0 | 0 | NO | NO | NO |
| Sweden | 0 | 0 | 0 | NO | NO | NO | 3 | 0 | 0 | NO | NO | NO |
| UK | NE | 0 | 0 | NO | NO | NO | NE | 0 | 0 | NO | NO | NO |
| **EU-15** | **-743** | **0** | **227** | **NO** | **NO** | **NO** | **-673** | **0** | **0** | **NO** | **NO** | **NO** |

# 6 AGRICULTURE (CRF SECTOR 4)

Half of the European Union's land is farmed. This fact alone highlights the importance of farming for the EU's natural environment. Farming and nature exercise a profound influence over each other. Farming has contributed over the centuries to creating and maintaining a variety of valuable semi-natural habitats. Today these shape the majority of the EU's landscapes and are home to many of the EU's richest wildlife. Farming also supports a diverse rural community that is not only a fundamental asset of European culture, but also plays an essential role in maintaining the environment in a healthy state30.

The links between the richness of the natural environment and farming practices are complex. While many valuable habitats in Europe are maintained by extensive farming, and a wide range of wild species rely on this for their survival, agricultural practices can also have an adverse impact on natural resources. Pollution of soil, water and air, fragmentation of habitats and loss of wildlife can be the result of inappropriate agricultural practices and land use.

Agriculture in Europe is determined by the Common Agriculural Policy (CAP) of the European Union. The CAP dates from 1957, and its foundations are entrenched in the Treaty of Rome. Initially, the emphasis of the CAP was to increase agricultural productivity, partly for food security reasons, but also to ensure that the EU had a viable agricultural sector and that consumers had a stable supply of affordable food (Gay et al., 2005). With the MacSharry reform of 1992 several steps were taken by the EU to shift CAP subsidies away from price and market support towards direct support for farmers. This was further pursued with the Agenda 2000 reform, as signified by the shift in focus towards the maintenance and enhancement of the rural environment and the growing recognition of agriculture as a multifunctional activity. In environmental terms, the focus is on

- less-favoured areas and areas with environmental restrictions, and
- on agricultural production methods designed to protect the environment and to maintain the countryside.

However price support and income payments, together with milk quotas, remained the dominant support measures. The 2003 CAP reform made further progress in the direction initiated by the Agenda 2000 reform, by aiming to make European agriculture more market oriented and giving a stronger focus to environmental protection. With the CAP reform, cross-compliance became an obligatory element of the CAP. Cross-compliance establishes a link between the granting of income support to the farmers and the compliance by the beneficiary with specified requirements of public interest (Oenema, 2008). These are given in

- “Statutory management requirements” (SMR, (Annex III of Regulation (EC) No 1782/2003) which are set in 19 community legislative acts on environment, food safety, animal health and welfare, as well as
- the obligation to maintaining land in good agricultural and environmental conditions (GAECs) and maintaining permanent pasture at level at 1.5.2004. Definitions of GAEC are specified at national or regional level and should warrant appropriate soil protection, ensure a minimum level of maintenance of soil organic matter and soil structure and avoid the deterioration of habitats.

An important driver of GHG emissions from agriculture were the milk quota. For example in the Netherlands, total milk production is determined mainly by EU policy on milk quota, which remained unchanged. Therefore, the effect of increasek milk production per cow needed to be counteracted by decreasing the animal number of adult dairy cattle.

30 http://europa.eu.int/comm/agriculture/envir/index_en.htm

The Nitrates Directive (Council Directive 91/676/EEC) is the SMR with the largest impact on greenhouse gas emissions from agriculture. The directive aims at reducing and preventing water pollution caused by nitrates from agricultural sources with the goal that nitrate concentrations in groundwater will not exceed 50 mg NO3 L-1 and listing codes of good practice (Annex II A) to be implemented by the farmers on a voluntary basis. Nitrate vulnerable zones must be designated on the basis of monitoring results which indicate that the groundwater and surface waters in these zones are or could be affected by nitrate pollution from agriculture. The action program must contain mandatory measures relating to: (i) periods when application of animal manure and fertilizers is prohibited; (ii) capacity of and facilities for storage of animal manure; and (iii) limits to the amounts of animal manure and fertilizers applied to land.

This affected emissions in most countries, for example in Belgium, manure Action Plans (based on the Nitrate directive) in Flanders affected NH3 volatilization from manure application. The first action plan in 1991 regulated the reduced in which manure can be spread and foresees low-emission techniques for the application of manure on land. The MAP2bis in 2000 focuses on the reduction of the manure surplus and manure processing in order to reduce the NH3 emissions from manure application on land. Other MAP's followed.

In Denmark, the environmental policy has introduced a series of measures to prevent loss of nitrogen from agricultural soil to the aquatic environment. The measures include improvements to the utilisation of nitrogen in manure, a ban on manure application during autumn and winter, increasing area with winter-green fields to catch nitrogen, a maximum number of animals per hectare and maximum nitrogen application rates for agricultural crops. All farmers are obliged to do N-mineral acounting a a farm and field level with the N-excretaion data from FAS (Faculty of Agriucltural Sciences). The N figures also include the quantities of mineral fertilisers bought and sold. Suppliers of mineral fertilisers are required to report all N sales to commmercial farmers to the Plant Directorate. An active environmental policy has brought about a decrease in the N-excretion, a decrease of emission per produced animal, because of more efficient feeding. As a result of increasing requirements to reduce the nitrogen loss to the environment, the consumption of nitrogen in synthetic fertiliser has more than halved from 1990 to 2008.

In the Netherlands, manure and fertilizer policy influences livestock numbers. Especially young cattle, pigs and poultry numbers decreased by the introduction of measures like buying up part of the so-called pig and poultyr production rights (ceilings for total animal numbers) by the government and lowering the maximum nutrient application standards for manure and fertilizer.

However, greater compliance to standards and requirements for animal welfare and the housing of animals may contribute to increasing emissions (so-called pollution swapping).

Beside the environmentally-targeted directives, also the so-called first pillar of the CAP (dealing with market support in contrast to pillar two covering rural development measures) had a strong impact on the greenhouse gas emissions from agriculture in Europe, namely through the milk quota system, which lead to a strong reduction of animal numbers in the dairy sector to compensate for the increasing animal performance during the last decades.

Other important policies affecting greenhouse gas emissions from agriculture, particularly by addressing the abatement of air pollution through the control of NOx and NH3 emissions include, under others,

- the 1999 Gothenburg Protocol under the Convention on Long Range Transboundary Air Pollution (CLRTAP) to 'Abate Acidification, Eutrophication and Ground-level Ozone', which entered into force on 22 June 2006;
- the National Emission Ceilings Directive (NEC - Directive 2001/81/EC), which sets upper limits for each Member State for the total emissions in 2010 of the four pollutants responsible for acidification, eutrophication and ground-level ozone pollution;
- the Integrated Pollution Prevention and Control (IPPC) Directive, which was established in 1996 (**http://ec.europa.eu/environment/ippc/index.htm**), and aims at minimizing pol-

lution from point sources, i. e., intensive animal production facilities (pig and poultry farms, with > 2000 fattening pigs; >750 sows; or > 40,000 head of poultry). These are required under the directive to apply control techniques for preventing NH3 emissions according to Best Available Technology (BAT).

Structural changes are caused also by the general development of countries. For example, in Finland, the membership in the EU resulted in changes in the economic structure followed by an increase in the average farm size and a decrease in the number of small farms (Pipatti 2001), causing also a decrease in the livestock numbers for most animal types. Swedish agriculture has undergone radical structural changes and rationalisations over the past 50 years. One fifth of the Swedish arable land cultivated in the 1950s is no longer farmed. Closures have mainly affected smallholdings and those remaining are growing larger. In 1999, some 31,000 agricultural holdings were livestock farms, 14,000 were purely crop husbandry farms, and only 5,000 were a combination of the two. Livestock farmers predominately engage in milk production and the main crops grown in Sweden are grain and fodder crops. The decrease of agricultural land area has continued since Sweden joined the European Union in 1995 and the acreages of land for hay and silage has increased. Organic farming has increased from 3 % of the arable land area in 1995 to 17 % in 2007.

## 6.1 Overview over the sector

CRF Sector 4 ‘Agriculture’ contributes 10.2 % to total EU-15 GHG emissions, making it the second largest sector after ‘Energy’. The most important GHGs from ‘Agriculture’ are $N_2O$ and $CH_4$ accounting for 5.6 % and 4.5 % of the total GHG emissions respectively. The emissions from this sector decreased by 14 % from 441 Tg in 1990 to 378 Tg in 2009 (Figure 6.1). In 2009, the emissions decreased by 2.1 % compared to 2008. The key sources in this sector are:

- 4 A 1 Cattle: ($CH_4$)
- 4 A 3 Sheep: ($CH_4$)
- 4 B 1 Cattle: ($CH_4$)
- 4 B 13 Solid Storage and Dry Lot: ($N_2O$)
- 4 B 8 Swine: ($CH_4$)
- 4 D 1 Direct Soil Emissions: ($N_2O$)
- 4 D 2 Pasture, Range and Paddock Manure: ($N_2O$)
- 4 D 3 Indirect Emissions: ($N_2O$)

Figure 6.1 shows that the three largest key sources account for about 70% of agricultural GHG emissions of the EU-15.

**Figure 6.1** EU-15 GHG emissions for 1990–2009 from CRF Sector 4: 'Agriculture' in $CO_2$ equivalents (Tg)

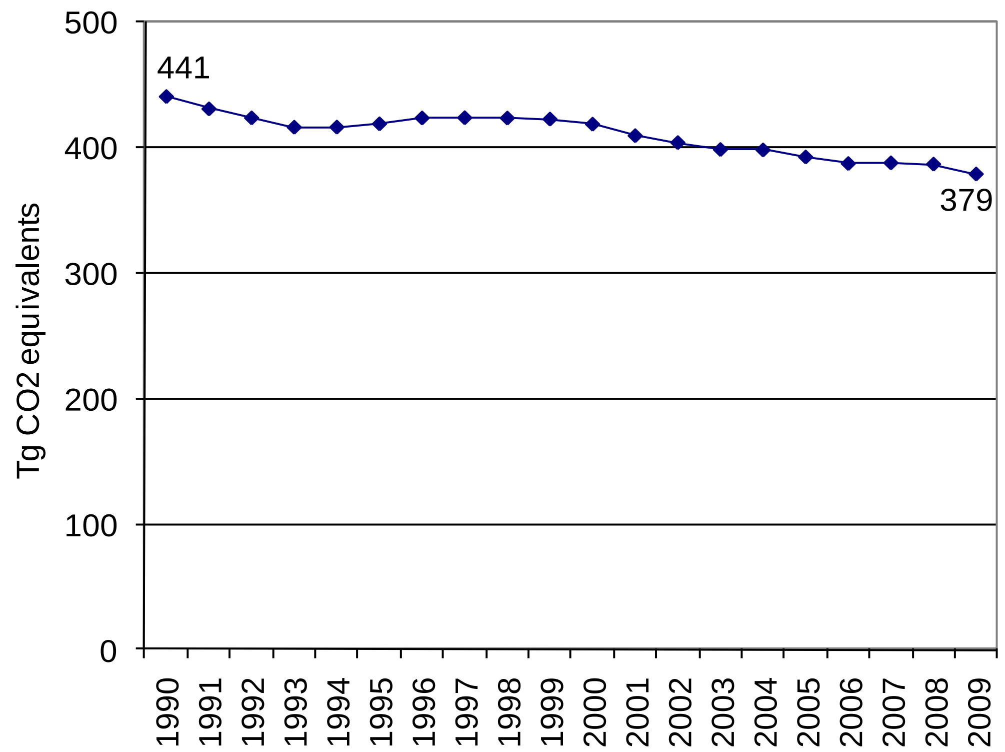
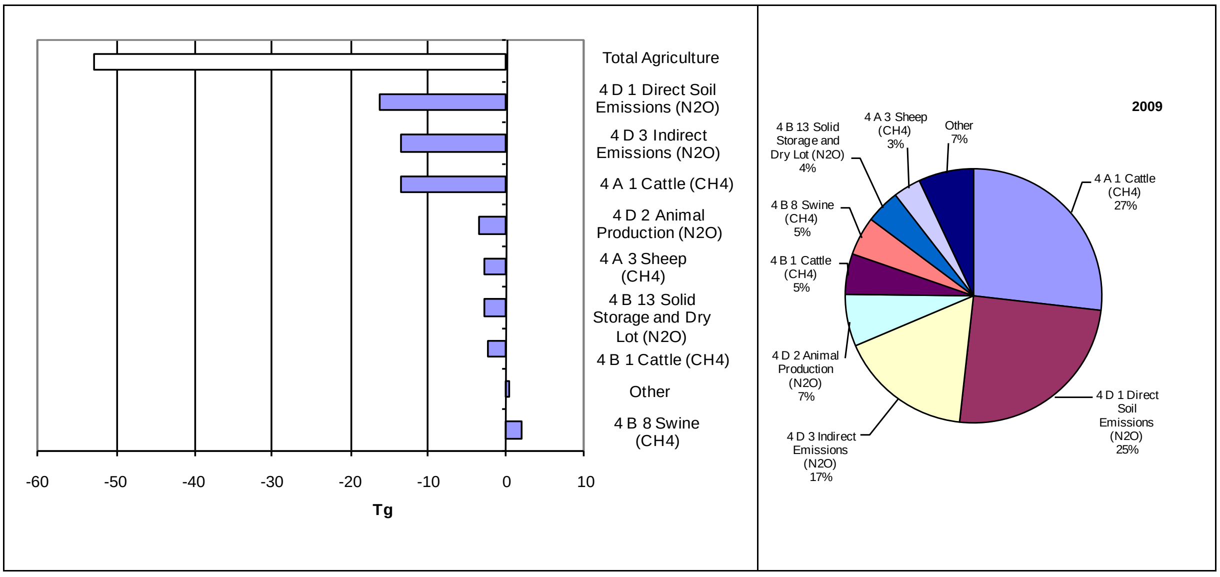



Figure 6.2 shows that large reductions occurred in the largest key sources $N_2O$ from 4.D.1: 'Direct soil emissions', 4.D.3: 'Indirect emissions' and $CH_4$ from 4.A.1: 'Cattle'. The main reasons for this are decreasing use of fertiliser and manure and declining cattle numbers in most Member States.

**Figure 6.2** Absolute change of GHG emissions by large key source categories 1990–2009 in $CO_2$ equivalents (Tg) in CRF Sector 4: 'Agriculture' and share of largest key source categories in 2009



## 6.2 Source Categories

### 6.2.1 Enteric fermentation (CRF Source Category 4A) (EU-15)

Table 6.1 shows total GHG and $CH_4$ emissions by Member State from 4A Enteric Fermentation. Between 1990 and 2009, $CH_4$ emission from 4A Enteric fermentation decreased by 12 %. The absolute decrease was largest in Germany, the absolute increase was largest in Spain.

**Table 6.1 4A Enteric Fermentation: Member States' contributions to total GHG and $CH_4$ emissions**

| Member State | GHG emissions in 1990 (Gg $CO_2$ equivalents) | GHG emissions in 2009 (Gg $CO_2$ equivalents) | $CH_4$ emissions in 1990 (Gg $CO_2$ equivalents) | CH4 emissions in 2009 (Gg $CO_2$ equivalents) |
|---|---|---|---|---|
| Austria | 3,753 | 3,265 | 3,753 | 3,265 |
| Belgium | 4,131 | 3,548 | 4,131 | 3,548 |
| Denmark | 3,249 | 2,859 | 3,249 | 2,859 |
| Finland | 1,933 | 1,580 | 1,933 | 1,580 |
| France | 32,067 | 29,484 | 32,067 | 29,484 |
| Germany | 27,294 | 20,951 | 27,294 | 20,951 |
| Greece | 3,246 | 3,235 | 3,246 | 3,235 |
| Ireland | 9,510 | 8,700 | 9,510 | 8,700 |
| Italy | 12,179 | 10,779 | 12,179 | 10,779 |
| Luxembourg | 261 | 246 | 261 | 246 |
| Netherlands | 7,540 | 6,496 | 7,540 | 6,496 |
| Portugal | 2,637 | 2,862 | 2,637 | 2,862 |
| Spain | 11,580 | 12,529 | 11,580 | 12,529 |
| Sweden | 3,058 | 2,697 | 3,058 | 2,697 |
| United Kingdom | 18,312 | 15,093 | 18,312 | 15,093 |
| **EU-15** | **140,750** | **124,325** | **140,750** | **124,325** |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

Enteric fermentation from cattle is the largest single source of $CH_4$ emissions in the EU-15 accounting for 2.8 % of total GHG emissions in 2009. Between 1990 and 2009, $CH_4$ emissions from enteric fermentation from cattle declined by 12 % in the EU-15 (Table 6.2). In 2009, the emissions were at the level of 2008. The main driving force of $CH_4$ emissions from enteric fermentation is the number of cattle, which was 19 % below 1990 levels in 2009. The Member States with most emissions from this source were France and Germany (together 45 %). All Member States except Spain, Portugal and Greece reduced $CH_4$ emissions from enteric fermentation of cattle between 1990 and 2009.

**Table 6.2** **4A1 Cattle: Member States' contributions to $CH_4$ emissions and information on method applied and emission factor**

| Member State | $CH_4$ emissions (Gg $CO_2$ equivalents) | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg CO2 equivalents) | (%) | (Gg CO2 equivalents) | (%) | | |
| Austria | 3,551 | 3,020 | 3,056 | 2.9% | 37 | 1% | -494 | -14% | T2 | CS |
| Belgium | 3,879 | 3,283 | 3,303 | 3.2% | 20 | 1% | -576 | -15% | T2 | D,CS |
| Denmark | 2,950 | 2,384 | 2,466 | 2.4% | 83 | 3% | -484 | -16% | T2 | CS |
| Finland | 1,011 | 761 | 770 | 0.7% | 9 | 1% | -242 | -24% | T2 | CS |
| France | 29,040 | 27,348 | 27,015 | 26.0% | -334 | -1% | -2,025 | -7% | T2 | CS |
| Germany | 25,962 | 19,788 | 19,761 | 19.0% | -27 | 0% | -6,201 | -24% | CS,T2 | CS |
| Greece | 929 | 949 | 945 | 0.9% | -4 | 0% | 16 | 2% | T2 | CS,D |
| Ireland | 8,422 | 8,118 | 8,036 | 7.7% | -81 | -1% | -386 | -5% | T2 | CS |
| Italy | 10,040 | 8,567 | 8,412 | 8.1% | -155 | -2% | -1,628 | -16% | T2 | CS |
| Luxembourg | 257 | 238 | 240 | 0.2% | 2 | 1% | -17 | -7% | T2 | CS |
| Netherlands | 6,783 | 5,782 | 5,831 | 5.6% | 49 | 1% | -952 | -14% | T2 | CS |
| Portugal | 1,814 | 2,141 | 2,095 | 2.0% | -46 | -2% | 281 | 15% | T2 | CS |
| Spain | 6,473 | 8,021 | 7,867 | 7.6% | -154 | -2% | 1,394 | 22% | CS,T2 | D,CS |
| Sweden | 2,698 | 2,364 | 2,345 | 2.3% | -19 | -1% | -353 | -13% | CS | CS |
| United Kingdom | 13,623 | 11,787 | 11,657 | 11.2% | -130 | -1% | -1,967 | -14% | T2 | D |
| **EU-15** | **117,434** | **104,550** | **103,800** | **100.0%** | **-750** | **-1%** | **-13,634** | **-12%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

Enteric fermentation from sheep is the fifth largest single source of $CH_4$ emissions in the EU-15 and accounts for 0.36 % of total GHG emissions in 2009. Between 1990 and 2009, $CH_4$ emissions from enteric fermentation of sheep declined by 19 % in the EU-15 (Table 6.3). In 2009, the emissions were 2 % lower compared to 2008. The main driving force of $CH_4$ emissions from enteric fermentation is the number of sheep, which was 22 % below 1990 levels in 2009. The Member States with most emissions from this source were Spain and the United Kingdom (51 %). Most Member States reduced $CH_4$ emissions from enteric fermentation of sheep.

**Table 6.3** **4A3 Sheep: Member States' contributions to $CH_4$ emissions and information on method applied and emission factor**

| Member State | $CH_4$ emissions (Gg $CO_2$ equivalents) | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg CO2 equivalents) | (%) | (Gg CO2 equivalents) | (%) | | |
| Austria | 52 | 56 | 58 | 0.4% | 2 | 3% | 6 | 11% | T1 | D |
| Belgium | 32 | 18 | 18 | 0.1% | 0 | -2% | -14 | -44% | T1 | D |
| Denmark | 33 | 42 | 42 | 0.3% | -1 | -2% | 9 | 26% | T2 | CS |
| Finland | 15 | 22 | 21 | 0.2% | -1 | -4% | 6 | 41% | T2 | CS |
| France | 2,296 | 1,694 | 1,667 | 12.4% | -27 | -2% | -629 | -27% | CR | CS |
| Germany | 549 | 409 | 395 | 2.9% | -15 | -4% | -154 | -28% | T1 | D |
| Greece | 1,656 | 1,677 | 1,673 | 12.4% | -4 | 0% | 17 | 1% | T2 | CS,D |
| Ireland | 1,032 | 633 | 589 | 4.4% | -44 | -7% | -444 | -43% | T1 | D |
| Italy | 1,468 | 1,373 | 1,346 | 10.0% | -27 | -2% | -122 | -8% | T1 | D |
| Luxembourg | 1 | 1 | 1 | 0.0% | 0 | 4% | 0 | 21% | T1 | D |
| Netherlands | 286 | 204 | 188 | 1.4% | -16 | -8% | -98 | -34% | T1 | D |
| Portugal | 560 | 625 | 583 | 4.3% | -43 | -7% | 23 | 4% | T2 | CS |
| Spain | 4,269 | 3,663 | 3,656 | 27.2% | -7 | 0% | -613 | -14% | CS,T2 | D,CS |
| Sweden | 68 | 88 | 91 | 0.7% | 3 | 3% | 23 | 33% | T1 | D |
| United Kingdom | 4,354 | 3,259 | 3,128 | 23.3% | -131 | -4% | -1,225 | -28% | T1 | CS |
| **EU-15** | **16,671** | **13,766** | **13,456** | **100.0%** | **-311** | **-2%** | **-3,216** | **-19%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

### 6.2.2 Manure management (CRF Source Category 4B) (EU-15)

Table 6.4 shows total GHG, $CH_4$ and $N_2O$ emissions by Member State from 4B Manure Management. Between 1990 and 2009, $CH_4$ and $N_2O$ emissions from 4B Manure Management decreased by 1 % and 13 % respectively.

**Table 6.4 4B Manure Management: Member States' contributions to total GHG emissions, $CH_4$ and $N_2O$ emissions**

| Member State | GHG emissions in 1990 (Gg $CO_2$ equivalents) | GHG emissions in 2009 (Gg $CO_2$ equivalents) | $CH_4$ emissions in 1990 (Gg $CO_2$ equivalents) | CH4 emissions in 2009 (Gg $CO_2$ equivalents) | $N_2O$ emissions in 1990 (Gg CO2 equivalents) | N2O emissions in 2009 (Gg CO2 equivalents) |
|---|---|---|---|---|---|---|
| Austria | 1,366 | 1,243 | 431 | 320 | 935 | 923 |
| Belgium | 2,687 | 2,394 | 1,728 | 1,620 | 960 | 774 |
| Denmark | 1,580 | 1,654 | 976 | 1,228 | 604 | 426 |
| Finland | 737 | 698 | 247 | 297 | 490 | 401 |
| France | 20,617 | 19,799 | 13,779 | 13,804 | 6,838 | 5,995 |
| Germany | 9,391 | 8,258 | 6,618 | 6,028 | 2,774 | 2,230 |
| Greece | 679 | 629 | 337 | 327 | 342 | 302 |
| Ireland | 2,681 | 2,504 | 2,333 | 2,140 | 348 | 365 |
| Italy | 7,383 | 6,648 | 3,462 | 2,886 | 3,921 | 3,762 |
| Luxembourg | 121 | 120 | 80 | 94 | 41 | 25 |
| Netherlands | 4,171 | 3,885 | 2,998 | 2,887 | 1,173 | 997 |
| Portugal | 1,701 | 1,582 | 1,182 | 1,266 | 520 | 317 |
| Spain | 6,342 | 8,076 | 4,072 | 5,592 | 2,270 | 2,484 |
| Sweden | 1,077 | 906 | 349 | 465 | 728 | 442 |
| United Kingdom | 6,275 | 4,795 | 3,586 | 2,800 | 2,689 | 1,995 |
| **EU-15** | **66,810** | **63,191** | **42,178** | **41,753** | **24,633** | **21,439** |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

$CH_4$ emissions from 4B1 Cattle account for 0.54 % of total EU-15 GHG emissions in 2009. Between 1990 and 2009, $CH_4$ emissions from this source decreased by 10 % (Table 6.5). Germany and France are responsible for 48 % of the total EU-15 emissions from this source. Nine Member States had reductions between 1990 and 2009. In absolute terms, France, Germany and Italy had the most significant decreases from this source.

**Table 6.5** **4B1 Cattle: Member States' contributions to $CH_4$ emissions and information on method applied and emission factor**

| Member State | $CH_4$ emissions (Gg $CO_2$ equivalents) | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg CO2 equivalents) | (%) | (Gg CO2 equivalents) | (%) | | |
| Austria | 282 | 217 | 221 | 1.1% | 4 | 2% | -62 | -22% | T2 | CS |
| Belgium | 336 | 278 | 281 | 1.4% | 4 | 1% | -55 | -16% | T2 | D,CS |
| Denmark | 535 | 585 | 606 | 3.0% | 20 | 3% | 70 | 13% | T2 | CS |
| Finland | 71 | 89 | 90 | 0.4% | 1 | 1% | 19 | 26% | T2 | CS |
| France | 8,817 | 8,374 | 8,129 | 40.6% | -245 | -3% | -688 | -8% | CR,T1 | D,CS |
| Germany | 4,259 | 3,624 | 3,619 | 18.1% | -5 | 0% | -639 | -15% | T2 | D |
| Greece | 48 | 47 | 47 | 0.2% | 0 | -1% | -1 | -2% | T1 | D |
| Ireland | 1,874 | 1,623 | 1,606 | 8.0% | -17 | -1% | -268 | -14% | T2 | CS |
| Italy | 1,636 | 1,122 | 1,087 | 5.4% | -35 | -3% | -549 | -34% | T2 | CS |
| Luxembourg | 47 | 58 | 60 | 0.3% | 2 | 3% | 12 | 26% | T2 | CS |
| Netherlands | 1,574 | 1,494 | 1,693 | 8.5% | 198 | 13% | 119 | 8% | T2 | CS |
| Portugal | 47 | 76 | 76 | 0.4% | 0 | 0% | 29 | 62% | T2 | CS |
| Spain | 473 | 423 | 418 | 2.1% | -6 | -1% | -55 | -12% | CS,T2 | D,CS |
| Sweden | 213 | 314 | 319 | 1.6% | 4 | 1% | 106 | 50% | T2 | CS |
| United Kingdom | 2,133 | 1,786 | 1,760 | 8.8% | -25 | -1% | -373 | -17% | T2 | CS,D |
| **EU-15** | **22,346** | **20,111** | **20,011** | **100.0%** | **-100** | **0%** | **-2,335** | **-10%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

$CH_4$ emissions from 4B8 Swine account for 0.51 % of total EU-15 GHG emissions in 2009. Between 1990 and 2009, $CH_4$ emissions from this source increased by 11 % (Table 6.6). France and Spain are responsible for 52 % of the total EU-15 emissions from this source. In absolute terms, Spain had the most significant increases from this source.

**Table 6.6** **4B8 Swine: Member States' contributions to $CH_4$ emissions and information on method applied and emission factor**

| Member State | $CH_4$ emissions (Gg $CO_2$ equivalents) | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg CO2 equivalents) | (%) | (Gg CO2 equivalents) | (%) | | |
| Austria | 123 | 74 | 76 | 0.4% | 2 | 2% | -48 | -39% | T2 | CS |
| Belgium | 1,369 | 1,297 | 1,309 | 6.9% | 12 | 1% | -60 | -4% | T2 | D,CS |
| Denmark | 389 | 551 | 539 | 2.8% | -12 | -2% | 149 | 38% | T2 | CS |
| Finland | IE | IE | IE | - | - | - | - | - | NA | NA |
| France | 4,206 | 5,065 | 4,974 | 26.2% | -91 | -2% | 768 | 18% | CR,T1 | D,CS |
| Germany | 2,260 | 2,219 | 2,281 | 12.0% | 62 | 3% | 21 | 1% | T2 | CS |
| Greece | 146 | 133 | 133 | 0.7% | 0 | 0% | -13 | -9% | T1 | D |
| Ireland | 326 | 408 | 411 | 2.2% | 3 | 1% | 85 | 26% | T1 | D |
| Italy | 1,432 | 1,349 | 1,292 | 6.8% | -56 | -4% | -140 | -10% | T2 | CS |
| Luxembourg | 31 | 33 | 33 | 0.2% | 0 | -1% | 2 | 6% | T1 | D |
| Netherlands | 1,140 | 1,118 | 1,126 | 5.9% | 8 | 1% | -14 | -1% | T2 | CS |
| Portugal | 1,087 | 1,051 | 1,054 | 5.5% | 3 | 0% | -33 | -3% | T2 | CS |
| Spain | 3,406 | 4,960 | 4,980 | 26.2% | 20 | 0% | 1,574 | 46% | T3,CS | D,CS |
| Sweden | 99 | 109 | 105 | 0.6% | -3 | -3% | 6 | 6% | T2 | CS |
| United Kingdom | 1,119 | 699 | 700 | 3.7% | 2 | 0% | -419 | -37% | T1 | D |
| **EU-15** | **17,134** | **19,066** | **19,013** | **100.0%** | **-53** | **0%** | **1,879** | **11%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

$N_2O$ emissions from 4B13 Solid Storage and Dry Lot account for 0.43 % of total EU-15 GHG emissions in 2009. Between 1990 and 2009, $N_2O$ emissions from this source decreased by 18 % (Table 6.7). Italy and France are responsible for 56.5 % of the total EU-15 emissions from this source.All counties but Ireland decreased their emissionsbetween 1990-2009. In absolute terms, France had the most significant decrease from this source.

**Table 6.7 4B13 Solid Storage and Dry Lot: Member States' contributions to $N_2O$ emissions and information on method applied and emission factor**

| Member State | $N_2O$ emissions (Gg $CO_2$ equivalents) | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg CO2 equivalents) | (%) | (Gg CO2 equivalents) | (%) | | |
| Austria | 750 | 668 | 677 | 4.1% | 9 | 1% | -73 | -10% | T1 | CS |
| Belgium | 892 | 713 | 717 | 4.3% | 4 | 1% | -175 | -20% | T1 | D |
| Denmark | 314 | 111 | 93 | 0.6% | -18 | -16% | -221 | -70% | CS | D |
| Finland | 423 | 330 | 315 | 1.9% | -15 | -4% | -108 | -25% | D | D |
| France | 6,604 | 5,777 | 5,760 | 34.5% | -17 | 0% | -843 | -13% | CR,T1 | D,CS |
| Germany | 1,360 | 832 | 830 | 5.0% | -2 | 0% | -530 | -39% | T1,T2 | D |
| Greece | 322 | 284 | 282 | 1.7% | -2 | -1% | -40 | -13% | D | D |
| Ireland | 295 | 311 | 311 | 1.9% | 0 | 0% | 15 | 5% | T1 | D |
| Italy | 3,728 | 3,319 | 3,299 | 19.8% | -20 | -1% | -429 | -12% | T2 | D,CS |
| Luxembourg | 40 | 23 | 23 | 0.1% | 0 | -2% | -17 | -42% | T1 | D |
| Netherlands | 937 | 828 | 838 | 5.0% | 10 | 1% | -99 | -11% | T2 | D |
| Portugal | 502 | 306 | 295 | 1.8% | -10 | -3% | -207 | -41% | D | D |
| Spain | 1,537 | 1,642 | 1,513 | 9.1% | -129 | -8% | -24 | -2% | D,CS,T3 | D |
| Sweden | 649 | 342 | 312 | 1.9% | -30 | -9% | -337 | -52% | T1,T2 | CS |
| United Kingdom | 1,835 | 1,435 | 1,417 | 8.5% | -19 | -1% | -419 | -23% | T1 | D |
| **EU-15** | **20,189** | **16,921** | **16,682** | **100.0%** | **-239** | **-1%** | **-3,507** | **-17%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

$N_2O$ emissions from 4B14 Other account for 0.07 % of total EU-15 GHG emissions in 2009. Between 1990 and 2009, $N_2O$ emissions from this source increased by 23 % (Table 6.8). Spain and the UK are responsible for about two thirds of the total EU-15 emissions from this source.

**Table 6.8** **4B14 Other: Member States' contributions to $N_2O$ emissions**

| Member State | $N_2O$ emissions (Gg $CO_2$ equivalents) | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | |
|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg CO2 equivalents) | (%) | (Gg CO2 equivalents) | (%) |
| Austria | 152 | 217 | 219 | 8.8% | 2 | 1% | 68 | 45% |
| Belgium | 57 | 47 | 48 | 1.9% | 0 | 1% | -10 | -17% |
| Denmark | 195 | 258 | 256 | 10.2% | -2 | -1% | 61 | 31% |
| Finland | 56 | 73 | 68 | 2.7% | -5 | -7% | 12 | 22% |
| France | NA | NA | NA | - | - | - | - | - |
| Germany | NO | NO | NO | - | - | - | - | - |
| Greece | 13 | 14 | 14 | 0.6% | 0 | 0% | 1 | 10% |
| Ireland | NO | NO | NO | - | - | - | - | - |
| Italy | NO | 298 | 304 | 12.1% | 6 | 2% | 304 | - |
| Luxembourg | 0.02 | 0.31 | 0.31 | 0.01% | 0 | 1% | 0 | 1192% |
| Netherlands | NO | NO | NO | - | - | - | - | - |
| Portugal | NO | NO | NO | - | - | - | - | - |
| Spain | 725 | 991 | 966 | 38.5% | -25 | -3% | 241 | 33% |
| Sweden | 64 | 113 | 106 | 4.2% | -6 | -6% | 42 | 65% |
| United Kingdom | 782 | 566 | 525 | 20.9% | -41 | -7% | -258 | -33% |
| **EU-15** | **2,044** | **2,577** | **2,506** | **100.0%** | **-71** | **-3%** | **463** | **23%** |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

### 6.2.3 Agricultural soils (CRF Source Category 4D) (EU-15)

$N_2O$ emissions from this source category account for 5 % of total GHG emissions. Table 6.9 shows total GHG and $N_2O$ emissions by Member State for $N_2O$ from 4D Agricultural Soils. $N_2O$ emissions from this source decreased by 18 % between 1990 and 2009. All EU-15 Member States decreased emissions.

**Table 6.9** **4D Agricultural Soils: Member States' contributions to total GHG and $N_2O$ emissions**

| Member State | GHG emissions in 1990 (Gg $CO_2$ equivalents) | GHG emissions in 2009 (Gg $CO_2$ equivalents) | $N_2O$ emissions in 1990 (Gg $CO_2$ equivalents) | N2O emissions in 2009 (Gg $CO_2$ equivalents) |
|---|---|---|---|---|
| Austria | 3,437 | 3,105 | 3,430 | 3,097 |
| Belgium | 4,763 | 3,674 | 4,763 | 3,674 |
| Denmark | 7,553 | 5,088 | 7,553 | 5,088 |
| Finland | 3,986 | 3,442 | 3,986 | 3,442 |
| France | 55,941 | 46,400 | 55,941 | 46,400 |
| Germany | 50,055 | 43,493 | 50,055 | 43,493 |
| Greece | 7,452 | 4,915 | 7,452 | 4,915 |
| Ireland | 7,062 | 6,287 | 7,062 | 6,287 |
| Italy | 19,482 | 15,459 | 19,482 | 15,459 |
| Luxembourg | 364 | 308 | 364 | 308 |
| Netherlands | 10,670 | 6,350 | 10,670 | 6,350 |
| Portugal | 3,419 | 2,904 | 3,419 | 2,904 |
| Spain | 19,056 | 17,466 | 19,056 | 17,466 |
| Sweden | 5,102 | 4,589 | 5,102 | 4,589 |
| United Kingdom | 32,091 | 24,905 | 32,091 | 24,905 |
| **EU-15** | **230,429** | **188,387** | **230,422** | **188,378** |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

Table 6.10 provides information on emission trends and information on methods applied and emissions factor of the key source from 4D1 Direct soil emissions by Member State. Direct $N_2O$ emissions from agricultural soils is the largest source category of $N_2O$ emissions and accounts for 2.6 % of total EU-15 GHG emissions in 2009. Direct $N_2O$ emissions from agricultural soils occur from the application of mineral nitrogen fertilisers and organic nitrogen from animal manure. Between 1990 and 2009, emissions declined by 18 % in the EU-15. The Member States with most emissions from this source were France and Germany. All Member States reduced $N_2O$ emissions from agricultural soils.

The main driving force of direct $N_2O$ emissions from agricultural soils is the use of nitrogen fertiliser and animal manure, which were 31 % and 10 % below 1990 levels in 2009, respectively. $N_2O$ emissions from agricultural land can be decreased by overall efficiency improvements of nitrogen uptake by crops, which should lead to lower fertiliser consumption on agricultural land. The decrease of fertiliser use is partly due to the effects of the 1992 reform of the common agricultural policy and the resulting shift from production-based support mechanisms to direct area payments in arable production. This has tended to lead to an optimisation and overall reduction in fertiliser use. In addition, reduction in fertiliser use is also due to directives such as the nitrate directive and to the extensification measures included in the agro-environment programmes (EC, 2001).

**Table 6.10 4D1 Direct soil emissions: Member States' contributions to $N_2O$ emissions and information on method applied and emission factor**

| Member State | $N_2O$ emissions (Gg $CO_2$ equivalents) | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg CO2 equivalents) | (%) | (Gg CO2 equivalents) | (%) | | |
| Austria | 1,909 | 1,878 | 1,822 | 1.9% | -57 | -3% | -87 | -5% | T1a,T1b | D |
| Belgium | 2,520 | 2,021 | 2,032 | 2.1% | 10 | 1% | -489 | -19% | T1 | D,CS |
| Denmark | 4,321 | 3,253 | 3,163 | 3.3% | -89 | -3% | -1,158 | -27% | T1b | D |
| Finland | 3,035 | 2,824 | 2,690 | 2.8% | -134 | -5% | -345 | -11% | T1 | CS,D |
| France | 26,765 | 23,283 | 21,685 | 22.5% | -1,598 | -7% | -5,080 | -19% | CR,T1 | D,CS |
| Germany | 30,785 | 28,392 | 27,168 | 28.2% | -1,224 | -4% | -3,618 | -12% | CR,T1,T2 | D |
| Greece | 2,761 | 1,372 | 1,360 | 1.4% | -11 | -1% | -1,401 | -51% | T1a,T1b | D |
| Ireland | 2,820 | 2,356 | 2,342 | 2.4% | -14 | -1% | -478 | -17% | T1a,T1b | D |
| Italy | 9,605 | 8,165 | 7,354 | 7.6% | -811 | -10% | -2,251 | -23% | T1 | D,CS |
| Luxembourg | 163 | 134 | 134 | 0.1% | 0 | 0% | -29 | -18% | T1a,T1b | D |
| Netherlands | 4,137 | 3,528 | 3,523 | 3.7% | -5 | 0% | -614 | -15% | T1b,T2 | CS |
| Portugal | 1,437 | 1,000 | 998 | 1.0% | -2 | 0% | -438 | -31% | T1a | D |
| Spain | 9,727 | 8,308 | 8,471 | 8.8% | 163 | 2% | -1,256 | -13% | T1a,T1b,CS | D |
| Sweden | 2,783 | 2,574 | 2,412 | 2.5% | -162 | -6% | -370 | -13% | T1a,T1b,CS | CS,D |
| United Kingdom | 14,465 | 11,190 | 11,178 | 11.6% | -12 | 0% | -3,287 | -23% | T1,T1a | D |
| **EU-15** | **117,233** | **100,279** | **96,332** | **100.0%** | **-3,947** | **-3.9%** | **-20,901** | **-18%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

$N_2O$ emissions from 4D2 Pasture, Range and Paddock Manure account for 0.7 % of total EU-15 GHG emissions in 2009. Between 1990 and 2009, $N_2O$ emissions from this source decreased by 16 % (Table 6.11). France and the United Kingdom are responsible for almost 50 % of the total EU-15 emissions from this source. The Netherlands had the greatest reduction in absolute terms while Spain had the largest increases.

**Table 6.11** **4D2 Pasture, Range and Paddock Manure: Member States' contributions to $N_2O$ emissions and information on method applied and emission factor**

| Member State | $N_2O$ emissions (Gg $CO_2$ equivalents) | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg CO2 equivalents) | (%) | (Gg CO2 equivalents) | (%) | | |
| Austria | 169 | 94 | 95 | 0.4% | 1 | 1% | -74 | -44% | T1a,T1b | D |
| Belgium | 994 | 783 | 784 | 3.1% | 1 | 0% | -209 | -21% | T1 | D |
| Denmark | 311 | 213 | 213 | 0.8% | 0 | 0% | -98 | -32% | D,CS | D |
| Finland | 182 | 172 | 175 | 0.7% | 3 | 2% | -7 | -4% | D | D |
| France | 8,593 | 7,407 | 7,390 | 28.9% | -18 | 0% | -1,204 | -14% | CR,T1 | D,CS |
| Germany | 2,075 | 1,585 | 1,580 | 6.2% | -5 | 0% | -495 | -24% | CR | CR |
| Greece | 1,821 | 1,791 | 1,780 | 7.0% | -11 | -1% | -42 | -2% | D | D |
| Ireland | 2,909 | 2,726 | 2,719 | 10.6% | -8 | 0% | -190 | -7% | T1a | D |
| Italy | 1,736 | 1,569 | 1,541 | 6.0% | -28 | -2% | -195 | -11% | T1 | D,CS |
| Luxembourg | 59 | 56 | 57 | 0.2% | 0 | 1% | -2 | -3% | T1 | D |
| Netherlands | 3,150 | 1,495 | 1,300 | 5.1% | -196 | -13% | -1,850 | -59% | T1b | CS |
| Portugal | 661 | 825 | 819 | 3.2% | -6 | -1% | 158 | 24% | T1a | D |
| Spain | 2,273 | 2,549 | 2,585 | 10.1% | 36 | 1% | 312 | 14% | T1a,T1b,CS | D |
| Sweden | 379 | 400 | 392 | 1.5% | -8 | -2% | 13 | 4% | T2 | CS |
| United Kingdom | 4,980 | 4,195 | 4,121 | 16.1% | -75 | -2% | -860 | -17% | T2 | CS |
| **EU-15** | **30,292** | **25,863** | **25,551** | **100.0%** | **-312** | **-1%** | **-4,741** | **-16%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

$N_2O$ emissions from 4D3 Indirect Emissions account for 1.75 % of total EU-15 GHG emissions in 2009. Between 1990 and 2009, $N_2O$ emissions from this source decreased by 21 % (Table 6.12). France, the UK, Spain, Germany and Italy are responsible for 84 % of the total EU-15 emissions from this source.

**Table 6.12** **4D3 Indirect Emissions: Member States' contributions to $N_2O$ emissions and information on method applied and emission factor**

| Member State | $N_2O$ emissions (Gg $CO_2$ equivalents) | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg CO2 equivalents) | (%) | (Gg CO2 equivalents) | (%) | | |
| Austria | 1,352 | 1,200 | 1,180 | 1.8% | -19 | -2% | -172 | -13% | T1a,T1b | D |
| Belgium | 1,248 | 860 | 857 | 1.3% | -3 | 0% | -391 | -31% | T1 | D,CS |
| Denmark | 2,920 | 1,864 | 1,712 | 2.6% | -152 | -8% | -1,208 | -41% | T1b | D |
| Finland | 769 | 632 | 577 | 0.9% | -56 | -9% | -192 | -25% | T1 | D |
| France | 20,582 | 18,590 | 17,326 | 26.6% | -1,264 | -7% | -3,257 | -16% | CR,T1 | D,CS |
| Germany | 17,195 | 15,359 | 14,745 | 22.6% | -614 | -4% | -2,449 | -14% | CR,D,T1 | CR,D |
| Greece | 2,869 | 1,781 | 1,775 | 2.7% | -6 | 0% | -1,094 | -38% | T1a | D |
| Ireland | 1,333 | 1,227 | 1,226 | 1.9% | -1 | 0% | -107 | -8% | T1b | CS |
| Italy | 8,140 | 7,145 | 6,564 | 10.1% | -581 | -8% | -1,577 | -19% | T1 | D,CS |
| Luxembourg | 142 | 116 | 117 | 0.2% | 1 | 0% | -25 | -18% | T1b | D |
| Netherlands | 3,358 | 1,539 | 1,523 | 2.3% | -16 | -1% | -1,835 | -55% | T1,T3 | D |
| Portugal | 1,321 | 1,092 | 1,087 | 1.7% | -5 | 0% | -234 | -18% | T1a | D |
| Spain | 7,056 | 6,250 | 6,410 | 9.8% | 160 | 3% | -646 | -9% | T1a,T1b,CS | D |
| Sweden | 1,222 | 987 | 1,055 | 1.6% | 68 | 7% | -167 | -14% | CS,T1 | D |
| United Kingdom | 12,431 | 8,998 | 8,982 | 13.8% | -16 | 0% | -3,450 | -28% | T1 | D |
| **EU-15** | **81,939** | **67,640** | **65,135** | **100.0%** | **-2,505** | **-4%** | **-16,803** | **-21%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

## 6.3 Methodological issues and uncertainty

All Member States consider their greenhouse gas inventories in the agricultural sector for complete for those categories that are reported to occur in the countries. For categories 4.A, 4.B (both methane and nitrous oxide) and 4.D (nitrous oxide) emissions in all relevant sub-categories are considered (CRF Tables 7s2). $CH_4$ emissions from rice fields are reported for France, Greece, Italy, Portugal and Spain.

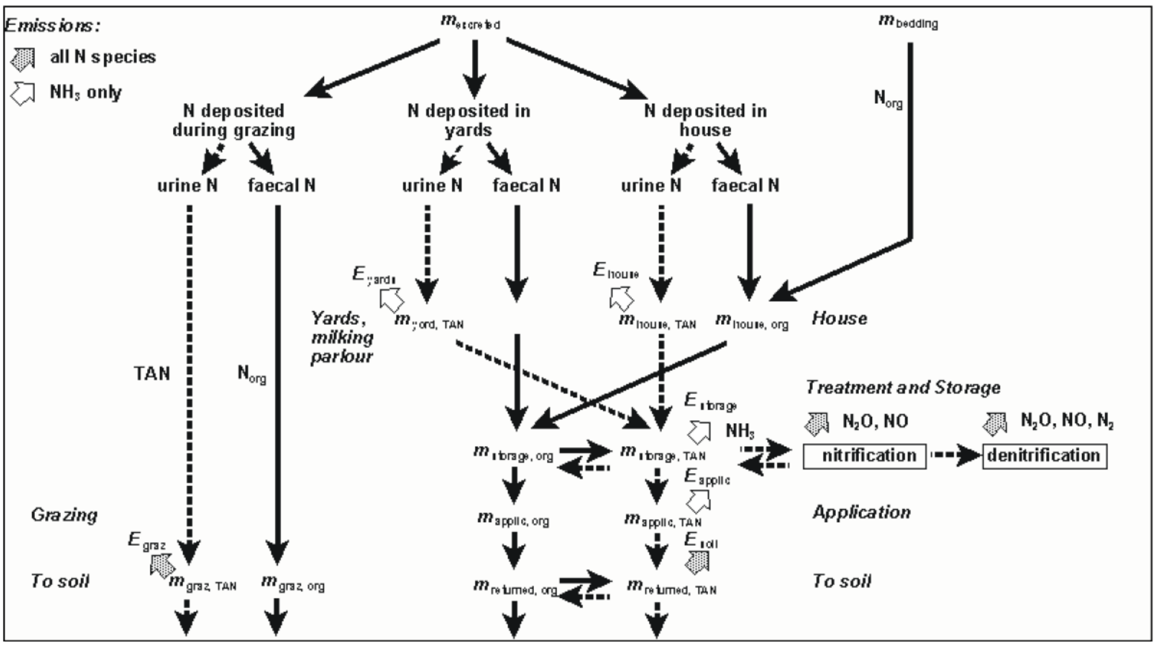
Many countries recognise that in the agriculture sector the emissions from the different categories are inherently linked and are best estimated in a comprehensive model that covers not only greenhouse gases ($CH_4$ and $N_2O$) in a consistent manner, but also ammonia. Estimations of ammonia emissions are required for reporting under the Convention on Long-Range Transboundary Air Pollution and are needed to estimate indirect $N_2O$ emissions. Hence, some countries have developed comprehensive models covering consistently different source categories and different gases.

Germany: GAS-EM (GASeous Emissions) calculates consistently the emissions from the agriucltural sector (Dämmgen et al., 2002). Figure 6.3 shows the flow of nitrogen in manure management systems tracking all fluxes and N-transformation processes in a mass-conservative mode.

Denmark: DIEMA (Danish Integrated Emission Model for Agriculture) covers emissions of greenhouse gases, ammonia and particulate matter (Mikkelsen et al., 2005). DIEMA operates with 30 different livestock categories (animal type, weight class, age), which are subdivided by stable and manure type to around 100 combinations. Information is obtained for each class and aggregated to the reported animal categories (Mikkelsen et al., 2005)

Finland uses a nitrogen mass flow model (except for N-fixing, crop residue and sewage sludge) accounts for nitrogen losses as ammonia and nitrous oxide emissions during manure management in animal houses, during storage and application; the calculation method was developed in order to avoid double-counting.

**Figure 6.3 Flow of nitrogen in manure management systems (Dämmgen et al., 2007)**



### 6.3.1 *Enteric Fermentation (CRF source category 4.A)*

#### 6.3.1.1 Source category description

Methane is produced in herbivores as a by-product of enteric fermentation, a digestive process by which carbohydrates are broken down by micro-organisms into simple molecules for absorption into the bloodstream. The amount of methane that is released depends on the type of digestive tract, age, and weight of the animal, and the quality and quantity of the feed consumed. Ruminant livestock (e.g., cattle, sheep) are major sources of methane with moderate amounts produced from non-ruminant livestock (e.g., pigs, horses). The ruminant gut structure fosters extensive enteric fermentation of their diet. Generally, higher feed intake induce also higher methane emission, but the extent of methane production may also be affected by the composition of the diet. Feed intake is positively related to animal size, growth rate, and production (e.g., milk production, wool growth, or pregnancy).

$CH_4$ emissions in the source category Enteric Fermentation stem for 10 Member States to over 85% from the sub-category “Cattle”. Substantial emissions from the sub-category “Sheep” (up to 52% of emissions in category 4.A. for Greece) are reported by Greece, Italy, Portugal, Spain, and United Kingdom. Emissions accounting for more than 5% of the emissions in this category are further reported by for the sub-category “Goats” (Greece, 17%) and for the sub-category “Swine” (Belgium,Denmark, Netherlands, with a maximum of 9%).

An overview of the $CH_4$ emissions, animal population and the corresponding implied emission factors for $CH_4$ emissions from enteric fermentation for the most important categories cattle and sheep (key source at EC-level) and also goats and swine are given in Table 6.13. Data are given for 2009 as the last inventory year and the base year 1990. The table shows that there is a general trend of decreasing animal numbers which are partly compensated by higher emissions per head due to intensification of livestock production in Europe.

**Table 6.13 Total $CH_4$ emissions in category 4A and implied Emission Factor at EU-15 level for the years 1990 and 2009**

| 1990[1)] | Dairy Cattle | Non-dairy cattle | Sheep | Goats | Swine |
|---|---|---|---|---|---|
| | | | | | |
| $CH_4$ emissions [Gg $CH_4$] | 2627 | 2965 | 794 | 75 | 137 |
| Animal population [1000 heads] | 26210 | 64051 | 114673 | 12682 | 111141 |
| Implied EF (kg $CH_4$/head/yr) | 100 | 47 | 6.9 | 5.9 | 1.2 |

| 2009 | Dairy Cattle | Non-dairy cattle | Sheep | Goats | Swine |
|---|---|---|---|---|---|
| | | | | | |
| $CH_4$ emissions [Gg $CH_4$] | 2124 | 2818 | 641 | 69 | 141 |
| Animal population [1000 heads] | 17810 | 57995 | 89094 | 11775 | 115607 |
| Implied EF (kg $CH_4$/head/yr) | 119 | 49 | 7.2 | 5.9 | 1.2 |

| 2009 value in percent of 1990 | Dairy Cattle | Non-dairy cattle | Sheep | Goats | Swine |
|---|---|---|---|---|---|
| | | | | | |
| CH4 emissions [Gg CH4] | 81% | 95% | 81% | 93% | 103% |
| Animal population [1000 heads] | 68% | 91% | 78% | 93% | 104% |
| Implied EF (kg CH4/head/yr) | 119% | 105% | 104% | 100% | 99% |

Information source: CRF for 1990 and 2009, submitted in 2011

### 6.3.1.2 Methodological Issues

$CH_4$ emissions from enteric fermentation is a key source category for cattle and sheep. For cattle, this is also true for all member states. Accordingly, Member States have used Tier 2 methodology for calculating enteric $CH_4$ emissions, as shown in Table 6.14. In addition to the methodology applied by the Member States for calculating $CH_4$ emissions, the table indicates also the total emissions in the category "enteric fermentation", the contribution of the animal types considered (dairy and non-dairy cattle and sheep) to the total emissions, and whether the emissions from the animal class are belonging to the key source categories in the different Member States.

The table indicates also the Tier level of the source category and of the emission estimates for the animal types considered. For this purpose we compare the implied emission factor for dairy cattle, non-dairy cattle and sheep with the IPCC default values for Western Europe of 100 kg $CH_4$ head$^{-1}$ year-1, 48 kg $CH_4$ head$^{-1}$ year-1 and 8 kg $CH_4$ head$^{-1}$ year-1, respectively. For a detailed description on the methodology used to estimate the "Tier-level" for the EC, see Section 6.4.1. Greece uses the default values of Eastern European countries of 56 kg $CH_4$ head$^{-1}$ year-1 for non-dairy cattle (for a detailed description of the estimation of the Tier level see section 6.4.1). A value of 56 kg $CH_4$ head$^{-1}$ year-1 was also used by Austria for non-dairy cattle, however, according to the national inventory report it was derived on the basis of a Tier 2 calculation. For cattle, all emissions are calculated with the help of country-specific data, while for sheep still 27% of the emissions are estimated with a Tier 1 approach. The Tier levels for goats, swine, and reindeer are included in Table 6.83.

Sheep is no key source category for most countries, even though several Member States did not report disaggregated key source categories for category 4A. However, considerable emissions from this category with more than 10% of total emissions in this category are reported by 5 countries. Therefore, most countries are applying Tier 1 methodology. Those Member States where sheep emissions are belonging to the key source categories have indeed developed a Tier 2 approach. In the case of the United Kingdom, where the default value was used, but it is adjusted for lambs, considering also the lifetime of lambs. Thus we assigned a Tier level of 1.5.

On EU-15 level, 97% of the $CH_4$ emissions in category 4.A have been estimated with a Tier 2 approach. Overall, a Tier level between Tier 1.5 and Tier 2.0 can be derived for the source category 'enteric fermenation' with a Tier level of Tier 1.96 for EU-15. This estimate includes also the Tier level for goat (Tier 1.3), swine (Tier 1.6) and reindeer (estimated by Finland and Sweden with national emission factors). The thus aggregated Tier level accounts for 98% of the emissions in category 4A and has been complemented with 'other emissions' assuming that these are estimated with a Tier 1 approach giving overall a quality of Tier 1.94.

**Table 6.14 Total emissions, contribution of the main sub-categories to $CH_4$ emissions in category 4A, methodology applied and key source assessment by Member States for the sub-categories dairy cattle, non-dairy cattle and sheep.**

| Member State | Total | | Dairy Cattle | | Non-dairy cattle | | Cattle | Sheep | |
|---|---|---|---|---|---|---|---|---|---|
| | Gg $CO_2$-eq | b | a | b | a | b | c | a | b |
| Austria | 3,265 | Tier 1.9 | 40% | Tier 2.0 | 54% | Tier 2.0 | y | 2% | Tier 1.0 |
| Belgium | 3,548 | Tier 1.9 | 35% | Tier 2.0 | 58% | Tier 2.0 | y | 1% | Tier 1.0 |
| Denmark | 2,859 | Tier 2.0 | 55% | Tier 2.0 | 31% | Tier 2.0 | y | 1% | Tier 2.0 |
| Finland | 1,580 | Tier 1.5 | 49% | Tier 2.0 | 40% | Tier 1.0 | y | 1% | Tier 1.0 |
| France | 29,484 | Tier 2.0 | 31% | Tier 2.0 | 60% | Tier 2.0 | y | 6% | Tier 2.0 |
| Germany | 20,951 | Tier 2.0 | 54% | Tier 2.0 | 40% | Tier 2.0 | y | 2% | Tier 1.0 |
| Greece | 3,235 | Tier 1.8 | 11% | Tier 2.0 | 18% | Tier 2.0 | y | 52% | Tier 2.0 |
| Ireland | 8,700 | Tier 2.0 | 29% | Tier 2.0 | 64% | Tier 2.0 | y | 7% | Tier 2.0 |
| Italy | 10,779 | Tier 1.8 | 41% | Tier 2.0 | 37% | Tier 2.0 | y | 12% | Tier 1.0 |
| Luxembourg | 246 | Tier 2.0 | 41% | Tier 2.0 | 57% | Tier 2.0 | y | 1% | Tier 1.0 |
| Netherlands | 6,496 | Tier 1.9 | 61% | Tier 2.0 | 29% | Tier 2.0 | y | 3% | Tier 1.0 |
| Portugal | 2,862 | Tier 2.0 | 27% | Tier 2.0 | 46% | Tier 2.0 | y | 20% | Tier 2.0 |
| Spain | 12,529 | Tier 2.0 | 14% | Tier 2.0 | 48% | Tier 2.0 | y | 29% | Tier 2.0 |
| Sw eden | 2,697 | Tier 2.0 | 37% | Tier 2.0 | 50% | Tier 2.0 | y | 3% | Tier 1.0 |
| United Kingdom | 15,093 | Tier 1.9 | 28% | Tier 2.0 | 49% | Tier 2.0 | y | 21% | Tier 1.5 |
| **EU-15** | **124,325** | **Tier 1.94** | **36%** | **Tier 2.0** | **48%** | **Tier 2.0** | **y** | **11%** | **Tier 1.7** |
| EU-15: Tier 1 | 3% | | 0% | | 0% | | | 27% | |
| EU-15: Tier 2 | 97% | | 100% | | 100% | | | 73% | |

a Contribution to $CH_4$ emissions from enteric fermentation

b Tier 1: default methodology; Tier 2: country-specific methodology

c Source category is key in the Member State's inventory (y/n). nr: not reported. Assessment for total cattle.

Details on the applied methodologies for the estimation of $CH_4$ emissions from enteric fermentation are given in

Table 6.15.

**Table 6.15 Methodology used by Member States for calculating $CH_4$ emissions in category 4A**

| Member State | Methodology |
|---|---|
| Austria | IPCC Tier 1 for Swine, Sheep, Goats, Horses and Other Animals (Deer). For Cattle Tier 2. For the calculation of emissions from category Poultry the IPCC Tier 2 method with Swiss emission factors (Gross Energy Intake, Methane Conversion Rate) was use. |
| Belgium | Tier 2 approach is in both regions (harmonized), Flanders and Wallonia for key-source animal types. $CH_4$ emissions from enteric fermentation from the other, non key source, animal categories (sheep, goats, swine, horses and mules and asses) are estimated using the Tier 1 methodology. |
| Denmark | The emissions from the agricultural sector are calculated in a comprehensive agricultural model complex called DIEMA (Danish Integrated Emission Model for Agriculture) (Mikkelsen, 2006; Mikkelsen and Gyldenkærne 2006). The implied emission factors for all animal categories are based on the Tier 2 approach. The category Non-Dairy Cattle includes Calves, Heifer, Bulls and Suckler Cows and the implied emission factor is a weighted average of these different subcategories. Data given for Non-Dairy Cattle covers data for heifer older than ½ year. The category Swine includes the subcategories Sows, Piglets and Slaughtering Pigs. The feed intake for sows and piglets has increased while the feed intake for slaughtering pigs has decreased as a result of improved fodder efficacy. |
| Finland | Tier 1 for Horses, Swine, Goats and Fur animal (Norway EFs). Tier 2 method for Cattle. $CH_4$ emissions from enteric fermentation of Reindeer have been calculated by estimating the GE on the basis of literature (McDonald, 1988) by using national data for estimating dry matter intake and its composition (hay and lichen) and calculating the respective emission factor. The same methodology has been used for estimating GE and EF for Sheep. Cattle's are not used for work in Finland. Piglets are included in the category 'sows with piglets'. |
| France | Emissions from Dairy Cattle are calculated using an equation developed at INRA (Tier 2+). Tier 1 other animal types. |
| Germany | Tier 2 for dairy and non-dairy cattle and swine. Tier 1 for other animals . |
| Greece | Dairy cattle and non-dairy cattle: Tier 2. Sheep: Tier 2 methodology. Livestock sub-categories are characterised based on the age of animals, their sex, weight, feeding situation and on the various management systems of animals. Other animal categories: Tier 1. |
| Ireland | Cattle: Tier 2. For Dairy cows and Suckler Cows, the country was divided into three regions: (1) south and east, (2) west and midlands, and (3) north west, coinciding with regions used for implementing the Nitrates Directive based on slurry storage requirements of local planning authorities. In the approach outlined by O'Mara (2006), the daily energy requirement of cows in each region is calculated by month or part thereof based on maintenance requirements, milk yield and composition, requirements for foetal growth and gain or loss of bodyweight (INRA, 1989). Given data for liveweight and liveweight gain, energy requirements of animals were estimated during the winter housing periods and grazing seasons of the animal's lifetime using the INRAtion computer programme, version 3.0. This programme is devised by the French research organisation INRA, and is based on the net energy system for Cattle. Other animals: Tier 1 Methodology, EFs IPCC default. |
| Italy | The Tier 2 IPCC GPG approach has been followed for Dairy, Non-Dairy and Buffalo. Country-specific emission factor suggested by the Research Centre on Animal Production for rabbits have been use. A Tier 1 approach, with IPCC default emission factors, has been used to estimate methane emissions from swine, sheep, goats, horses, mules and asses. |
| Luxembourg | The IPCC Tier 1 method has been applied to all farm animal categories with the exception of cattle for which a Tier 2 method has been used (option B). |
| Netherlands | Cattle: Tier 2, calculated annually for several subcategories of dairy, non-dairy and young cattle. The calculation of the methane production via enteric fermentation by dairy cows is performed using dynamic modelling (Tier 3; Smink, 2005), employing the model of Mills et al. (2001), including updates (Bannink et al., 2005a,b). This model is based on the rumen model of Dijkstra et al. (1992). It has been developed for dairy cows and is therefore not suitable for all cattle categories. The model calculates the gross energy intake and methane production per cow per year on the basis of data on the share of feed components (grass silage, maize silage, wet by-products and concentrates) and their chemical nutrient composition (sugars, NDF, etc). All relevant documents concerning methodology, emission factors and activity data are published on the website www.greenhousegases.nl. |
| Portugal | Tier 2 for all animal types, with an enhanced characterization of livestock, with subdivision per age, sex and management conditions for most animal types. Milk yield was estimated dividing the annual production of milk cow over the number of cows in production101, both of which are published by the National Statistical Institute (INE). Three different cattle types were considered: (1) Imported breeds; (2) Traditional breeds on pasture; (3) Traditional breeds on range. The methodology used by the French I.N.R.A. (INRA, 1984) was used to estimate feed intake for each swine sub-class. |
| Spain | Cattle and Sheep: Tier 2. Swine: Tier 3; Other animal categories: Tier 1. For cattle and sheep, national literature on the main animal breed present in Spain are used. Animal characterization is obtained according to UPV (2006). Milk production are not sufficiently disaggregated model calculations are used to obtain milk production for the different breeds. Digestibility is calculated from feed composition. For swine a Tier 3 methodology has been developed (MARM, 2010) on the basis of the feed and energy requirement balances defining a typical feed composition. |
| Sweden | Significant Cattle subgroups: national emission factor (Tier 1). Reindeer: according to Tier 2 methodology using a Finnish value of gross energy requirements. Other animal categories: Tier 1. The national methodology for Dairy Cows, Beef Cows and Other Cattle. |
| United Kingdom | Tier 2 method for beef cattle. |

### Activity Data

Animal population of dairy and non-dairy cattle, sheep, goat, swine, and poultry in 2009 are given in Table 6.16. The characterization of the livestock population across the background tables 4.A, 4.B(a), and 4.B(b) is done in a consistent way by all Member States and will therefore be discussed only here. Luxembourg and Netherlands have chosen to use the option B for the classification of cattle. In order to allow the calculation of an EC implied emission factor for the categories listed under option A, these numbers were "converted" using the following rule: Mature Dairy Cattle → Dairy Cattle; Mature Non-dairy Cattle + Young Cattle → Non-dairy cattle.

Other animal types with population data reported in Table4.A are reindeers (Finland, Sweden), deer (Austria, Denmark, United Kingdom), fur farming (Denmark, Finland), rabbits (Italy, Luxembourg, Netherlands, Portugal), and other poultry (Denmark).

Some information on the source of the animal numbers for the different Member States is given in Table 6.17.

**Table 6.16 Animal population [1000 heads] in 2009**

| Member State 2009 | Dairy Cattle | Non-dairy cattle | Sheep | Goats | Swine | Poultry |
|---|---|---|---|---|---|---|
| Austria | 533 | 1,493 | 345 | 68 | 3,137 | 13,027 |
| Belgium | 476 | 2,174 | 108 | 32 | 6,437 | 30,644 |
| Denmark | 563 | 977 | 116 | 16 | 12,369 | 19,676 |
| Finland[1)] | 290 | 628 | 118 | 6 | 1,381 | 9,369 |
| France | 3,737 | 16,099 | 8,062 | 1,332 | 11,329 | 254,186 |
| Germany | 4,205 | 8,739 | 2,350 | 220 | 23,445 | 128,144 |
| Greece | 147 | 504 | 8,790 | 5,267 | 906 | 31,592 |
| Ireland | 1,105 | 4,830 | 4,727 | 10 | 1,535 | 13,871 |
| Italy | 1,878 | 4,224 | 8,013 | 961 | 9,157 | 199,925 |
| Luxembourg[2)] | 81 | 312 | 9 | 3 | 80 | 97 |
| Netherlands[2)] | 2,978 | 4,957 | 1,117 | 374 | 12,186 | 99,987 |
| Portugal | 299 | 1,126 | 3,044 | 446 | 2,344 | 26,659 |
| Spain | 833 | 5,215 | 19,718 | 2,934 | 25,046 | 155,465 |
| Sweden | 357 | 1,182 | 540 | 6 | 1,529 | 17,689 |
| United Kingdom | 533 | 1,493 | 345 | 68 | 3,137 | 13,027 |
| EU-15 | 19,340 | 60,630 | 89,094 | 11,775 | 115,607 | 1,155,080 |

Information source: CRF for 1990 and 2009, submitted in 2011

1) Finland reports non-dairy cattle under "other" in the following categories: bulls, cows, heifers, and calves. 2) For Luxembourg and the Netherlands the numbers for cattle have been calculated using the figure given under option B.

**Table 6.17 Information on the source of animal population data**

| Member State | Activity Data |
|---|---|
| Austria | The Austrian official statistics (Statistic Austria, 2006) provides national data of annual livestock numbers on a very detailed level. In 1998-2002 swine numbers were fluctuating due to a high elasticity to market prices. The animal numbers of Young Swine were not taken into account because the emission factors for Breeding Sows already includes nursery and growing pigs (Schechtner 1991). Information about the extent of organic farming in Austria was provided in the Austrian INVEKOS database (Kirner and Schneeberger, 1999). From 2004 onwards INVEKOS data of organic cattle population as reported in the so called 'Green Reports' of the ministery of agriculture (BMLFUW 2007) was used. |
| Belgium | The National Institute of Statistics (NIS) publishes land-use and the livestock figures yearly (NIS, 2006 http://www.statbel.fgov.be/downloads/cah2006m_fr.xls). All agricultural businesses have to fill in a form each year about the situation at 1 may of that year and sent it to the NIS. In Flanders, livestock figures from 2000 on are obtained by the Manure Bank of the Flemish Land Agency. Further details on the agricultural census methodology and QA/QC issues can be found on the NIS website (www.statbel.fgov.be). Mules and Asses are included in the category Horses. "Other" includes Horses, Mules and Asses, Goats and Rabbits. |
| Denmark | Livestock production is primarily based on the agricultural census from Statistics Denmark. The emission from slaughter pigs and poultry is based on slaughter data. Approximate numbers of horses, goats and sheep on small farms are added to the number in the Agricultural Statistics, in agreement with the Danish Agricultural Advisory Centre (DAAC), as Statistics Denmark |

| | |
|---|---|
| | does not include farms less than 5 hectares. Animal numbers of sheep, goats, ostriches and deer are based on the Central House animal farm Register (CHR). Pheasant numbers are based on expert judgemet from NERI and the pheasant breeding association. |
| Finland | The number of cattle, sheep, swine, poultry and goats was received from the Matilda-database maintained by the Information Centre of the Ministry of Agriculture and Forestry (http://www.mmmtike.fi/en/) as well as from the Yearbook of Farm Statistics published annually by the Ministry of Agriculture and Forestry. The number of animals describes the number of animals in 1st of May (cattle, swine, poultry) and it has been reported consistently over the time series. Cattle category has been divided into the following sub-categories: Dairy cows, Suckler cows, Bulls, Heifers and Calves for which separate emission factors have been calculated. Animal numbers are harmonized with the Nitrogen mass flow model used by the Finnish Environment Institute. |
| France | Agricultural statistics are issued by the ministry of agriculture (SCEES/AGRESTE). Activity data is a one year average. Heifers are included in Other Cattle, but heifers more than 2 years old (40% of the total heifer livestock) are considered as Dairy cattle. |
| Germany | Animal types are disaggregated, if significant differences exist between emission factors. For example, dairy cattle are grouped into sub-categories in each district on the basis of animal performance and feeding indicators. Other cattle include calves, heifers, bulls (beef), suckler cowws and mature males. Sows and suckling pigs are calculated separately, as well as sheep and lambs, and the results are aggregated and IEFs covering both sub-categories are reported. The category 'poultry' is differentiated into the sub-categories laying hens, broilers, pullets, geese and ducks and turkey hens and cocks. A complete animal census at the "Kreise" level is available for every second year in the official agricultural statistics with the exception of goats, mules and asses, and buffalo. For the other years, animal numbers are available at the "Länder" level. The number of horses is taken from the official statistics, but are probably too low, they are partly corrected (Daemmgen, 2006). Numbers for sheep have to be corrected for some years. Calculation methods and elaboration of activity data are detailed in Daemmgen et al. (2007). Individual cattle are registered since 2008 in a specific data base (HIT). As no threshold exist, this lead to higher animal numbers.Information on feeding and stable types are taken from the agricultural model 'RAUMIS' available at vTI (Regionalisiertes Agrar- und UmweltInformationsSystems fuer Deutschland). The model is based on national statistics at district level, description of standard production methods from KTBL, information from the ministry for agriculture and results from surveys. Data gaps are filled by expert knowledge. |
| Greece | Data on animal population, agricultural production and cultivated areas used for the emissions calculation were provided by the NSSG. Data on animal population 2007 are provisional estimations. Animal population except Sheep, is a 3-year average. Because of the analytic methodology used for Sheep, data on disaggrated population are the actual reported in the Statistics for each year. Milk yield derives from data of the annual Agricultural Statistics. |
| Ireland | Because of the importance of agriculture in the country, Ireland has very extensive and up-to-date statistical data on all aspects of the sector, compiled and published by the Central Statistics Office. The Irish cattle herd is now characterised by 11 principal animal categories for which annual census data are published by CSO. The number of Cows in each category given by CSO statistics was allocated to the regions using CMMS reports published by the Department of Agriculture and Food (DAF, 2007). The most important parameter is liveweight gain as it directly affects the energy requirement and thus feed intake. There is little statistical information on the liveweight gain of the different types of Cattle in the Irish Cattle herd, but the weight of carcasses of all slaughtered cattle is recorded by the Department of Agriculture and Food. |
| Italy | Livestock data are collected from the National Institute of Statistics (ISTAT) and are based on specific national surveys, such as the 'milk production' and the 'farm structure and production' surveys, and from a general agricultural census carried out every 10 years. The last Farm was carried out at the end of 2005, surveying about 1.38 million agricultural holdings of an economic size of at least 1 European Size Unit. Since 2006 submission, results from the MeditAIRaneo project have been included in the preparation of the emission inventory. |
| Luxembourg | The activity data are the livestock data reported in the national statistics. |
| Netherlands | Activity data for the animal population are based on the annual agricultural survey performed by Statistics Netherlands (CBS). Data can be found on the website www.cbs.nl and in background documents (Van der Hoek and Van Schijndel, 2006; Van Schijndel and Van der Sluis, 2008). For cattle three categories are distinguished: Dairy cattle: adult female cows (for milk production); Non-dairy cattle: adult cows (for meat production); Young cattle showing a mix of different age categories (for breeding and meat production). |
| Portugal | Activity data are 3-years average except for last year. Annual livestock numbers were available from the statistical databases of the National Statistics Institute (INE) for Cattle, Swine, Sheep, Goats, Horses, Mules and Donkeys, dissagregated per region, age and sex. The number of Rabbits, Hens, Broilers, Turkeys, Ducks, Geese and Guinea-fowl, is only available for 1999 – from the national agriculture census that is done every ten years. |
| Sweden | The Farm Register provides the main basis for agricultural statistics in Sweden. The Register is administered by the Swedish Board of Agriculture and Statistics Sweden and provides annual information on the total number of animals of different categories on Swedish farms. The information on livestock refers to the situation prevailing in mid-June of that year and thus is considered to be equivalent to a one-year average. Mink and foxes are minor contributors to greenhouse gas emissions and are not included in the inventory due to a lack of well-founded emission factors. The number of slaughter chickens (mean number of chickens kept during the year) is provided by the Swedish Poultry Meat Association. |
| United Kingdom | The animal population data are collected in an annual census (Defra). Animal weights based on slaughter weights (Defra). Pre-1995 is corrected home killed slaughter weights (UK livestock Slaughter Statistics, Defra, SERAD, WAG and DARDNI and their predecessors, 1995 and onwards are weights from the over 30 months scheme (courtesy of Rural Payments Agency). In using the animal population data, it is assumed that the reported numbers of animals are alive for that whole year. The exception is the treatment of sheep where it is normal practice to slaughter lambs and other non-breeding sheep after 6 to 9 months. Hence it is assumed that breeding sheep are alive the whole year but that lambs and other non-breeding sheep are only alive 6 months of a given year (based on Smith and Frost, 2000). |

**Emission Factors and other parameters**

Considerable variation is found in the IEF for dairy and non-dairy cattle with values between 103 kg $CH_4$ head$^{-1}$ yr$^{-1}$ (Spain) and 134 kg $CH_4$ head$^{-1}$ yr$^{-1}$ (Denmark) for dairy cattle, and 36 kg $CH_4$ head$^{-1}$ yr$^{-1}$ (Netherlands2)) and 56 $CH_4$ head$^{-1}$ yr$^{-1}$ (Austria) for non-dairy cattle. The difference can mainly be explained by the different levels of intensity for dairy production and will be discussed below. The IEF for the EU-15 Member States and the $CH_4$ conversion factors used are given in Table 6.18. For EU-15, the implied emission factor in 2009 was 119 kg $CH_4$ head$^{-1}$ yr$^{-1}$.

More detailed information on the development of the emission factors for category 4A is given in Table 6.19.

The following outliers can be identified:

- **IEF - Dairy cattle, Netherlands**
  The slightly lower Dutch IEF compared to the default IPCC IEF for adult dairy cattle at a comparable milk production rate (at a milk production rate of 6700 kg per cow per year) can be explained by the higher feed digestibility in the Netherlands.
- **IEF - Non-dairy cattle, Denmark.**
  Non-Dairy Cattle" includes calves, heifers, bulls and suckler cows and the implied emission factor is a weighted average of these different subcategories. The Danish IEF for non-dairy cattle is lower compared with the default value, this is due to lower weight and lower feed intake and a higher digestibility of feed.
- **IEF - Non-dairy cattle, Germany**
  The low IEF is due to large share of cattle with low EF. The level of IEF seems to be comparable to that given by a number of other countries (comparison based on 2007 submissions, including Option B). Further, the low IEF is consistent with a low animal weight for non-dairy cattle in Germany.
- **IEF - Horses, Germany**
  A distinction is made for large and small horses, whereby the IEF for large horses was taken from IPCC (2006) and the IEF for small horses used was smaller with 12 kg head$^{-1}$ yr$^{-1}$. The overall IEF for horses is thus smaller then the IPCC value.
- **IEF – Goat, mules and asses, Germany**
  For goats, the IEF is based on the assumption of all-round grazing, which is not the case. Emissions are calculated with realistic management system frequency distributions.
- **IEF - Sheep and goat, Denmark**
  The emissions from sheep include lamb and thus explains the high IEF value. The same situation exists for goats, which include kids. This is due to the availability of data. The Danish normative data from the Faculty of Agricultural Sciences operate with sheep including lamb as a standard and do not distinguish between sheep and lamb.
- **IEF - Non-dairy cattle, Portugal**
  In Portugal non dairy cattle are usually kept in range (mother cows) or in solid storage systems (steers and feedlots). According to agriculture experts the use of liquid systems has no expression.

**Table 6.18** **Implied Emission factors for $CH_4$ emissions from enteric fermentation and $CH_4$ conversion factors used in Member State's inventory**

| Member State | Implied EF (kg $CH_4$/head/yr) [1)] | | | | | $CH_4$ conversion (%) [1)] | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 2009 | Dairy Cattle | Non-dairy cattle | Sheep | Goats | Swine | Dairy Cattle | Non-dairy cattle | Sheep | Goats | Swine |
| Austria | 116 | 56 | 8.0 | 5.0 | 1.5 | 6.0 | 6.0 | 6.0 | 5.0 | 0.6 |
| Belgium | 124 | 45 | 8.0 | 5.0 | 1.5 | 6.0 | 6.0 | NE | NE | NE |
| Denmark | 134 | 43 | 17.2 | 13.1 | 1.0 | 6.0 | 6.0 | 6.0 | 5.0 | 0.6 |
| Finland[1)] | 126 | 48 | 8.4 | 5.0 | 1.5 | 6.0 | 6.0 | NA | NA | NA |
| France | 117 | 53 | 9.8 | 11.8 | 1.1 | NA | NA | NA | NA | NA |
| Germany | 128 | 46 | 8.0 | 5.0 | 1.2 | 6.0 | 6.2 | 6.0 | 5.0 | 0.6 |
| Greece | 117 | 55 | 9.1 | 5.0 | 1.5 | 6.0 | 6.0 | 6.6 | NE | NE |
| Ireland | 108 | 55 | 5.9 | 5.0 | 0.5 | 6.0 | 6.0 | 7.0 | NE | NE |
| Italy | 113 | 45 | 8.0 | 5.0 | 1.5 | 6.0 | 4.4 | NA | NA | NA |
| Luxembourg[2)] | 118 | 43 | 8.0 | 5.0 | 1.5 | 6.0 | 6.0 | 6.0 | 5.0 | 0.6 |
| Netherlands[2)] | 127 | 36 | 8.0 | 5.0 | 1.5 | NE | NE | NE | NE | NE |
| Portugal | 125 | 55 | 9.1 | 8.0 | 1.4 | 6.0 | 5.9 | 6.0 | 5.0 | 0.6 |
| Spain | 103 | 55 | 8.8 | 5.0 | 0.9 | 5.5 | 5.3 | 6.7 | NA | 82.1 |
| Sweden | 132 | 55 | 8.0 | 5.0 | 1.5 | 6.2 | 7.0 | 6.0 | 5.0 | 0.6 |
| United Kingdom | 109 | 43 | 4.6 | 5.0 | 1.5 | 6.0 | 6.0 | NE | NE | NE |
| EU-15 | 119 | 49.1 | 7.2 | 5.9 | 1.2 | 6.0 | 5.8 | 6.6 | 5.0 | 30.6 |

Information source: CRF for 1990 and 2009, submitted in 2011. Abbreviations explained in the Chapter 'Units and abbreviations'.

1) Finland reports non-dairy cattle under "other" in the following categories: bulls, cows, heifers, and calves. The IEF has been calculated as a weighted average. 2) The IEF for Luxembourg and the Netherlands has been calculated as a weighted average has been calculated using the values given under option B (mature non-dairy and young cattle).

**Table 6.19** **Member State's background information for $CH_4$ emissions in category 4.A. Emission Factor and other parameters**

| Member State | Emission Factor and other parameters |
|---|---|
| Austria | Country specific emission factors for cattle calculated from the specific gross energy intake and the methane conversion rate (IPCC for "all other cattle" because there are few if any feedlot cattle with a high-energy diet). Austrian energy intake data were recalculated by from the Agricultural Research and Education Centre (AREC) Raumberg-Gumpenstein (Poetsch et al. 2005, Gruber and Poetsch, 2006). The time series of average milk yields per dairy cow was taken from national statistics, milk yield of suckling cows is from Hausler (2009). For the period from 1990 to 2007 a constant average milk yield of 3 000 kg kg was applied, resulting in a Gross Energy Intake of 235.3 MJ per suckling cow and day. For the calculation of emissions from poultry the IPCC Tier 2 method with Swiss emission factors (Gross Energy Intake, Methane Conversion Rate) was used. The animal category Other livestock corresponds to deer with default EF used for sheep. |
| Belgium | The average animal weight and weight gain originate in Flanders from the Department Agriculture and Fishery and in Wallonia from average weights published by the federal finance department. In Flanders, data for feed digestibility (DE%) originate from a report [http://www.rivm.nl/bibliotheek/rapporten/680125001.html] from the Netherlands, a neighbouring country with comparable feeding situations. In both regions a methane conversion rate (Ym) of 6% is used to calculate the emission factor for each cattle type. The emission factors for all categories with exception for dairy cows stay constant over the entire time series. For dairy cows the emission factor increases with increasing milk production. |
| Denmark | Feed consumption for all animal categories is based on the Danish normative figures. The estimation of the national values of Ym is based on model "Karoline" developed by FAS based on average feeding plan for 20% of all dairy cows in Denmark obtained from the Danish Agricultural Advisory Centre DAAC (Danfær, A. 2005). New investigations from FAS have shown a change in fodder practice from use of sugar beets to use of maize. Research showed that sugar beets as feeding stuff is resulting in a higher methane conversion rate than the default values. Enteric $CH_4$ emissions are, in general, lower than the IPCC default values due to the professional way farms are managed in Denmark. For goats and horses new subcategories are introduced in 2007 and therefore the IEF differs from the other years. For sheep the IEF is constant. |
| Finland | IPCC gives no default emission factor for reindeer, thus it has been calculated by using national methodology for estimating gross energy intake of reindeer from the basis of their forage. The same equation has been used for sheep also. Emission factors for cattle are updated annually. EF´s for other animal groups will be updated if more national data will become available. Average daily weight gain for cattle was estimated to remain constant. |
| France | The EF for Dairy Cattle, is depending to the milk production. Emissions factors are used for enteric fermentation from a study published in 2008 by the French National Institute of Agronomy. These emission factors are based on parameters equivalent to Ym and GE, but these parameters are not directly available in the study. |
| Germany | The calculation of the EF for Dairy Cattle is based on milk production, animal weight (derived from nation data on milk production and milk quality), and animal feed. Feeding composition (mixed grass/maize/feed concentrates and grass/concentrates) and their characterization is available for each district. Feed digestibility is estimated as function of feed composition and productivity. For milk-feed calves it has been considered that they do not belong to the ruminant animals. |

| | |
|---|---|
| Greece | The average milk production for domestic and in flock and for nomadic sheep is 0.48 kg/day and 0.43 kg/day respectively. |
| Ireland | The Tier 2 emission factors for the 11 animal categories was initially carried out for the 2006 herd and then repeated for 1990 and 2005. The study and analysis underlying the new emission factors is available (O'Mara, 2006). Emission factors for the Beef cattle categories were determined by calculating lifetime emissions for the animal and by partitioning between the first, second and third years of the animal's life. |
| Italy | Data to calculate the emission factor from dairy and non-dairy cattle are national (ISTAT, Centro Ricerche Produzioni Animali, Reggio Emilia - CRPA). This information has been discussed in a specific working group in the framework of the MidetAIRaneo project (CRPA, 2006; CRPA, 2005). The emission factor for buffalo has been calculated by Condor et al. (2006). The emission factor for rabbits is national. |
| Luxembourg | For the Tier 1 method, default GE are usually provided in the IPCC Guidelines. For the Tier 2 method, GE is the combination of various feed intake – or net energy – estimates relating to maintenance, activity, growth, etc. of the animals. |
| Netherlands | The emission factors for three cattle types are calculated annually (e.g. adult dairy, adult non-dairy and young cattle, respectively). Swine, sheep, goat and horses: default. |
| Portugal | For the emission factor for Rabbit, the default EF for Horse has been downscaled to the average weight of a rabbit according to the scaling equation in IPCC GPG. Default EF for Horses, Mules and Asses, due to the unavailability of a more detailed livestock characterization and specific characterization of national populations. In accordance with the unavailability of emissions factors in IPCC96 for broilers, laying hens, turkeys, ducks, geese, guinea fowl and other poultry, emissions from these classes were not estimated and were assumed as negligible. |
| Spain | |
| Sweden | A national methodology based on feed energy requirements expressed as metabolisable energy is used in the Swedish inventory to estimate emission factors for dairy cows, beef cows and other cattle. The calculations for dairy cows were revised some years ago. The emission factors for other cattle groups were also reevaluated, using the same methodology. The initial step in estimating emission factors for cattle according to the Swedish method is enhanced characterisation of feed intake estimates (Tier 2 methodology). The energy requirements for maintenance, growth, lactation and pregnancy are estimated, but expressed as metabolisable energy (MJ/day) instead of as net energy. The metabolisable energy requirement is then recalculated to digestible energy. A lactation period of 305 days and a non-lactating period of 60 days was used (Bertilsson, 2002; Nieminen, 1998). The default values in the IPCC Guidelines are used for the less significant animal groups. Reindeer: according to IPCC GPG (Tier 2) using a Finnish value of gross energy requirements. |
| United Kingdom | Apart from cattle, lambs and deer, the methane emission factors are IPCC Tier 1 defaults. The dairy cattle emission factors are estimated following the IPCC Tier 2 procedure and vary from year to year. For dairy cattle, the calculations are based on the population of the 'dairy breeding herd' rather than 'dairy cattle in milk'. The emission factors for beef and other cattle were also calculated using the IPCC Tier 2 procedure, but do not vary from year to year. The enteric emission factors for Beef cattle were almost identical to the IPCC Tier 1 default so the default was used in the estimates. The emission factor for Lambs is assumed to be 40% of that for adult Sheep (Sneath, 1997). The exception is the treatment of sheep where it is normal practice to slaughter lambs and other non-breeding sheep after 6 to 9 months. |

Milk productivity is one of the most important factors determining the level of $CH_4$ emissions from dairy cattle. Several countries have reported milk productivity, which are reproduced in Table 6.20 and Table 6.21 beside information on feed intake, animal weight, and feed digestibility. The data show clearly that a strong intensification of cattle husbandry occurred, with increases in the milk yield ranging from 13% (Ireland) to 108% (Spain). This is thus more than the increase in the $CH_4$ emission factor. The increased production was only partly achieved by increased energy intake (up to a maximum of 42%, but some countries report also a stable feed intake), and partly by an improved feed efficiency. This is expressed in the feed digestibility, which for some countries increased by up to 6%, however it must be kept in mind that most countries do not estimate a time-varying feed digestibility (only 3 do, compared to 11 countries which report a time-dependent milk productivity). Higher feed digestibility reduces the portion of carbon intake that is transformed to methane in ruminants. As the feed intake increase is smaller than the increase in milk productivity (for EU15 the numbers are 21% and 41%, respectively), the feed quality and consequently also the feed digestibility increase most probably in more countries. This suggests that these countries tend to overestimate the increase in methane emissions from enteric fermentation of dairy cattle. Calculating the average for those countries which have reported data, the milk yield was higher by 12% than the default value for Western Europe (11.5 kg/day) in 1990, and increased to a level which was 58% above IPCC default in 2009. Even though feed digestibility for dairy cattle was not separately estimated for each year by all countries, the level is 21% to 22% above IPCC default (60%) digestibility.

**Table 6.20 Additional background information for calculating $CH_4$ emissions from enteric fermentation from dairy cattle**

| Member State | Dairy Cattle | | | |
|---|---|---|---|---|
| 2009 | Feed Intake[1)] | Animal Weight (kg) | Milk prod.[1)] | Feed Digest. (%) |
| Austria | 294 | 700 | 17 | 70 |
| Belgium | 314 | 1200 | 18 | 75 |
| Denmark | 343 | 575 | 24 | 71 |
| Finland | 321 | 634 | 22 | 70 |
| France | NA | NA | 17 | NA |
| Germany | 326 | 642 | 19 | 75 |
| Greece | 296 | 600 | 14 | 60 |
| Ireland | 232 | 535 | 13 | NE |
| Italy | 287 | | | |
| Luxembourg | 300 | | | |
| Netherlands | NE | NE | NE | NE |
| Portugal | 318 | NE | 18 | 60 |
| Spain | 284 | 649 | 21 | 71 |
| Sweden | 339 | NE | NE | NE |
| United Kingdom | 278 | 643 | 19 | 74 |
| EU-15 | 301 | 656 | 18 | 73 |

| Member State | Dairy Cattle | | | |
|---|---|---|---|---|
| 1990 | Feed Intake[1)] | Animal Weight (kg) | Milk prod.[1)] | Feed Digest. (%) |
| Austria | 247 | 700 | 10 | 66 |
| Belgium | 252 | 1200 | 11 | 75 |
| Denmark | 278 | 575 | 17 | 71 |
| Finland | 250 | 520 | 16 | 70 |
| France | NA | NA | 14 | NA |
| Germany | 269 | 608 | 13 | 74 |
| Greece | 224 | 600 | 7 | 60 |
| Ireland | 222 | 535 | 11 | NE |
| Italy | 236 | | | |
| Luxembourg | 247 | | | |
| Netherlands | NE | NE | NE | NE |
| Portugal | 241 | NE | 12 | 60 |
| Spain | 200 | 642 | 10 | 71 |
| Sweden | 339 | NE | NE | NE |
| United Kingdom | 227 | 572 | 14 | 74 |
| EU-15 | 248 | 632 | 13 | 72 |

Information source: CRF for 1990 and 2009, submitted in 2011. Abbreviations explained in the Chapter 'Units and abbreviations'. 1) Unit for feed intake: MJ/head/yr; unit for Milk productivity: kg/day/head.

**Table 6.21 Additional background information for calculating $CH_4$ emissions from enteric fermentation from non-dairy cattle**

| Member State | Non-dairy Cattle | | | |
|---|---|---|---|---|
| 2009 | Feed Intake[1)] | Animal Weight (kg) | Milk prod.[1)] | Feed Digest. (%) |
| Austria | 143 | 425 | NO | 73 |
| Belgium | 112 | 820 | NA | 76 |
| Denmark | 130 | 325 | NO | 71 |
| Finland | 122 | NA | NA | 70 |
| France | NA | NA | NA | NA |
| Germany | 109 | 328 | NE | 72 |
| Greece | 140 | 412 | NO | 60 |
| Ireland | 133 | 302 | 8 | NE |
| Italy | 142 | | | |
| Luxembourg | 108 | | | |
| Netherlands | NE | NE | NE | NE |
| Portugal | 144 | 418 | 3 | 62 |
| Spain | 155 | 470 | 1 | 69 |
| Sweden | 181 | NE | NE | NE |
| United Kingdom | 189 | NE | NE | |
| EU-15 | 144 | 407 | 4 | 70 |

| Member State | Non-dairy Cattle | | | |
|---|---|---|---|---|
| 1990 | Feed Intake[1)] | Animal Weight (kg) | Milk prod.[1)] | Feed Digest. (%) |
| Austria | 123 | 364 | NO | 74 |
| Belgium | 104 | 762 | NA | 76 |
| Denmark | 107 | 325 | NO | 71 |
| Finland | 103 | NA | NA | 70 |
| France | NA | NA | NA | NA |
| Germany | 101 | 300 | NE | 73 |
| Greece | 136 | 382 | NO | 60 |
| Ireland | 132 | 279 | 8 | NE |
| Italy | 141 | | | |
| Luxembourg | 104 | | | |
| Netherlands | NE | NE | NE | NE |
| Portugal | 130 | 355 | 2 | 62 |
| Spain | 155 | 460 | 1 | 69 |
| Sweden | 181 | NE | NE | NE |
| United Kingdom | 189 | NE | NE | |
| EU-15 | 135 | 364 | 5 | 72 |

Information source: CRF for 1990 and 2009, submitted in 2011. Abbreviations explained in the Chapter 'Units and abbreviations'.
1) Unit for feed intake: MJ/head/yr; unit for Milk productivity: kg/day/head.

## Trends

*Animal population.* Regarding animal numbers, some major changes occurred since 1990. In all countries, the numbers of cattle and sheep are considerably reduced, on the average by 31% for dairy cattle and 10% for non-dairy cattle, and by 22% for sheep. An increase in the number of cattle has only been observed in the category of non-dairy cattle in Greece (5%), Sweden (3%), Ireland (4%), Portugal (15%) and Spain (50%). Largest decrease of the number of dairy cattle occurred in Spain (2009 at 52% of the 1990 level). For non-dairy cattle, largest decrease occurred in Denmark (2009 at 66%).

The picture is a little bit different for the categories Goats and Swine, as some countries have encountered a significant increase of the populations, for example the goat population in Belgium in 2009 has increased by 263% respective to the population in 1990; in the Netherlands this figure amounts to 516%. However, due to a decrease of the goat number in other countries with a high population (mainly Spain with 2,934,000 heads in 2009), the goat population at EU15 level was rather stable (2009 at 93% of 1990-level).

The swine population was increasing especially in Denmark (30%), Spain (53%), and Ireland (27%), but this was balanced from reductions in other countries. Poultry numbers saw a slight increase of 8% in EU15; only Austria and Luxembourg reported $CH_4$ emissions from enteric fermentation of poultry.

The trend in animal numbers is to a large extend influenced by EU policy such as suckler cow premia, milk quota, but also environmental legislation linked to agricultural policy through cross-compliance and the rural development. Animal development is also determined by epidemies such as the avian flu (reducing e. g. the number of poultry in the Netherlands in 2003), the BSE crisis between 2001 and 2003, to name just the most important. Further examples for driving forces of the observed trends are given in

Table 6.22 below.

*Implied emission factor*. At the aggregated level for EU-15, the implied emission factor for dairy cattle increase from 100.2 kg $CH_4$ head$^{-1}$ yr$^{-1}$ to 119 kg $CH_4$ head$^{-1}$ yr$^{-1}$ while at the same time the animal number of dairy cattle decreased by 31%, resulting in a decrease of European $CH_4$ emissions from enteric fermentation in the category of dairy cattle by Dairy Cattle.

The increase of the implied emission factor of 22% for dairy cattle is due to changes reported all countries, while for non-dairy cattle, 14 countries have used a time-varying implied emission factor. Changing IEFs, however, are not necessarily due to a changing (assumed) productivity of non-dairy cattle sub-categories, but can rather be the consequence of a different composition of non-dairy cattle (e. g. ratio of heifers to young cattle) with different implied emission factor. Nevertheless, the IEF for non-dairy cattle was more stable that that for dairy cattle and changed only by 5% between 1990 and 2009 from 46.9 kg $CH_4$ head$^{-1}$ yr$^{-1}$ to 49.1 kg $CH_4$ head$^{-1}$ yr$^{-1}$. It decreased in 3 countries (Ireland, Italy, Netherlands). The maximum decrease was observed in Netherlands by 6%.

For sheep, the implied emission factors changed since 1990 in 6 countries, but stayed close to the 1990-value for EU15. Only Finland and Portugal saw a substantial increase of the IEF for sheep by 23% and 9%, respectively. Note that the IEF for sheep and goats used in Denmark (Tier 2 methodology) is with 17.2 kg $CH_4$ head$^{-1}$ yr$^{-1}$ and 13.1 kg $CH_4$ head$^{-1}$ yr$^{-1}$ considerably higher than the IPCC default values and the numbers used in other Member States. This is explaind by the Danish normative data, which operate with sheep including lamb and goats including kids. The emissions of lamb and kids are therefore included in the numbers for sheep and goats, respectively. On the other hand, the IEF for sheep for UK is with 4.6 kg $CH_4$ head$^{-1}$ yr$^{-1}$ the lowest from EU and is similar to the IEF for developing countries according to the IPCC 2006 GL. The emission factor was fixed by Tier 1 with the assumption that IEF for lambs is 40% of that for adult sheep (breeding sheep are alive the whole year but that lambs and other non-breeding sheep are only alive 6 months of a given year).

The $CH_4$ conversion factor is IPCC default for most Member States.

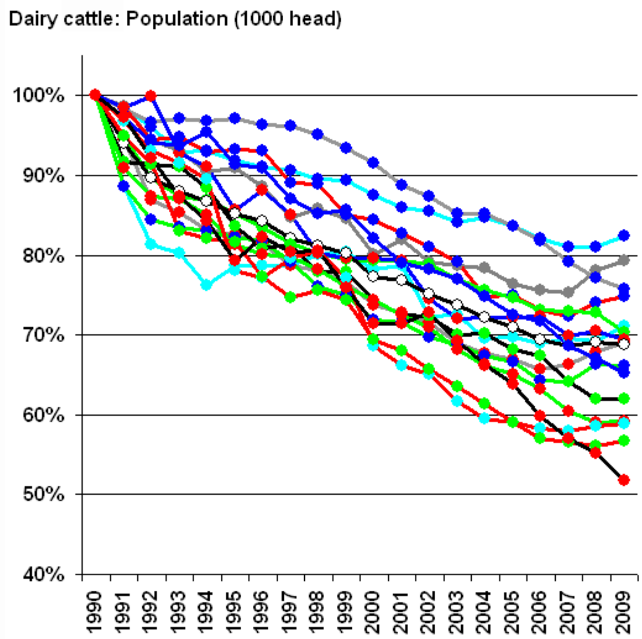
Figure 6.4 through Figure 6.13 show the trend in the activity data for the key source in the category of enteric fermentation as well as the trend of one important indicator for animal productivity, the average daily gross energy intake for dairy and non-dairy cattle and sheep. The trend of the populations of swine, goat, and poultry are included as well.

Table 6.22 gives additional information on the trend in category 4A as reported in the national inventory reports.

**Table 6.22 Member State's background information on the trend for $CH_4$ emissions in category 4.A.**

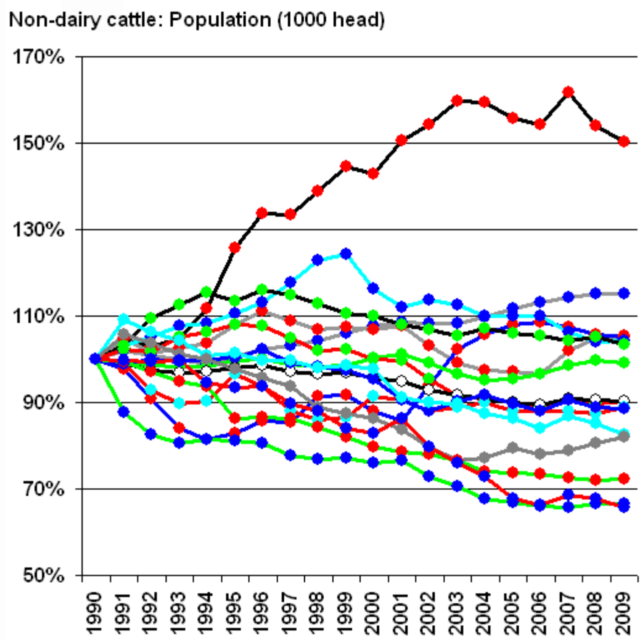
| Member State | Trend in category 4A |
|---|---|
| Austria | Up to the early 1990ies Austrian dairy husbandry was determined by traditional Austrian green feeding and traditional Austrian races. From the mid 1990ies onwards milk production has been intensified: diets with higher energy concentration were fed and the share of high yield breeds (e.g. Holstein Friesian) in dairy farming was increased. |
| Belgium | In Belgium, there is the trend of disappearance of small businesses, also reinforced by the BSE crises. Additionally in Flanders, this partly can be explained due to the subsidized cut down of the number of Cattle. This affected only swine in 2001 and 2002, but in 2003 also bovine animals and poultry. Nevertheless the land area used for agricultural purposes remained identical during this period. In 2005 Wallonia has 55% of the land used for agriculture, but 67% of agricultural businesses are situated in Flanders. The land area used for farming is on average 19 ha per farm in the Flemish region and 47 ha per farm in the Walloon region. |
| Denmark | The increase in the IEF for dairy cattle from 1990-2007 is the result of increasing feed consumption due to rising milk yields. On average, the milk yield has increased from 6200 litre per cow per year in 1990 to approximately 8600 litre per cow per year in 2007 (Statistics Denmark). The interannual increase of methane IEF for non-dairy cattle in 2008/2009 is 7%. This is due to an increase in the number of heifers >½ year, which have a relatively high EF. |
| Finland | The IEF for sheep is calculated annually on the basis of forage consumption and the number of animals (lambs and ewes separately). Thus, next to the relative numbers of lambs and ewes, changes in the diet are reflected in the IEF, which lead to an inter-annual fluctuation of the emissions. |
| Ireland | Increased beef population is explained by the earlier finishing time for male beef cattle since the BSE crisis that affected agriculture during the 1990s. |
| Germany | The reduction of animal numbers since 1990, and in particular between 1990 and 1991 is a consequence of the German unification causing a change in consumer behavior. At the same time, animal performance (calculated for cattle and swine) increased. |
| Netherlands | Decreases in emissions from cattle the decrease in numbers is mainly explained by an increase in milk production per dairy cow combined with an unchanged total milk production. Milk production per cow increased significantly since 1990, a development which has resulted from both genetic changes in cattle (due to breeding programmes) and the change in amount and composition of feed intake. Total milk production in the Netherlands is determined mainly by EU policy on milk quota. Milk quota remained unchanged in the same period. In order to comply with the unchanged milk quota, animal numbers of (dairy) cattle had to decrease to counteract the effect of increased milk production per cow. The numbers of young (dairy) cattle follow the same trends as those of adult female cattle – namely, a decrease. (Van Schijndel and Van der Sluis, 2008). Goat numbers increased by a factor 5 and horse numbers nearly doubled in this period. The increase in the number of goats might be explained as an effect of the milk quota for cattle.<br>The increased number of swine in 1997 was a direct result of the outbreak of classical swine fever in that year. In areas where this disease was present, the transportation of pigs, sows and piglets to the slaughterhouse was not allowed, so the animals had to remain on the pig farms for a relatively long period (accumulation of pigs). |
| Portugal | Portugal's IEF for sheep has been calculated with a Tier 2 method. The database available contains includes for the twelve native Portuguese breeds of sheeps information such as the number of registered animals, the number of producers, products (milk, meat or wool), dominant reproductive period, weaning age, age at slaughtering, weight (birth, 90 days and adult weight, distinguishing males from females), milk production, wool production (for sheep, males and females) and territorial distribution. Estimates were done individually for each race and distinctly for ewes, does, lambs (for slaughtering), kids (slaughtering) and males (rams, bucks and young males). Thus, the trend in the IEF does not solely depend on the number of adult sheep relative to lambs. Data from National Statistics show a decrease in net stripped weight per animal from 2007 to 2008 causing an inter-annual decrease in emission factor for sheep by 5%. |

**Figure 6.4** Trend of activity data (population) for dairy cattle.




| | 1990 | Trend (%) 1990-2009 | 2009 |
|---|---|---|---|
| Ireland | 1,342 | 82% | 1,105 |
| Netherlands | 3,755 | 79% | 2,978 |
| Portugal | 394 | 76% | 299 |
| Denmark | 753 | 75% | 563 |
| Italy | 2,642 | 71% | 1,878 |
| France | 5,310 | 70% | 3,737 |
| Greece | 212 | 69% | 147 |
| Luxembourg | 118 | 69% | 81 |
| EU-15 | 28,147 | 69% | 19,340 |
| Germany | 6,355 | 66% | 4,205 |
| United Kingdom | 2,847 | 65% | 1,857 |
| Sweden | 576 | 62% | 357 |
| Finland | 490 | 59% | 290 |
| Austria | 905 | 59% | 533 |
| Belgium | 839 | 57% | 476 |
| Spain | 1,611 | 52% | 833 |

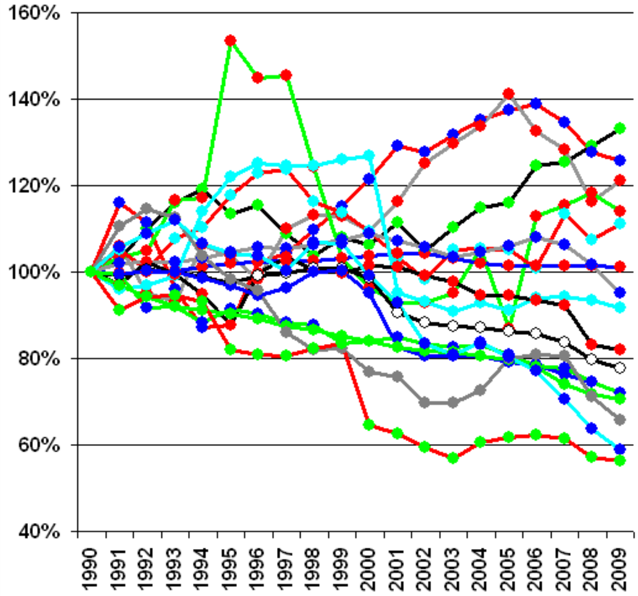
**Figure 6.5** Trend of activity data (population) for non-dairy cattle.




| | 1990 | Trend (%) 1990-2009 | 2009 |
|---|---|---|---|
| Spain | 3,469 | 150% | 5,215 |
| Portugal | 978 | 115% | 1,126 |
| Luxembourg | 186 | 105% | 196 |
| Greece | 479 | 105% | 504 |
| Ireland | 4,628 | 104% | 4,830 |
| Sweden | 1,142 | 103% | 1,182 |
| France | 16,227 | 99% | 16,099 |
| Belgium | 2,410 | 90% | 2,174 |
| EU-15 | 67,258 | 90% | 60,630 |
| Austria | 1,679 | 89% | 1,493 |
| United Kingdom | 9,232 | 88% | 8,169 |
| Italy | 5,110 | 83% | 4,224 |
| Netherlands | 3,168 | 82% | 2,602 |
| Finland | 870 | 72% | 628 |
| Germany | 13,133 | 67% | 8,739 |
| Denmark | 1,486 | 66% | 977 |

**Figure 6.6 Trend of activity data (population) for sheep**

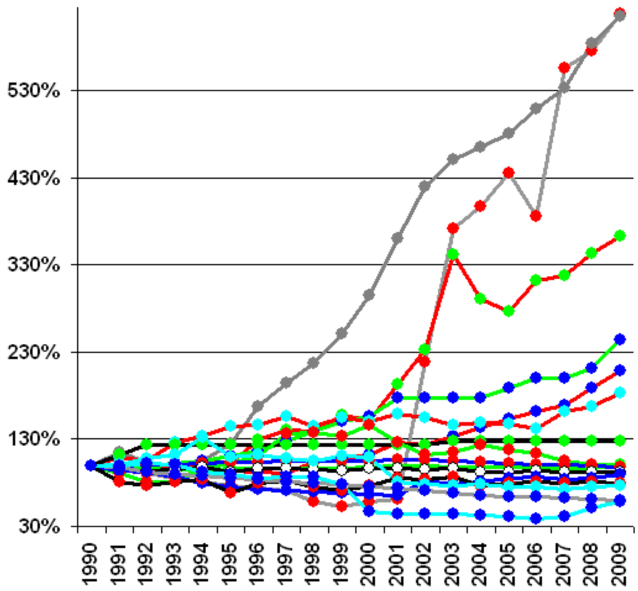
Sheep: Population (1000 head)




| | 1990 | Trend (%) 1990-2009 | 2009 |
|---|---|---|---|
| Sweden | 406 | 133% | 540 |
| Denmark | 92 | 126% | 116 |
| Luxembourg | 7 | 121% | 9 |
| Finland | 103 | 114% | 118 |
| Austria | 310 | 111% | 345 |
| Greece | 8,692 | 101% | 8,790 |
| Portugal | 3,197 | 95% | 3,044 |
| Italy | 8,739 | 92% | 8,013 |
| Spain | 24,037 | 82% | 19,718 |
| EU-15 | 114,673 | 78% | 89,094 |
| United Kingdom | 44,469 | 72% | 32,038 |
| Germany | 3,266 | 72% | 2,350 |
| France | 11,439 | 70% | 8,062 |
| Netherlands | 1,702 | 66% | 1,117 |
| Ireland | 8,021 | 59% | 4,727 |
| Belgium | 192 | 56% | 108 |

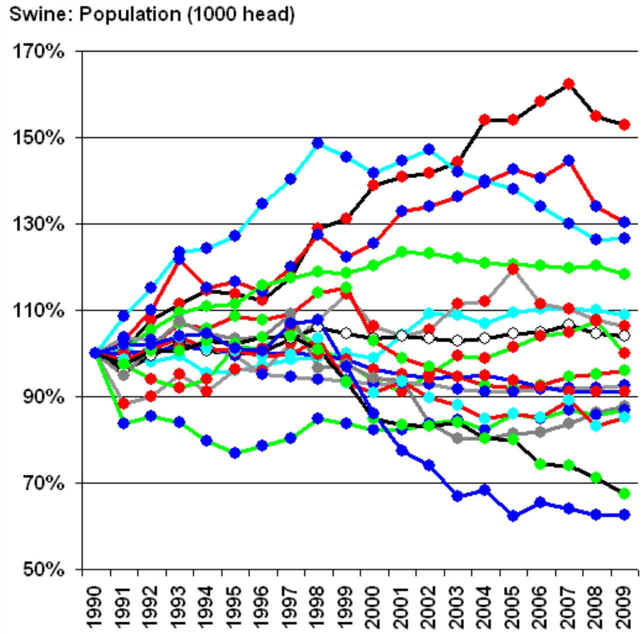
**Figure 6.7 Trend of activity data (population) for goats**

Goats: Population (1000 head)



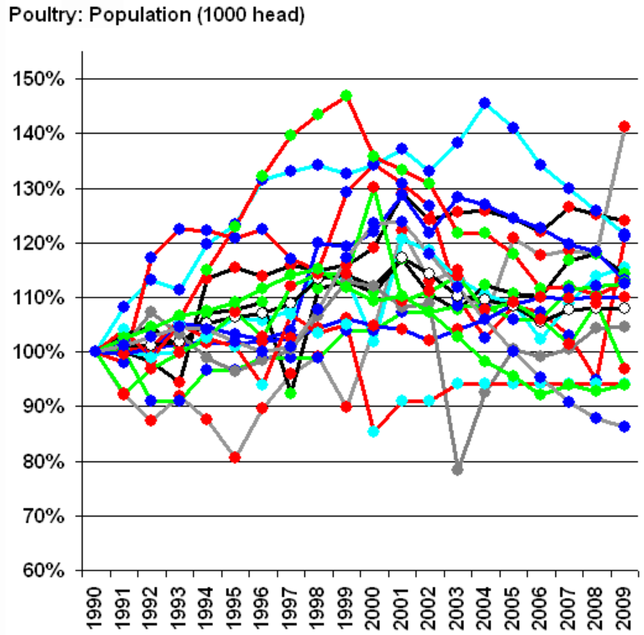

| | 1990 | Trend (%) 1990-2009 | 2009 |
|---|---|---|---|
| Luxembourg | 1 | 619% | 3 |
| Netherlands | 61 | 616% | 374 |
| Belgium | 9 | 363% | 32 |
| Germany | 90 | 244% | 220 |
| Denmark | 7 | 209% | 16 |
| Austria | 37 | 183% | 68 |
| Sweden | 4 | 128% | 6 |
| Finland | 6 | 100% | 6 |
| France | 1,329 | 100% | 1,332 |
| Greece | 5,339 | 99% | 5,267 |
| EU-15 | 12,682 | 93% | 11,775 |
| United Kingdom | 113 | 89% | 101 |
| Spain | 3,663 | 80% | 2,934 |
| Italy | 1,259 | 76% | 961 |
| Portugal | 745 | 60% | 446 |
| Ireland | 17 | 58% | 10 |

**Figure 6.8 Trend of activity data (population) for swine**



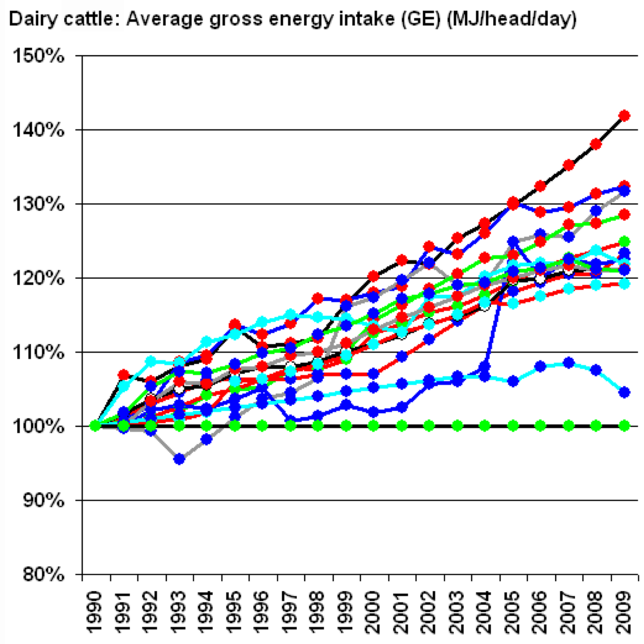

| | 1990 | Trend (%) 1990-2009 | 2009 |
|---|---|---|---|
| Spain | 16,371 | 153% | 25,046 |
| Denmark | 9,497 | 130% | 12,369 |
| Ireland | 1,212 | 127% | 1,535 |
| France | 9,587 | 118% | 11,329 |
| Italy | 8,407 | 109% | 9,157 |
| Luxembourg | 75 | 106% | 80 |
| EU-15 | 111,141 | 104% | 115,607 |
| Finland | 1,381 | 100% | 1,381 |
| Belgium | 6,700 | 96% | 6,437 |
| Portugal | 2,536 | 92% | 2,344 |
| Greece | 994 | 91% | 906 |
| Netherlands | 13,915 | 88% | 12,186 |
| Germany | 26,965 | 87% | 23,445 |
| Austria | 3,688 | 85% | 3,137 |
| Sweden | 2,264 | 68% | 1,529 |
| United Kingdom | 7,548 | 63% | 4,724 |

**Figure 6.9 Trend of activity data (population) for poultry**



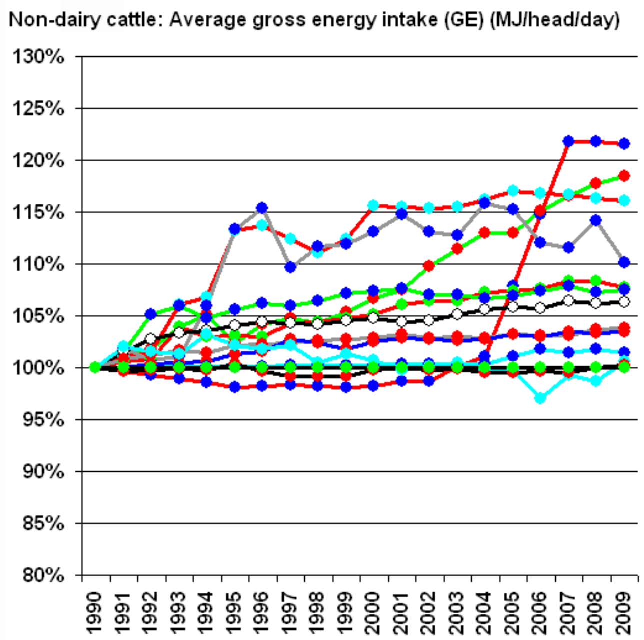

| | 1990 | Trend (%) 1990-2009 | 2009 |
|---|---|---|---|
| Luxembourg | 69 | 141% | 97 |
| Spain | 125,292 | 124% | 155,465 |
| Ireland | 11,413 | 122% | 13,871 |
| Denmark | 16,249 | 121% | 19,676 |
| Italy | 173,342 | 115% | 199,925 |
| Sweden | 15,490 | 114% | 17,689 |
| United Kingdom | 136,805 | 113% | 154,750 |
| Belgium | 27,167 | 113% | 30,644 |
| Germany | 113,879 | 113% | 128,144 |
| Greece | 28,747 | 110% | 31,592 |
| EU-15 | 1,069,046 | 108% | 1,155,080 |
| Netherlands | 95,561 | 105% | 99,987 |
| Finland | 9,663 | 97% | 9,369 |
| Austria | 13,821 | 94% | 13,027 |
| France | 270,658 | 94% | 254,186 |
| Portugal | 30,891 | 86% | 26,659 |

**Figure 6.10 Trend of activity data (gross energy intake) for dairy cattle.**




| | 1990 | Trend (%) 1990-2009 | 2009 |
|---|---|---|---|
| Spain | 200 | 142% | 284 |
| Greece | 224 | 132% | 296 |
| Portugal | 241 | 132% | 318 |
| Finland | 250 | 129% | 321 |
| Belgium | 252 | 125% | 314 |
| Denmark | 278 | 123% | 343 |
| United Kingdom | 227 | 122% | 278 |
| Italy | 236 | 122% | 287 |
| EU-15 | 248 | 121% | 301 |
| Luxembourg | 247 | 121% | 300 |
| Germany | 269 | 121% | 326 |
| Austria | 247 | 119% | 294 |
| Ireland | 222 | 105% | 232 |
| Sweden | 339 | 100% | 339 |
| France | | | |
| Netherlands | | | |

**Figure 6.11 Trend of activity data (gross energy intake) for non-dairy cattle.**




| | 1990 | Trend (%) 1990-2009 | 2009 |
|---|---|---|---|
| Denmark | 107 | 122% | 130 |
| Finland | 103 | 118% | 122 |
| Austria | 123 | 116% | 143 |
| Portugal | 130 | 110% | 144 |
| Belgium | 104 | 108% | 112 |
| Germany | 101 | 108% | 109 |
| EU-15 | 135 | 106% | 144 |
| Luxembourg | 104 | 104% | 108 |
| Greece | 136 | 103% | 140 |
| Ireland | 132 | 101% | 133 |
| Italy | 141 | 101% | 142 |
| Spain | 155 | 100% | 155 |
| United Kingdom | 189 | 100% | 189 |
| Sweden | 181 | 100% | 181 |
| France | | | |
| Netherlands | | | |

**Figure 6.12 Trend of activity data (gross energy intake) for sheep**

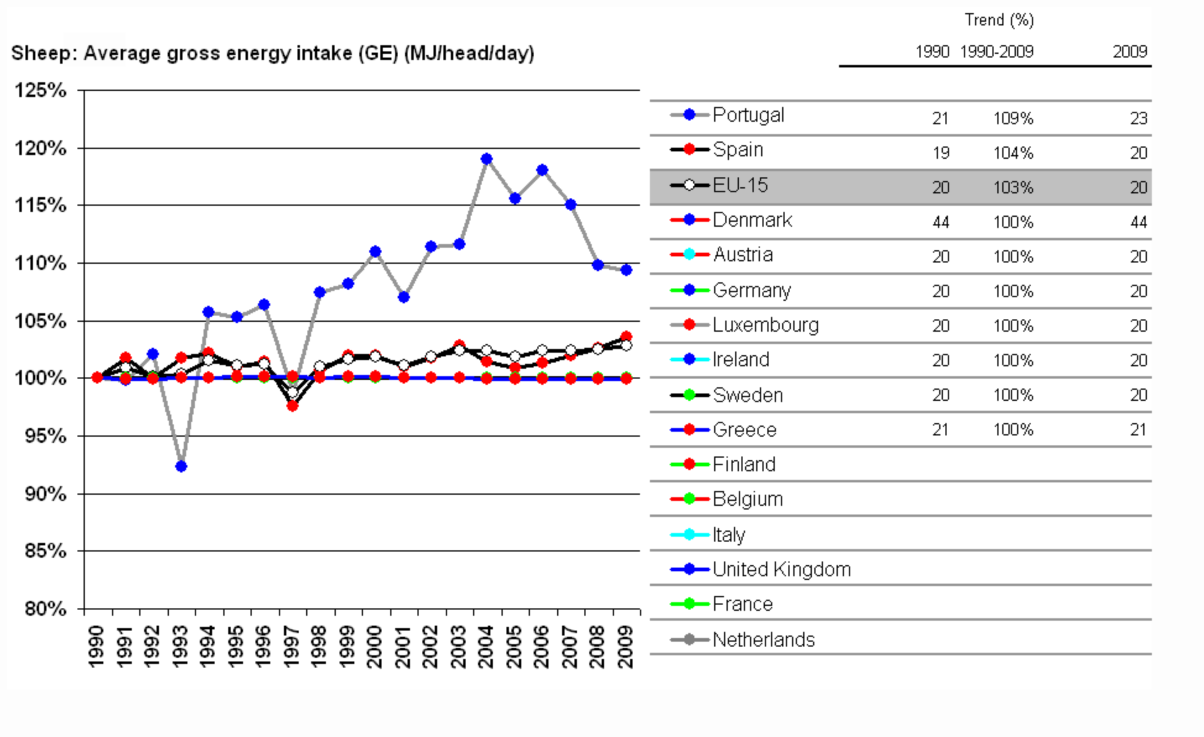
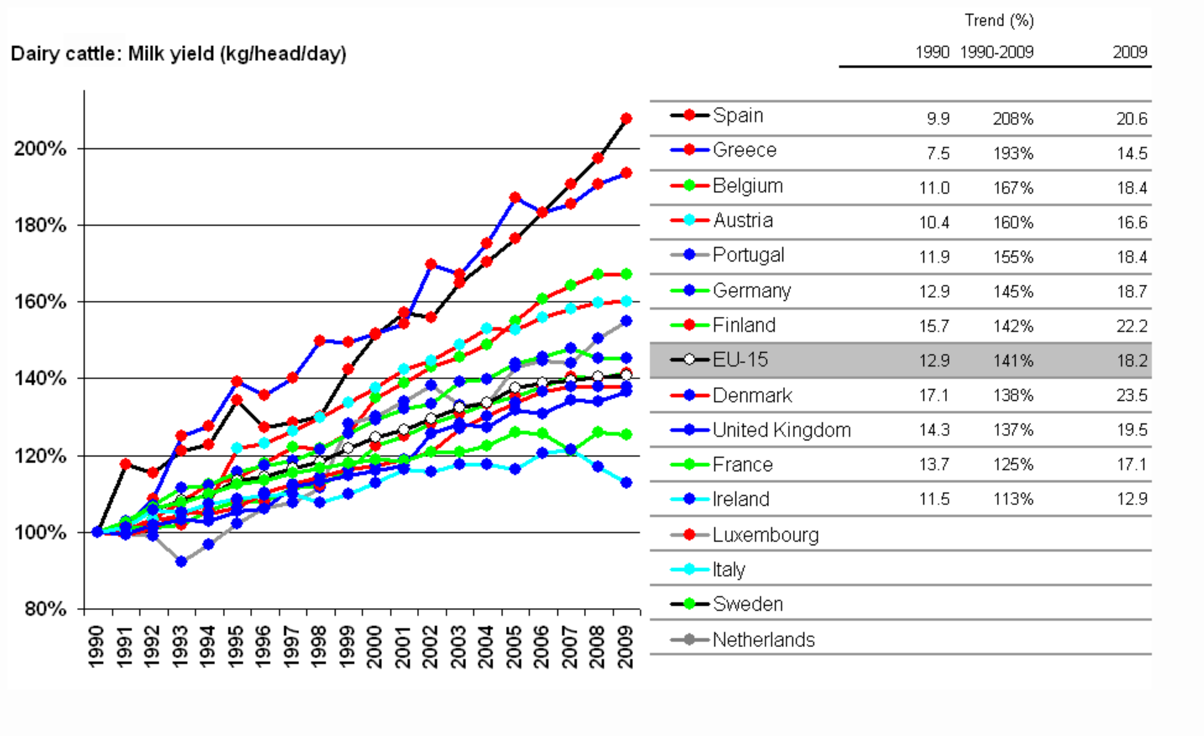



**Figure 6.13 Trend of activity data (milk productivity) for dairy cattle**



### 6.3.1.3 Uncertainty and time series consistency

$CH_4$ emissions from enteric fermentation belong to the source categories in agriculture, which are less uncertain. Animal numbers are assumed to be correct with a maximum uncertainty of 10% (with the exception of Portugal), and also the emission factor, which is calculated to a large extent with the Tier 2 methodology, is estimated to be known with a precision better than 20% for most countries, with 40% being the highest uncertainty estimate (Belgium and France) for cattle and 50% (Portugal) for other animal types. One exception is the high uncertainty assigned to some animal types (mules and asses, poultry and rabbit) in Portugal. The absence of statistic numbers for poultry, the need to estimate a time-series based on surrogate drivers, and the prevalence of dispersed animals in small farms, naturally causes higher uncertainty values for these animals. Finally, animals that are usually not considered as meat, such as equines, are less controlled and numbers tend to be known with less rigour.

The contribution of enteric fermentation to the overall inventory uncertainty is generally 1% or less, only France, Sweden and Ireland report a contribution of 2.3%, 1.1%, and 1.6% to the total inventory uncertainty, respectively.

An overview of the uncertainty estimates for activity data and emission factors are given in Table 6.39 and Table 6.40. An overview of uncertainty estimates for agriculture at country and EU15 levels will be given in 6.4. Note that some countries (Finland) are using Tier 2 methodology for combining uncertainty estimates in agriculture at a much finer level of disaggregation and thus do not report AD and EF uncertainty estimates separately. Instead, due the combined uncertainty estimate is reported also in the cells for the EF uncertainty and the AD uncertainty is set to zero.

Table 6.25 compiles some background information on the estimates of the uncertainty of the values used as activity data and emission factors to estimate $CH_4$ emissions from enteric fermentation.

**Table 6.23 Relative uncertainty estimates for activity data in category 4A**

| Member State 2009 | Total | Cattle | Dairy Cattle | Non-Dairy Cattle | Buffalo | Sheep | Goats | Camels and Llamas | Horses | Mules and Asses | Swine | Poultry | Other |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Austria | | 10.0 | | | | | | | | | | | |
| Belgium | 5.0 | | | | | | | | | | | | |
| Denmark | 2.0 | | | | | | | | | | | | |
| Finland | | | | | | | | | | | | | |
| France | 5.0 | | | | | | | | | | | | |
| Germany | | | 6.0 | 3.7 | 7.7 | | | | | | | | |
| Greece | 5.0 | | | | | | | | | | | | |
| Ireland | | | 1.0 | 1.0 | | | | | | | | | 1.0 |
| Italy | 20.0 | | | | | | | | | | | | |
| Luxembourg | 2.0 | | | | | | | | | | | | |
| Netherlands | | | 5.0 | 5.0 | | | | | | | 5.0 | | 5.0 |
| Portugal | | | 6.1 | 6.5 | | 19.1 | 19.1 | | 71.2 | 271.8 | 11.0 | | 770.6 |
| Spain | 3.0 | | | | | | | | | | | | |
| Sweden | 5.0 | | | | | | | | | | | | |
| United Kingdom | 0.1 | | | | | | | | | | | | |

**Table 6.24 Relative uncertainty estimates for implied emission factors in category 4A**

| Member State 2009 | Total | Cattle | Dairy Cattle | Non-Dairy Cattle | Buffalo | Sheep | Goats | Camels and Llamas | Horses | Mules and Asses | Swine | Poultry | Other |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Austria | | 20.0 | | | | | | | | | | | |
| Belgium | 20.0 | | | | | | | | | | | | |
| Denmark | 20.0 | | | | | | | | | | | | |
| Finland | 32.0 | | | | | | | | | | | | |
| France | 40.0 | | | | | | | | | | | | |
| Germany | | | 40.0 | 24.6 | 26.4 | | | | | | | | |
| Greece | 30.0 | | | | | | | | | | | | |
| Ireland | | | 15.0 | 15.0 | | | | | | | | | 30.0 |
| Italy | 20.0 | | | | | | | | | | | | |
| Luxembourg | 30.0 | | | | | | | | | | | | |
| Netherlands | | | 15.0 | 20.0 | | | | | | | 50.0 | | 30.0 |
| Portugal | | | 20.0 | 20.0 | | 20.0 | 20.0 | | 50.0 | 50.0 | 20.0 | | 20.0 |
| Spain | 10.0 | | | | | | | | | | | | |
| Sweden | 25.0 | | | | | | | | | | | | |
| United Kingdom | 20.0 | | | | | | | | | | | | |

**Table 6.25 Member State's background information for the uncertainty estimates in category 4.A**

| Member State | Background information to uncertainy estimates |
|---|---|
| Austria | **Activity Data:** Animal numbers, in accordance to WINIWARTER & ORTHOFER (2000) were estimated at 10% uncertainty and considered statistically independent. **Emission Factor:** Uncertainties of emission factors for $CH_4$ emissions of enteric fermentation, according to AMON et al. (2002) were considered 20% for cattle and sheep (representing ruminants) and 30% for all other animals. EFs are correlated. Uncertainties of $CH_4$ emissions from Enteric Fermentation were estimated with a "Monte Carlo" simulation. Assuming a normal probability distribution, the calculated standard deviation is 4%. This indicates there is a 95% probability that $CH_4$ emissions are between +/- 2 standard deviations. Uncertainties considered are Gross Energy Intake, Methane Conversion Factor, Livestock, Share of oragnic farming, emission factor. The emission factors for the Tier 2 method are determined by the uncertainty of the gross energy intake and the $CH_4$ conversion rate. |
| Belgium | **Activity Data:** The only activity data here is the national livestock census. The uncertainty is judged small taken into account the features of the monitoring (census twice a year, individual earmarks and registration for all bovines, …),. **Emission Factor:** The emission factors are mainly the IPCC default values, using Tier 1 methodology. Consequently, the IPCC uncertainty estimate of 40% is used for the emission factor. |
| Denmark | **Activity Data:** Due to the large number of farms included in the norm figures, the arithmetic mean can be assumed as a very good estimate,with a low uncertainty. All cattle have theyr own ID-number (ear tags) and, thencd, the uncertainty in this number is almost non-existent. The Danish Plant Directorate, as the controlling authority, performs analysis of feed sold to farmers. Onaverage, 1600 to 2000 samples are analysed everly ear. Uncertainty in the data is seen as negligible. The combined effect of low uncertainty in actual animal numbers, feed ocnsumption and excretion rates gives a very low uncertainty in the activity data. The major uncertainty, therefore, relates to the emission factors. |
| Finland | **Activity Data:** Uncertainty estimates of animal numbers were based on knowledge on the reliability and coverage of data collection. Cattle has individual earmarks that enable very accurate assessment of animal numbers (uncertainty of ±3%), but uncertainty in animal numbers for other species in farms is higher (±5%). The uncertainty in animal numbers is estimated to be the highest for reindeer (±10%). **Emission Factor:** IPCC default uncertainties for emission factors were used excluding reindeer, for which the national emission factor has been used. The uncertainty in the Tier 2 method for evaluating emissions from enteric fermentation of cattle was assessed by estimating uncertainty in each calculation parameter (except coefficients, whose importance was expected to be minor) and combining uncertainties using Monte Carlo simulation. Uncertainty in $CH_4$ emissions from enteric fermentation of domestic livestock were estimated at -20% to +30% in 2007. |
| Germany | **Activity Data:** The uncertainties in the animal head counts in each class (with the exception of horses) are on the order of less than 6 % (DÄMMGEN, 2005). For the new Länder, herd sizes and their regional distribution for the years 1990 and 1991 were calculated using the RAUMIS model (HENRICHSMEYER et al., 1996), which provides regional data for agricultural production and products. As the data sources do not vary with the years, the time series is considered to be basically consistent. Derivation of the corrections is described in DÄMMGEN (2005). **Emission Factor:** The uncertainties in the methane emission factors are on the order of 30 % (EMEP, 2000: Chapter B1040-6). The primary sources of inaccuracy in these figures include the methane conversion factor (for cattle, 0.06 ± 0.005, i.e. 10 %, cf. IPCC, 2006) and the actual federation composition, especially that for cattle. |
| Luxembourg | **Activity Data:** Animal numbers' uncertainty is estimated between 2% (for cattle, which are extremely well covered due to their inclusion in a register) and 10% for animals distributed over many small farms (sheep, horses, chicken). **Emission Factor:** The uncertainty in $CH_4$ emission factors for livestock categories (sheep, goats, horses) is reported to be ±20%. |
| Netherlands | **Activity Data:** For cattle, uncertainty in animal numbers 5% (Olivier et al.,2009), **Emission Factor:** For cattle, uncertainty in emission factor 15% (Bannink, 2009).The uncertainty in the emission factor for swine and other animals is estimated to be 50% and 30%, respectively (Olivier et al.,2009) |

The following issues related to time-series consistency are identified:

- **Sweden, AD general**
  The time series in the agricultural sector in Sweden are calculated consistently but the data needed are not always available for every year covered by the inventory. In cases where statistics are not produced annually, interpolation and extrapolation are necessary tools for the imputation of estimates. Methane from enteric fermentation may be a bit more certain with an error of about 30 %.
- **United Kingdom, AD general**
  In the United Kingdom, the time-series consistency of these activity data is very good due to the continuity in data provided. There is an increase in slaughter weight from 2004 (238kg) to 2005 (343kg). This increase was a result of the lifting of the Over Thirty Month rule, which is a measure to control the exposure of humans to the disease BSE.
- **Austria, agricultural data base**
  The FAO agricultural data base provides worldwide harmonized data (FAO AGR. STATISTICAL SYSTEM 2001). In the case of Austria, these data come from the national statistical system (Statistik Austria). However, there are inconsistencies between these two data sets. Analysis shows that there is often a time gap of one year between the two data sets.
- **Denmark, animal population of sheep, goats and horse**
  Agricultural Statistics, in agreement with the Danish Agricultural Advisory Centre (DAAC), as Statistics Denmark does not include farms less than 5 hectares. Statistics Denmark is the source for the database kept by FAO (Food and Agriculture Organization of the United Nations). This explains why the number of sheep, goats and horses in FAO and the Danish emission inventory disagree. The largest difference is found for horses. Improvements to the documentation of number of horses, sheep and goats on small farms, in cooperation with DAAC, is planned for the 2010 reporting. Since the year 2007, a decision was taken to improving methodology in estimation of animal number to add number of sheep, goats and horses on small farms less than 5 ha.
- **Germany, buffalo population**
  Buffalo have been kept in Germany since 1996. In 1990, their population was zero. They are therefore not reported for the whole time series
- **Luxembourg, goat population**
  For those animal categories for which no accurate data are available in official statistics for the years prior to 1997 (i.e. 4A4 and 4A10), it has not been attempted to “backcast” the methane emissions back to the base year, because: not estimated emissions under- but not overestimate the base year GHG emissions; it would not make much sense to devote efforts for estimating the missing years since $CH_4$ emissions for the concerned animal categories are particularly low and almost negligible.
  Goat numbers in Luxembourg are not reported for the whole time series. The exact number of Luxembourg’s goats was not recorded with precision before the year 2000. Numbers of goats are only available regularly, and with enough confidence, since 2000 onwards. In 1997, the first year goat population was reported, the goat population of Luxembourg corresponded to 0.003% of the goat population in EU-15. In 1990, the goat population of Luxembourg is assumed to be negligible.
- **Germany, animal population**
  There is some inconsistency in the time series of animal numbers in Germany due to the modification of the "Agrarstatistikgesetzes" with a rupture between 1998 and 1999. This applies particularly to sheep and horses, for both animal categories an approach for correction has been developed and applied (Daemmgen, 2006).

## *6.3.2 Manure Management $CH_4$ (CRF source category 4.B(a))*

### 6.3.2.1 Source category description

During storage and management of manure, $CH_4$ can be produced and emitted to the atmosphere. In accordance with the IPCC guidelines, the term 'manure' is used collectively to include both dung and urine (i.e., the solids and the liquids) produced by livestock. Source category 4.B(a) excludes emissions that originate from burning of manure. The decomposition of manure generates $CH_4$ under anaerobic conditions (i.e., in the absence of oxygen). These conditions occur most readily when large numbers of animals are managed in a confined area (e.g., dairy farms, beef feedlots, and swine and poultry farms), and where manure is disposed of in liquid-based systems. If manure is managed or treated in liquid systems, it decomposes anaerobically and can produce a significant quantity of $CH_4$. The temperature and the retention time of the storage unit greatly affect the amount of methane produced.

Table 6.26 shows that at the European level, swine and cattle contribute more or less equally to $CH_4$ emissions from manure management (48% and 46% of total emissions in category 4B(a), respectively). For cattle, the contributions of non-dairy cattle are prevailing with percentages of total emissions in this category amounting to 27% and 21%, respectively. The highest contribution of cattle to $CH_4$ emissions from manure management are observed in Ireland (75%) and the United Kingdom (63%); the lowest in Portugal and Spain, where cattle contribute with only 7%. This is compensated with the emissions from swine manure with 89% of the total $CH_4$ from manure management. As also for enteric fermentation, significant emissions from sheep and goat occur in Greece with 14% and 6.1% of total $CH_4$ from manure management, respectively. Greece has also the highest contribution of poultry to $CH_4$ emissions from manure management with 24%.

At the EU-15 level, $CH_4$ emissions from manure management have decreased for cattle and sheep, but have increased for swine, which is mainly due to an intensification of swine production resulting in a higher IEF. Emissions from goats and poultry remained more or less stable.

**Table 6.26 Total $CH_4$ emissions in category 4B(a) and implied Emission Factor at EU-15 level for the years 1990 and 2009**

| | Dairy Cattle | Non-dairy cattle | Swine |
|---|---|---|---|
| | 1990 | | |
| Total Emissions of $CH_4$ [Gg $CH_4$] | 473 | 592 | 816 |
| Total Population [1000 heads] | 26210 | 64051 | 111141 |
| Implied Emission Factor [kg $CH_4$ / head / year] | 18.0 | 9.4 | 7.4 |
| | Dairy Cattle | Non-dairy cattle | Swine |
| | 2009 | | |
| Total Emissions of $CH_4$ [Gg $CH_4$] | 410 | 543 | 905 |
| Total Population [1000 heads] | 17810 | 57995 | 115607 |
| Implied Emission Factor [kg $CH_4$ / head / year] | 23.0 | 9.5 | 7.9 |
| | Dairy Cattle | Non-dairy cattle | Swine |
| | 2009 value in percent of 1990 | | |
| Total Emissions of $CH_4$ [Gg $CH_4$] | 87% | 92% | 111% |
| Total Population [1000 heads] | 68% | 91% | 104% |
| Implied Emission Factor [kg $CH_4$ / head / year] | 128% | 101% | 107% |

Source of information: CRF Table4s1 and 4.B(a) for 1990 and 2009, submitted in 2011

Dairy cattle includes Mature Dairy cattle, Non-dairy cattle includes Mature Non-Dairy Cattle and Young Cattle

### 6.3.2.2 Methodological Issues

**Methods**

$CH_4$ emissions from manure management are a key source category for cattle and swine at EU-15 level. This is true also for many Member States. Table 6.27 shows the total emissions in category 4.B(a), how this is composed and the methodology used for calculating the emissions for cattle and swine by Member States. Also, it is reports whether the source category is a key source category for the Member States.

The method for calculation of $CH_4$ emissions from manure management implies the need to estimate for each animal category the excretion of volatile organic solids (VS) and a maximum methane producing capacity ($B_0$); furthermore, for each animal category and manure management system, a methane conversion factor must be determined, which is dependent on the climate region. Each country must determine the fractions of the manure managed in all AWMS-climate region combinations. A weighted average of the methane conversion factor over all occurring climate regions must then be calculated for each animal waste management system. The IPCC *Guidelines* list default values for all these parameters. In Table 6.27, we report also the Tier that has been used by the Member States to estimate $CH_4$ emissions from manure management according to the approach described in section 6.4.1 (see Table 6.84 through Table 6.87).In the case of $CH_4$ emissions from manure management, a Tier 2 approach was assigned according to the “median-rule” with the weighting factors 0.75, 0.13, and 0.13 for VS, $B_0$, or MCF, respectively (see Section 6.4.1.2 for details). For the methane conversion factor, we calculated the default value by using the allocation to the different climate regions reported by the countries and multiplying with the respective IPCC value. For the Netherlands, no background data are given, so the level of the method could not be calculated. However, according to the NIR of the Netherlands, a country-specific Tier 2 method has been applied.

Overall, the quality of the emission estimates in category 4B(a) range between Tier 1.2 and Tier 2.0 with a Tier level for EU-15 of Tier 1.6 (corresponding to 63% of the emissions being calculated with country-specific data). This relatively low quality for this source category is due to the fact that countries with a high number of animals have intermediate quality (Tier 1.5, e.g. because no country-specific estimation of VS has been done).

Some additional information on the methodological approaches for some Member States is given in

Table 6.28.

**Table 6.27 Total emissions and contribution of the main sub-categories to $CH_4$ emissions in category 4B(a), methodology applied and key source assessment by Member States for the sub-categories dairy cattle, non-dairy cattle and swine.**

| | Total | | Dairy Cattle | | Non-dairy cattle | | Cattle | Swine | |
|---|---|---|---|---|---|---|---|---|---|
| | Gg $CO_2$-eq | b | a | b | a | b | c | a | b |
| Austria | 320 | Tier 1.8 | 30% | Tier 1.9 | 39% | Tier 1.9 | y | 24% | Tier 1.9 |
| Belgium | 1,620 | Tier 1.9 | 10% | Tier 1.9 | 7% | Tier 1.9 | y | 81% | Tier 1.9 |
| Denmark | 1,228 | Tier 1.9 | 32% | Tier 1.9 | 17% | Tier 1.9 | y | 44% | Tier 1.9 |
| Finland | 297 | Tier 1.6 | 30% | Tier 1.9 | 15% | Tier 1.9 | y | 27% | Tier 1.2 |
| France | 13,804 | Tier 1.2 | 10% | Tier 1.2 | 48% | Tier 1.2 | y | 36% | Tier 1.2 |
| Germany | 6,028 | Tier 1.9 | 43% | Tier 1.9 | 17% | Tier 2.0 | y | 38% | Tier 1.9 |
| Greece | 327 | Tier 1.3 | 9% | Tier 1.9 | 5% | Tier 1.9 | y | 41% | Tier 1.2 |
| Ireland | 2,140 | Tier 1.6 | 22% | Tier 1.8 | 53% | Tier 1.8 | y | 19% | Tier 1.2 |
| Italy | 2,886 | Tier 1.8 | 17% | Tier 2.0 | 20% | Tier 2.0 | y | 45% | Tier 2.0 |
| Luxembourg | 94 | Tier 1.8 | 33% | Tier 1.8 | 30% | Tier 1.8 | y | 35% | Tier 1.8 |
| Netherlands | 2,887 | Tier 2.0 | 45% | Tier 2.0 | 13% | Tier 2.0 | y | 39% | Tier 2.0 |
| Portugal | 1,266 | Tier 1.9 | 3% | Tier 1.9 | 3% | Tier 1.8 | y | 83% | Tier 1.9 |
| Spain | 5,592 | Tier 1.8 | 5% | Tier 1.8 | 2% | Tier 1.8 | y | 89% | Tier 1.8 |
| Sweden | 465 | Tier 1.9 | 33% | Tier 1.9 | 36% | Tier 1.9 | y | 23% | Tier 1.9 |
| United Kingdom | 2,800 | Tier 1.5 | 37% | Tier 1.8 | 25% | Tier 1.9 | y | 25% | Tier 1.0 |
| EU-15 | **41,753** | **Tier 1.6** | **21%** | **Tier 1.8** | **27%** | **Tier 1.5** | **y** | **46%** | **Tier 1.7** |
| EU-15: Tier 1 | 37% | | 22% | | 52% | | | 35% | |
| EU-15: Tier 2 | 63% | | 78% | | 48% | | | 65% | |

a Contribution to $CH_4$ emissions from manure management
b Tier 1: default methodology; Tier 2: country-specific methodology
c Source category is key in the Member State's inventory (y/n)

**Table 6.28: Member State's background information for the calculation of $CH_4$ emissions in category 4.B(a)**

| Member State | Methods |
|---|---|
| Austria | Cattle and swine: Tier 2 (key sources); Sheep, Goats, Horses and Other Soliped, Chicken, Other Poultry and Other animals: Tier 1. |
| Belgium | Tier 2 methodology is used for both cattle and swine in Flanders and for cattle alone in Wallonia since the 2009 submission. Wallonia may use this Tier 2 as well, but swine is not a key source in Wallonia and only grows 5 % of the total Belgian swine. EF used in de current methodology are close to the IPCC value. Because of the availability of detailed statistics on livestock composition in Flanders, including data on e.g. slaughter weights, a more extended variant of the IPCC methodology has been applied. Accounting for the fact that the weight of the cattle over the whole lifetime is not the same as the slaughter weight, the weight is integrated from birth to slaughtering. A study performed by the Flemish Institute for Technological Research (Vito), indicates that $CH_4$ emissions during manure processing are negligible. |
| Denmark | The emissions from the agricultural sector are calculated in a comprehensive agricultural model complex called DIEMA (Danish Integrated Emission Model for Agriculture, Mikkelsen, 2006). The IPCC Tier 2 approaches are used for the estimation of the $CH_4$ emission from manure management. The amount of manure is calculated for each combination of livestock subcategory and stable type. The estimation is based on national data for feed consumption (Poulsen et al. 2001) and standards for ash content and digestibility.In 2007, approximately 8% (0.97 Mt of cattle slurry and 1.18 Mt of pig slurry) were treated in biogas plants (DEA 2008). The reduction in the $CH_4$ emission is based on model calculations for an average size biogas plant with a capacity of 550 m3 per day. For methane, a reduction of 30% for cattle slurry and 50% for pig slurry is obtained (Nielsen et al. 2002, Sommer et al. 2001). |
| Finland | Methane emissions from manure management are calculated in the same generic way as emissions from enteric fermentation, i.e. by multiplying the number of the animals in each category with the emission factor for each category. In Finland the Tier 2 method is used for all animal categories. The national emission factor for each cattle subcategory has been calculated by using the IPCC Tier 2 methodology. |
| France | Tier 1+. |
| Germany | Tier 2 for dairy cattle, non-dairy cattle and swine. Tier 2 is used also for most poultry sub-categories. The IPCC 2006 Guidelines were applied and Tier 1b (advance) methodology was used for key source categories. The values for VS and MCF are updated (Daemmgen et al., 2008). The emission factors represent the general situation in Germany. Calculations are done at the district level. |
| Greece | Dairy cattle, non-dairy cattle and sheep: Tier 2. Other animals: Tier 1. |
| Ireland | The analysis of the feeding regime for cattle (O' Mara, 2006) included a full evaluation of the organic matter content of the feeds applicable to the 11 categories that characterise the national herd, which facilitates the estimation of their respective levels of organic matter excretion. |
| Italy | IPCC Tier 2 approach has been used for estimating $CH_4$ EFs for manure management from cattle, buffalo and swine. For estimating slurry and solid manure EFs and the specific conversion factor, a detailed methodology (Method 1) has been applied at a regional basis (cattle and buffalo categories). Then, a simplified methodology, for estimating EFs time series, has been followed (Method 2). Since the 2006 submission, a reduction of $CH_4$ emissions because of biogas production has been considered. |
| Luxembourg | Tier 1 method has been applied to estimate methane emissions from manure management – i.e. for all animal categories except cattle. Population and methane emission growths are exactly the same as in enteric fermentation. What distinguishes one tier from the other is the fact that, for cattle, the average gross energy intake – as a component of the volatile solid daily excretion – is not a default value but, rather, the value obtained when estimating enteric fermentation methane related emissions with a Tier 2 method. |
| Netherlands | Tier 2 approach is used based on country specific data on animal manure production per animal, on manure characteristics (like organic matter (OM) content) and (liquid) manure storage conditions. |
| Portugal | All animal types: Tier 2. Emission factors by animal type and climatic conditions.Emissions factors for each animal type were established according to the tier 2 methodology, which considers the use of country specific information concerning the quantity of manure produce per animal and the share of each Manure Management System that is used for each animal type. |
| Spain | Tier 3 for swine and poultry; Tier 2 for cattle; Tier 1 for other animal categories.VS is estimated according to IPCC for cattle, and a national methodology for swine and poultry. Smooth temperature functions for the MCF for swine, poultry and cattle are used (modification accepted by IPCC). It has been calculated by interpolating IPCC default factors for the three climatic regions (with mid-point mean annual temperature of 10, 20, and 28°C) using the formula: MCF(T)=MCF(10°C) + b (10-T)^m, where b and m are parameters that vary with animal waste management system. |
| Sweden | Tier 2 for Cattle and Swine, Tier 1 methodology is used for other animal groups. |
| United Kingdom | Cattle, Lambs and Deer: Tier 2; other: Tier 1. For Dairy cattle, the calculations are based on the population of the 'dairy breeding herd' rather than 'Dairy cattle in milk' used in earlier inventories. The former definition includes 'cows in calf but not in milk'. The waste factors used for beef and other cattle are now calculated from the IPCC Tier 2 procedure but do not vary from year to year. |

## Activity Data

Table 6.29 and Table 6.30 summarize the allocation of the produced manure over the animal wastes management systems ‘liquid systems’, ‘solid storage and dry lot’ and ‘pasture, range and paddock’ for the animal categories dairy and non-dairy cattle and swine in 2009 and 1990, respectively. The table shows, that in all countries more manure is managed in liquid systems for swine than for cattle, whereby in Italy, Ireland and the Netherlands, 100% of the swine manure is managed in liquid systems. Only in the UK more manure is managed in solid than in liquid systems. In the category cattle, generally more manure is managed in liquid systems for dairy cattle than for non-dairy cattle, expressed in relative numbers, with the exception of Italy and France.

Substantial changes in the allocation of manure to manure management systems are reported for Sweden, Germany, Finland, and Denmark, however, with different signs of the direction of the changes. For example, liquid systems were more frequently used to manage manure from dairy cattle in Sweden (from 23% in 1990 to 58% in 2009).

**Table 6.29 Member State's Allocation of Animal Waste Management Systems over liquid systems, solid storage and dry lot, and pasture range and paddock in 2009**

| Member State | Dairy Cattle - Allocation of AWMS (%) | | | | Non-Dairy Cattle - Allocation of AWMS (%) | | | | Swine - Allocation of AWMS (%) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2009 | Liquid system[1)] | Daily Spread | Solid storage and dry lot | Pasture range paddock | Liquid system[1)] | Daily Spread | Solid storage and dry lot | Pasture range paddock | Liquid system[1)] | Daily Spread | Solid storage and dry lot | Pasture range paddock |
| Austria | 30% | | 49% | 3% | 21% | | 44% | 5% | 79% | NO | 3% | NO |
| Belgium | 12% | NO | 25% | 43% | 4% | NO | 38% | 45% | 6% | 3% | 6% | NO |
| Denmark | 88% | NO | 3% | 5% | 32% | NO | 1% | 30% | 96% | NO | 3% | 0% |
| Finland | 46% | NO | 27% | 26% | NO | NO | NO | NO | 72% | NO | 23% | |
| France | 11% | NO | 42% | 47% | 36% | NO | 23% | 40% | 83% | NO | 17% | 0% |
| Germany | 73% | NO | 14% | 13% | 53% | NO | 27% | 19% | 90% | NO | 10% | NO |
| Greece | | 2% | 90% | 8% | | 3% | 62% | 33% | 90% | | 10% | |
| Ireland | 29% | NO | 2% | 69% | 30% | NO | 11% | 59% | 100% | NO | NO | NO |
| Italy | 38% | NO | 57% | 5% | 59% | NO | 39% | 2% | 100% | NO | NA | NA |
| Luxembourg | 34% | NO | 16% | 45% | 26% | NO | 19% | 50% | 90% | NO | 5% | NO |
| Netherlands | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO |
| Portugal | 21% | NO | 49% | 30% | 12% | NO | 1% | 87% | 93% | NO | 2% | 6% |
| Spain | 15% | 25% | 60% | NO | NO | NO | 35% | 65% | NO | NO | NO | NO |
| Sweden | 58% | NO | 16% | 25% | 18% | NO | 20% | 46% | 85% | NO | 12% | NO |
| United Kingdom | 31% | 14% | 10% | 46% | 6% | 23% | 21% | 50% | 31% | 6% | 55% | 7% |
| EU15 | 39% | 3% | 29% | 28% | 29% | 3% | 25% | 40% | 61% | 0% | 8% | 1% |

Source of information: CRF 4.B(a) for 2009, submitted in 2011. Abbreviations explained in the Chapter ‘Units and abbreviations’.
[1)] Anaerobic lagoon + Liquid system. Missing fraction belong to the category 'Other'

**Table 6.30 Member State's Allocation of Animal Waste Management Systems over liquid systems, solid storage and dry lot, and pasture range and paddock in 1990**

| Member State | Dairy Cattle - Allocation of AWMS (%) | | | | Non-Dairy Cattle - Allocation of AWMS (%) | | | | Swine - Allocation of AWMS (%) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1990 | Liquid system[1)] | Daily Spread | Solid storage and dry lot | Pasture range paddock | Liquid system[1)] | Daily Spread | Solid storage and dry lot | Pasture range paddock | Liquid system[1)] | Daily Spread | Solid storage and dry lot | Pasture range paddock |
| Austria | 33% | | 49% | 11% | 24% | | 46% | 9% | 69% | NO | 9% | NO |
| Belgium | 10% | NO | 27% | 43% | 3% | NO | 37% | 45% | 3% | 3% | 6% | NO |
| Denmark | 70% | | 13% | 15% | 37% | | 4% | 28% | 89% | | 11% | NO |
| Finland | 23% | NO | 51% | 25% | NO | NO | NO | NO | 44% | NO | 51% | 0% |
| France | 11% | NO | 42% | 47% | 37% | NO | 23% | 40% | 83% | NO | 17% | 0% |
| Germany | 55% | NO | 27% | 18% | 60% | NO | 27% | 13% | 81% | NO | 19% | NO |
| Greece | | 2% | 90% | 8% | | 3% | 62% | 33% | 90% | | 10% | |
| Ireland | 32% | NO | 2% | 66% | 29% | NO | 11% | 60% | 100% | NO | NO | NO |
| Italy | 38% | NO | 57% | 5% | 58% | NO | 40% | 2% | 100% | NO | NA | NA |
| Luxembourg | 23% | NO | 32% | 45% | 19% | NO | 31% | 50% | 90% | NO | 5% | NO |
| Netherlands | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO |
| Portugal | 35% | NO | 35% | 30% | NO | NO | 28% | 72% | 95% | NO | 3% | 2% |
| Spain | 15% | 25% | 60% | NO | NO | NO | 31% | 69% | NO | NO | NO | NO |
| Sweden | 23% | NO | 52% | 25% | 17% | NO | 32% | 42% | 44% | NO | 52% | NO |
| United Kingdom | 31% | 14% | 10% | 46% | 6% | 23% | 21% | 50% | 31% | 6% | 55% | 7% |
| EU15 | 32% | 3% | 35% | 29% | 33% | 4% | 26% | 35% | 60% | 1% | 15% | 1% |

Source of information: CRF 4.B(a) for 2009, submitted in 2011. Abbreviations explained in the Chapter ‘Units and abbreviations’.
[1)] Anaerobic lagoon + Liquid system. Anaerobic lagoon contributes significantly only in Portugal.

For some countries, background information on in addition to what is reported in Table 6.17 on the activity data used for the estimation of $CH_4$ emissions from manure management is given in the respective National Inventory Reports and is listed in Table 6.31.

**Table 6.31 Member State's background information on the allocation to animal waste management systems used for the calculation of $CH_4$ and $N_2O$ emissions in category 4.B(a)**

| Member State | Activity data |
|---|---|
| Austria | AWMS distribution was taken from the research project "Animal husbandry and manure management systems in Austria" (Amon et al. 2007) which was a a comprehensive survey on the agricultural practice in Austria. As a result of TIHALO, for 2005 new representative data on animal husbandry and manure management systems all over Austria is available. For the year 1990 AWMS data based on (Konrad 1995) is available. The AWMS data from 2005-2008 were derived by linear extrapolation. From 2008 onwards the AWMS distribution is held constant in order to prevent implausible trends by the end of the commitment period. It is not planned to have another survey before the end of the commitment period. In the 2008 inventory, the following new systems have been taken into account: yard, deep litter, composting, aerobic treatment and anaerobic digester; these AWMS have been summarised under "Other". Manure management systems are distinguished for Dairy Cattle, Suckling Cows and Cattle 1–2 years in "summer situation" and "winter situation". |
| Belgium | In Wallonia, the allocation of animals to AWMS comes from the NIS agricultural census of 1992 and 1996, where those data were published by animal type. Those data are not collected yearly by the NIS given their slow pace of change; an update would be desirable. |
| Denmark | From 2006, all farmers have to report which stable type they are using to the Danish Plant Directorate. These information are now included in the inventory and are in overall consonant with the expert judgement from DAAC. At present, there exist no official statistics concerning the distribution of animals according to stable type. The distribution is, therefore, based on an expert judgement from the Danish Agricultural Advisory Centre (DAAC). Approximately 90-95% of Danish farmers are members of DAAC and DAAC regularly collects statistical data from the farmers on different issues, as well as making recommendations with regard to farm buildings. |
| Finland | Distribution over animal systems (slurry, solid storate, pasture) is country-specific from literature (MKL, 1993; Seppänen and Matinlassi, 1998) and expert judgement. Anaerobic lagoons and daily spread not used in Finland. |
| France | AWMS distribution national on the basis of a survey carried out in 1994. |
| Ireland | The allocation to animal waste management system is based on the farm facilities survey. The same values are used for all years. The bulk of animal wastes in housing are managed in liquid storage systems. New information obtained from a national farm facilities survey (Hyde et al., 2008). |
| Luxembourg | The allocation of AWMS for dry lot is included in solid storage. |
| Netherlands | Specified data on manure management are based on statistical information on management systems; these data are documented in Van Schijndel and Van der Sluis, 2008. |
| Portugal | Livestock numbers per animal type were available at Concelho level from two detailed agriculture surveys: RGA89 and RGA99. Livestock numbers in each Concelho area were allocated to each climate region, for year 1999, according to the land are percentage, and always assuming an homogeneous distribution of animals in the Concelho territorial area. Number of animals were summed at each Administrative Region (Região). Livestock population in each climate region and by Região was estimated annually from total livestock population in Região and considering the constant share and, finally, the total national livestock population for each region was calculated. |
| Sweden | Information on waste management systems is collected from the survveys publishes in the biannual statistical report on the use of fertilisers and animal manure in agriculture (Statistics Sweden, MI 30-series). Three manure management systems are considered apart form grazing animals: liquid systems (including semi-liquid manure), solid storage and deep litter (sometimes categorised as "other" in the national inventory). National estimates of stable periods are collected from the statistical report on use of fertilisers and animal manure in agriculture (Statistics Sweden, MI 30-series). This information has been available biannually since 1997. Before 1997, the data are extrapolated to 1990. Since dairy cows are often stabled at night, the data on stable periods for this animal category is combined with an assumption that 45% of its manure was produced in the stable during the grazing period (caclulated according to the STANK model, Swedish Board of Agriculture, 2005) |
| United Kingdom | The distribution to AWMS was revised in 2000 for cattle and poultry. Data on 'no significant storage capacity' of farmyard manure were allocated. This could have a large effect on emissions because it amounted to around 50% of manure and the 'Daily spread (DS)' category has an emission factor of zero, compared to 0.02 for the 'Solid storage and dry lot (SSD)' category. There was a revision (in 2002) of the allocation of manure to the different management systems based on new data.Data for waste management systems for swine and poultry are from a survey. For other animal types the values are from expert judgement (UPV 2006). |

**Emission Factors and other parameters**

The implied emission factors for $CH_4$ emissions from manure management vary substantially among the Member States, as shown in Table 6.32. The range of the implied emission factors for dairy cattle, non-dairy cattle and swine covers about one order of magnitude, which is more than the range proposed in the IPCC *Guidelines* for different climate regions (for dairy cattle in Western Europe, for example, an emission factor of 14 kg $CH_4$ head$^{-1}$ y$^{-1}$ is proposed for cool climate regions and a factor of 81kg $CH_4$ head$^{-1}$ y$^{-1}$ of warm climate regions), but less than the ratio of the methane conversion factors of liquid (39% - 72%) and solid (1% – 2%) manure. The ratio of the highest and the smallest IEF used by the Member States is 6 for dairy cattle, and 16 for non-dairy cattle and 26, 21, and 19 for sheep, goats and swine, respectively. The highest IEF for dairy cattle is used by Netherlands with 41.7 kg $CH_4$/head/year and the smallest by Portugal with 6.8 kg $CH_4$/head/year.

As mentioned above, the two most important factors influencing the amount of $CH_4$ emitted from manure management systems are the climate region and if solid or liquid systems are dominating. We have already discussed the large range of systems used in the EU-15 Member States. The other two factors, the excretion rate of volatile solids and the methane producing potential, are not significantly influencing the order of magnitude.

The following outliers can be identified:

- **IEF - Dairy cattle, Germany**
  Germany uses higher $CH_4$-IEF for dairy cattle then neighbouring countries. This might partly be caused by the use of MCF values from IPCC(2006), while most countries use data from IPCC(1997).
- **IEF - Dairy cattle, Portugal**
  Part of dairy cattle is managed in "Fossas" (Pits)", which corresponds best to the IPCC class "Pit storage below animal confinements". The storage time is very short, less than one month. Therefore, Portugal set the MCF to zero. In 2006 guidelines the MCF is revised to 3 per cent, but no clear distinction is made between pits and liquid/slurry system. A more detailed assessment would require a country-specific study.
- **IEF - Non-dairy cattle, Denmark.**
  Non-Dairy Cattle" includes calves, heifers, bulls and suckler cows and the implied emission factor is a weighted average of these different subcategories. The Danish IEF for non-dairy cattle is lower compared with the default value, this is due to lower weight and lower feed intake and a higher digestibility of feed.
- **IEF - Non-dairy cattle, France**
  The IEF is calculated with the default values of the IPCC. First, for the MCF indicator, the climate region is "temperate" in the metropolitan territory and "warm" in DOM and COM, high values of "MCF" are used for France. Then the part of non dairy cattle relating to liquid management must be higher than in other countries because this AWMS has a bigger impact.
- **$CH_4$ Emissions – Dairy cattle, Non-Dairy cattle, Luxembourg**
  Value of IEF for $CH_4$ emissions is the highest among EU27. The only national values used are those for the breakdown of manure by systems (liquid, daily spread). It is based on an expert judgment. That might, perhaps, be the reason for the high IEFs for $CH_4$.
- **IEF - Non-dairy cattle, Spain**
  Spain uses a Tier 2 approach. Gross energy is calculted using tier 2 methodology of enteric fermentation whilst percentages of manure management systems are taken from national references. The dominant systems for non-dairy cattle are solid storage and pasture, both of which have very a low MCF at 10ºC.

**Table 6.32** **Implied Emission factors for $CH_4$ emissions from manure management used in Member State's inventory 2009**

| Member State | Implied EF (kg $CH_4$/head/yr) | | | | |
|---|---|---|---|---|---|
| 2009 | Dairy Cattle | Non-dairy cattle | Sheep | Goats | Swine |
| Austria | 8.6 | 4.0 | 0.19 | 0.12 | 1.1 |
| Belgium | 16.3 | 2.6 | 0.62 | 0.76 | 9.7 |
| Denmark | 33.1 | 10.5 | 2.82 | 2.45 | 2.1 |
| Finland[1)] | 14.8 | 3.3 | 0.19 | 0.12 | 3.8 |
| France | 18.3 | 19.8 | 0.28 | 0.18 | 20.9 |
| Germany | 29.1 | 5.7 | 0.22 | 0.22 | 4.6 |
| Greece | 9.3 | 1.7 | 0.25 | 0.18 | 7.0 |
| Ireland | 20.4 | 11.2 | 0.15 | 0.12 | 12.7 |
| Italy | 12.7 | 6.6 | 0.22 | 0.15 | 6.7 |
| Luxembourg | 36.7 | 8.7 | 0.19 | 0.12 | 19.5 |
| Netherlands | 41.7 | 7.5 | 0.16 | 0.36 | 4.4 |
| Portugal | 6.8 | 1.4 | 1.67 | 1.76 | 21.4 |
| Spain | 16.1 | 1.2 | 0.24 | 0.16 | 9.5 |
| Sweden | 20.2 | 6.7 | 0.19 | 0.12 | 3.3 |
| United Kingdom | 26.9 | 4.2 | 0.11 | 0.12 | 7.1 |
| EU-15 | 23.0 | 9.5 | 0.24 | 0.24 | 7.9 |

*Source of information: CRF 4.B(a) for 2009, submitted in 2011 Abbreviations explained in the Chapter 'Units and abbreviations'.*

1) Finland reports non-dairy cattle under "other" in the following categories: bulls, cows, heifers, and calves. Swine is reported under "other" in the categories: fattening pigs, sows with piglets and weaned pigs. The IEFs have been calculated as a weighted average. The IEF for the Netherlands and Luxembourg has been calculated as a weighted average has been calculated using the values given under option B (mature non-dairy and young cattle).

The parameter of interest are the allocation of manure to climate regions (Table 6.33) and methane conversion factor used (Table 6.34). Most of Europe falls into the cool climate region with average annual temperatures below 15°C. Accordingly, most countries are allocating 100% of the animal population to the cool climate region, with Italy and Portugal allocating a part of the population into the temperate region (for dairy cattle for example 8% and 58%, respectively) and only Greece allocating 100% of the animals to the temperate climate region. France assumes 0.1% of the dairy cattle and 0.9% of the non-dairy cattle in the warm climate region, which is due to the extra-territorial regions; the remaining manure is allocated to the temperate climate region. The distribution of the animals over the climate regions is somewhat different for different animal types; in Portugal, for example, the portion of animals living in the temperate region increases from dairy cattle over non-dairy cattle to swine.

For the categories dairy cattle, non-dairy cattle and swine, only in few cases is the allocation of animal population to climate regions reported to be dynamic. However, in Portugal, for example, a general shift of livestock production to warmer climate regions has been observed increasing the percentage of manure managed in the temperate region by 6%, 18%, and 3% for dairy cattle, non-dairy cattle, and swine, respectively.

The potential methane producing factor is IPCC default or close to IPCC default for most countries (Table 6.35); the amount of volatile organic solid excreted per animal (Table 6.36) and year varies across the countries on the basis of the animal characterization with a ratio of highest to lowest average VS excretion rate between 2.1 (Non-dairy cattle) and 3.8 (Goats).

**Table 6.33 Member State's allocation of dairy cattle, non-dairy cattle and swine to the climate regions "cool", "temperate" and "warm" in 2009**

| Member State | Dairy Cattle - Allocation by climate region[1)] | | | Non-Dairy Cattle - Allocation by climate region[1)] | | | Swine - Allocation by climate region[1)] | | |
|---|---|---|---|---|---|---|---|---|---|
| 2009 | Cool (%) | Temperate (%) | Warm (%) | Cool (%) | Temperate (%) | Warm (%) | Cool (%) | Temperate (%) | Warm (%) |
| Austria | 100% | NO | NO | 100% | NO | NO | 100% | NO | NO |
| Belgium | 100% | NO | NO | 100% | NO | NO | 100% | NO | NO |
| Denmark | 100% | NO | NO | 100% | NO | NO | 100% | NO | NO |
| Finland | 100% | NO | NO | NO | NO | NO | 100% | NO | NO |
| France | NO | 100% | 0.1% | NO | 99% | 0.9% | NO | 99% | 1.3% |
| Germany | 100% | NO | NO | 100% | NO | NO | 100% | NO | NO |
| Greece | | 100% | | | 100% | | | 100% | |
| Ireland | 100% | NO | NO | 100% | NO | NO | 100% | NO | NO |
| Italy | 92% | 8% | NO | 87% | 13% | NO | 97% | 3% | NO |
| Luxembourg | 100% | NA | NA | 100% | NA | NA | 100% | NA | NA |
| Netherlands | NO | NO | NO | NO | NO | NO | NO | NO | NO |
| Portugal | 42% | 58% | NO | 24% | 76% | NO | 20% | 80% | NO |
| Spain | 87% | 13% | NO | 69% | 31% | NO | 63% | 37% | NO |
| Sweden | 100% | NO | NO | 100% | NO | NO | 100% | NO | NO |
| United Kingdom[1)] | 100% | | | 100% | | | 100% | | |
| EU-15 | 74% | 26% | 0% | 64% | 35% | 0% | 77% | 23% | 0% |

Source of information: CRF 4.B(a) for 2009, submitted in 2011. Abbreviations explained in the Chapter 'Units and abbreviations'.

[1)] The portion lacking for 100% are reported as daily spread (only UK) and 'other'.

**Table 6.34 Member State's Methane Conversion Factor used for dairy cattle, non-dairy cattle and swine for the different animal waste management systems in 2009**

| Member State | Dairy Cattle - Methane Conversion Factor (%) [1)] | | | | Non-dairy Cattle - Methane Conversion Factor (%) [1)] | | | | Swine - Methane Conversion Factor (%) [1)] | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2009 | Anaerobic lagoon | Liquid system | Solid storage and dry lot | Pasture range paddock | Anaerobic lagoon | Liquid system | Solid storage and dry lot | Pasture range paddock | Anaerobic lagoon | Liquid system | Solid storage and dry lot | Pasture range paddock |
| Austria | NA | 9% | 1.00% | 1.00% | NA | 8% | 1.00% | 1.00% | NA | 3% | 1.00% | 1.00% |
| Belgium | NO | 19% | 2.00% | 1.00% | NO | 19% | 2.00% | 1.00% | NO | 19% | 2.00% | NO |
| Denmark | NO | | | | NO | | | | NO | | | |
| Finland | NA | 10% | 1.00% | 1.00% | NA | 10% | 1.00% | 1.00% | NA | 10% | 1.00% | 1.00% |
| France | NO | 59% | 1.75% | 1.75% | NO | 59% | 1.75% | 1.75% | NO | 59% | 1.75% | 1.75% |
| Germany | NO | 13% | 2.00% | 1.00% | NO | 13% | 2.00% | 1.00% | NO | 16% | 2.00% | 1.00% |
| Greece | | | | | | | | | | | | |
| Ireland | NA | 39% | 1.00% | 1.00% | NA | 39% | 1.00% | 1.00% | NA | 39% | NA | NA |
| Italy | NO | 16% | 3.00% | 1.25% | NO | 16% | 3.00% | 1.25% | NO | 26% | NA | NA |
| Luxembourg | NA | 39% | 1.00% | 1.00% | NA | 39% | 1.00% | 1.00% | NA | 39% | 1.00% | NA |
| Netherlands | | | | | | | | | | | | |
| Portugal | 42% | NA | 1.25% | 1.25% | NA | NA | 1.25% | 1.25% | 42% | NA | 1.25% | 1.25% |
| Spain | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Sweden[2)] | NO | 10% | 1.00% | 1.00% | NO | 10% | 1.00% | 1.00% | NO | 10% | 1.00% | NO |
| United Kingdom | N/A | 39% | 1.00% | 1.00% | | 39% | 1.00% | 1.00% | NA | NA | NA | NA |
| EU15 | 42% | 43% | 1.96% | 1.50% | NA | 45% | 1.82% | 1.50% | 42% | 42% | 1.76% | 1.50% |

Source of information: CRF 4.B(a) for 2009, submitted in 2011. Abbreviations explained in the Chapter 'Units and abbreviations'.

[1)] Anaerobic lagoon + Liquid system. [2)] Values reported by Sweden have been multiplied with a factor of 100.

**Table 6.35** **Member State's methane producing potential for emissions from manure management for the main animal types in 2009**

| Member State 2009 | CH4 producing potential (Bo) (CH4 m3/kg VS) | | | | |
|---|---|---|---|---|---|
| | Dairy Cattle | Non-dairy cattle | Sheep | Goats | Swine |
| Austria | 0.24 | 0.17 | 0.19 | 0.17 | 0.45 |
| Belgium | 0.24 | 0.17 | 0.19 | 0.17 | 0.45 |
| Denmark | 0.24 | 0.17 | 0.19 | 0.17 | 0.45 |
| Finland | 0.24 | 0.17 | 0.19 | 0.17 | 0.45 |
| France | 0.24 | 0.17 | 0.19 | 0.17 | 0.45 |
| Germany | 0.24 | 0.18 | 0.19 | 0.18 | 0.45 |
| Greece | 0.24 | 0.17 | 0.19 | NE | NE |
| Ireland | 0.24 | 0.24 | 0.19 | 0.17 | 0.45 |
| Italy | 0.14 | 0.13 | 0.19 | 0.17 | 0.46 |
| Luxembourg | 0.24 | 0.17 | 0.19 | 0.17 | 0.45 |
| Netherlands | NE | NE | NE | NE | NE |
| Portugal | 0.24 | 0.17 | 0.19 | 0.17 | 0.45 |
| Spain | 0.24 | 0.17 | NA | NA | 0.45 |
| Sweden | 0.24 | 0.17 | 0.20 | 0.20 | 0.45 |
| United Kingdom | 0.24 | 0.24 | NE | NE | NE |
| EU-15 | 0.23 | 0.19 | 0.19 | 0.17 | 0.45 |

*Source of information: CRF 4.B(a) for 2009, submitted in 2011. Abbreviations explained in the Chapter 'Units and abbreviations'.*

**Table 6.36** **Member State's volatile solid excretion from managed manure for the main animal types in 2009**

| Member State 2009 | VS excretion (kg dm/head/day) | | | | |
|---|---|---|---|---|---|
| | Dairy Cattle | Non-dairy cattle | Sheep | Goats | Swine |
| Austria | 4.2 | 1.9 | 0.4 | 0.3 | 0.3 |
| Belgium | 3.9 | 1.4 | 0.5 | 0.5 | 0.5 |
| Denmark | 6.2 | 2.8 | 1.1 | 1.1 | 0.2 |
| Finland | 4.8 | 1.8 | 0.4 | 0.3 | 0.5 |
| France | 5.1 | 2.7 | 0.4 | 0.3 | 0.5 |
| Germany | 4.6 | 1.5 | 0.4 | 0.3 | 0.3 |
| Greece | 6.4 | 2.8 | 0.4 | NE | NE |
| Ireland | 2.8 | 1.3 | 0.4 | 0.3 | 0.5 |
| Italy | 6.4 | 2.8 | 0.4 | 0.3 | 0.3 |
| Luxembourg | 4.5 | 1.9 | 0.4 | 0.3 | 0.5 |
| Netherlands | NE | NE | NE | NE | NE |
| Portugal | 6.3 | 2.8 | 0.5 | 0.5 | 0.5 |
| Spain | 4.1 | 2.4 | NA | NA | 0.3 |
| Sweden | 5.3 | 1.4 | 0.4 | 0.3 | 0.3 |
| United Kingdom$ | 3.7 | 2.7 | NE | NE | NE |
| EU-15 | 4.8 | 2.3 | 0.4 | 0.3 | 0.3 |

*Source of information: CRF 4.B(a) for 2009, submitted in 2011 Abbreviations explained in the Chapter 'Units and abbreviations'. $ Values have been multiplied by 365 (non-dairy cattle).*

Some additional background information on the factors and parameters used by the Member States is given in

Table 6.37.

**Table 6.37 Member State's background information on the emission factors and other parameters used for the calculation of $CH_4$ emissions in category 4.B(a)**

| Member State | Emission Factors and other parameters |
|---|---|
| Austria | The default MCF values for 'cool climate regions' were used. For liquid systems a national value is used based on measurements; these values are considerably lower than IPCC default values. For yard (which is not included in the GPG2000, the MCF of pasture, range and paddock has bee taken. For deep litter the MCF of the 2006 IPCC Guidelines (17%) has been taken because the MCF of the GPG 2000 (39%) is not applicable to Austria's cold climate conditions. Austrian measurements showed that $CH_4$ emissions from farmyard manure were always lower than $CH_4$ emissions from liquid manure. It would contradict latest scientific results to apply a higher MCF to deep litter systems than to liquid manure systems. In the IPCC guidelines the default MCF for deep litter systems equals the default MCF for liquid systems. Hence, for Austria the chosen MCF of 17% (IPCC 2006) is a conservative estimate. Austrian specific values for dairy cows were calculated in dependency of annual milk yields and corresponding feed intake data (gross energy intake, feed digestibility, ash content).<br>For the calculation of VS excretion of suckling cows an average milk yield of 3 000 kg was applied. Austrian specific values on VS excretion for all other cattle categories were calculated from typical Austrian diets under organic and conventional management. As no major changes in diets of Non-Dairy Cattle occurred, methane emissions from manure management of Non-Dairy Cattle are calculated with a constant gross energy intake and thus constant VS excretion rate for the whole time series for swine. From Manure Management for Sheep, Goats, Horses, Poultry and Other Livestock / Deer are estimated with Tier 1 approach. |
| Belgium | Emission factors for each animal category have been developed by Siterem 2001. Those factors take into account the type and volume of manure produced during the time spent in stables, its density and carbon content, and its carbon volatilisation ratio. The resulting EF are comparable to the default IPCC for cool climate. |
| Denmark | The IEF for sheep and goats includes lambs and kids, which corresponds the Danish normative data. This explains why the Danish IEF is nearly twice as high as the IPCC default value. Swine: typical animal mass is based on slaughter pigs. Old-style tethering systems with solid manure have been replaced by loose housing with slurry-based systems. The MCF for liquid manure is ten times higher than that for solid manure. For non-dairy cattle, the opposite development has taken place. An increasing proportion of bull-calves are raised in stables with deep litter, where the MCF is lower than for liquid manure. |
| Finland | Cattle: National values for digestible energy (DE %), fraction of animal´s manure managed annually in each manure management system (MS), average milk production and animal weight. For Reindeer it is assumed that all manure is deposited on pastures and for fur animals it is assumed that all manure is managed as solid. For fur animals, VSi value is based on expert judgement being 0.17 kg/head/day. |
| France | IPCC EFs, only some specific national conditions were considered. |
| Germany | According to the calculation at district level, IEF are varying with time and space due to differences in AWMS distribution and climate. No national data for the methane producing potential exist and IPCC (2006) default values are used. IPCC 2006 is used as it allows for a better description of emissions from storage allowing consistent mass flow calculations. In addition, it provides temperature-dependent methane conversion factors. For goats, the IEF is based on the assumption of all-round grazing, which is not the case. Emissions are calculated with realistic management system frequency distributions. Emissions from buffalo are calculated on the basis of 100% formation of natural crusts. |
| Greece | |
| Ireland | New information obtained from a national farm facilities survey (Hyde et al., 2008) and the work on emission factors for enteric fermentation in cattle is the basis of the $CH_4$ emission factors for manure management. The emission factors for manure management are derived using the quantified organic matter excretion as volatile solids (VS), a BO (the methane production potential of animal waste), the allocation to animal waste management system based on the farm facilities survey and the corresponding values of MCF (methane conversion factor) given for the cool climate zone. |
| Italy | The detailed calculation includes a monthly regional emission factor as an exponential function from the monthly average regional temperature for slurry and the average regional monthly storage temperature for solid manure (Husted, 1993; Husted, 1994). The storage temperature is by itself an exponential function of the regional temperature. A specific conversion factor has then been estimated to correlate methane emissions and volatile solid production (15.32 g $CH_4$ kg-1 VS for slurry and 4.80 g $CH_4$ kg-1 VS for solid manure). These factors have then been used to calculate the aggregated methane emissions. The methane producing potential $B_0$ has been calculated for reporting purposes only. Swine. National emission data from experimental research at the Research Centre on Animal Production (CRPA, 1996). |
| Luxembourg | For cattle, the IEF has been calculated by combining the country specific activity data, coefficients and parameters according to the Tier 2 methodology. |
| Netherlands | The Netherlands uses a country-specific emission factor for a specific animal category, which is expressed as amount of methane emitted per kg animal manure per year for all three manure management systems for every animal category on a Tier 2 level. These calculations are based on country-specific data on manure characteristics: organic matter (OM) and maximum methane-producing potential ($B_0$), manure management system conditions (storage temperature and period) for liquid manure systems, which determine the methane conversion factor (MCF). Country-specific data on manure characteristics (volatile solids and maximum methane producing potential). Country-specific data on manure management system conditions (storage temperature and period) are also taken into account for liquid manure systems. For the other manure systems (solid manure and manure produced in the meadow), IPCC default values for the methane conversion factor are used. The Netherlands uses a MCF of 1.5% for all animal categories; for manure production in the meadow, it uses the IPCC default MCF value. |
| Portugal | Emissions factors for each animal type were established according to the tier 2 methodology, which considers the use of country specific information concerning the quantity of manure produce per animal and the share of each Manure Management System that is used for each animal type. |
| Spain | VS is estimated according to IPCC for cattle, and a national methodology for swine and poultry. Smooth temperature functions for the MCF for swine, poultry and cattle are used (modification accepted by IPCC). It has been calculated by interpolating IPCC default factors for the three climatic regions (with mid-point mean annual temperature of 10, |

| | |
|---|---|
| | 20, and 28°C) using the formula: MCF(T)=MCF(10°C) + b (10-T)^m, where b and m are parameters that vary with animal waste management system. |
| Sweden | The $B_0$i and MCF factors used are the default values in the Good Practice Guidance, except for the revised MCF for liquid manure, where the value of 10 % given by IPCC Guidelines, is adopted as a national value. This value is considered to be a more appropriate for Swedish conditions, firstly because of Sweden's cold climate, and secondly because of the fact that the slurry containers usually have a surface cover. |
| United Kingdom | Apart from cattle, lambs and deer, IPCC Tier 1 defaults (IPCC, 1997) are used and do not change from year to year. The emission factors for lambs are assumed to be 40% of that for adult sheep. Emission factors for dairy cattle were calculated from the IPCC Tier 2 procedure. The waste factors used for beef and other cattle are now calculated from the IPCC Tier 2 procedure but do not vary from year to year. |

**Trends**

Shifts in emission factors are partly explained by the increasing milk yield for dairy cows and by changes in the use of manure management systems. For example, in Denmark, an increasing IEF for dairy cattle results from an increasing milk yield and a shift to liquid manure systems. For pigs, there has been a similar development with a move from solid manure to slurry-based systems. For non-dairy cattle, the opposite development has taken place; an increasing proportion of bull-calves is raised in stables with deep litter, where the MCF is lower than for liquid manure. A similar effect is seen for Finland. The fluctuations underlying the general increase in emissions in Finland are related to both changes in animal numbers, which is largely dependent on agricultural policy, as well as changes in the distribution of manure management systems used. Slurry-based systems increase methane emissions per animal tenfold compared to the solid storage or pasture. In the Netherlands, liquid manure systems were replaced for poultry by solid manure systems which explain the decreasing emissions for poultry.

Figure 6.14 through Figure 6.19 show the trend of the development of animal productivity in terms of volatile solid excretion for dairy and non-dairy cattle and swine, and the IEF for $CH_4$ emissions from manure management. These figures show how the different development of the animal sectors in the various countries affects the average characteristics at EU level. Spain is the country with the largest increase in the Swine population and also the country which estimates the highest estimated volatile solid excretion rate. Thus the trend observed at EU-15 level (steepest increase in volatile solid excretion) can entirely be explained by a shift of the weight towards Spanish conditions.

Table 6.22 gives additional information on the trend in category 4B(a) as reported in the national inventory reports.

**Table 6.38 Member State's background information on the trend for $CH_4$ emissions in category 4.A.**

| Member State | Trend in category 4B(a) |
|---|---|
| Denmark | The emission from manure management has increased due to a change towards greater use of slurry-based stable systems, which have a higher emission factor than systems with solid manure. By coincidence, the decrease and the increase almost balance each other out and the total $CH_4$ emission from 1990 to 2007 has decreased by 5%. For pigs, there has been a similar development as for dairy cattle with a move from solid manure to slurry-based systems. Updated stable type data for 2007 shows fewer animals on slurry systems than previous estimated by the expert judgement from the Danish Agricultural Advisory Centre. An increase of the EF for swine has been observed between 2007 and 2008 (6%). This is due to changes in the allocation between the subcategories sows, slaughter pigs and piglets. Looking at the time serie for EF similar changes is seen, for example between 1993 and 1994 (increase by 7%), 2000-2001 (decrease by 5%) and 2004-2005 (decrease by 6%). |
| Finland | Methane emissions from manure management have been fluctuating during 1990-2007 but overall there is an increase of 23% in the emissions since 1990. This is due to an increase in the number of animals kept in a slurry-based system. This is due to an increase in the number of animals kept in a slurry-based system. The fluctuation in the emissions is related to both changes in animal numbers, which is largely dependent on agricultural policy, as well as changes in the distribution of the manure management systems used. Slurry-based systems increase methane emissions per animal tenfold compared with solid storage or pasture. |
| Germany | A reduction of the $CH_4$ emissions during the time period observed in Germany can be explained by the reduction of animal numbers after the German reunification. There is some inconsistency in the time series of animal numbers due to the modification of the "Agrarstatistikgesetzes" with a rupture between 1998 and 1999. This applies particularly to sheep and horses, for both animal categories an approach for correction has been developed and applied. |
| Ireland | A decrease of the IEF for non-dairy catte between 2005 and 2006 (by 5%) is explained by the strong increase of recovery of biogas from the animal waste storage for energy purposes in 2006. |
| Italy | Strong increase in biogas recovery in 2006 affected significantly $CH_4$ emissions from manure management. |
| Luxembourg | Methane emissions from manure management are increased by more than 22% for the period 1990-2006. Animals who did contribute the most of these emissions are cattle, swine and chicken. Beside livestock population developments, the methane emission increase is mainly driven by the changes in the AWMS for cattle: the liquid system share in AWMS went from 23% to about 38% for dairy cattle and from 18.9% to 28.9% for non-dairy cattle.65 Now, liquid system is the AWMS that has the highest methane conversion factor: 39%. This explains why, despite a decreasing cattle population, related $CH_4$ emissions did rise over the period 1990-2006. |
| Netherlands | The interannual increase of methane emissions is 13% and methane IEF for dairy cattle in 2008/2009 is 11%. This is not due to shorter grazing periods but the result of a shift from day and night grazing towards during the daytime only. Methane emissions from the stable are far higher than during grazing thus explaining the difference. |
| Spain | The interannual increase of $CH_4$ emissions for Swine 2005/2006 by 11% is due to several factors: a) an increse of 5% in the numbers of animals that superimposes to an increase in the per animal weight, and b) to an increase of the annual average temperatures (based on annual meteorological - not climatic - data for temperature). |

**Figure 6.14 Trend of volatile solid excretion for dairy cattle**

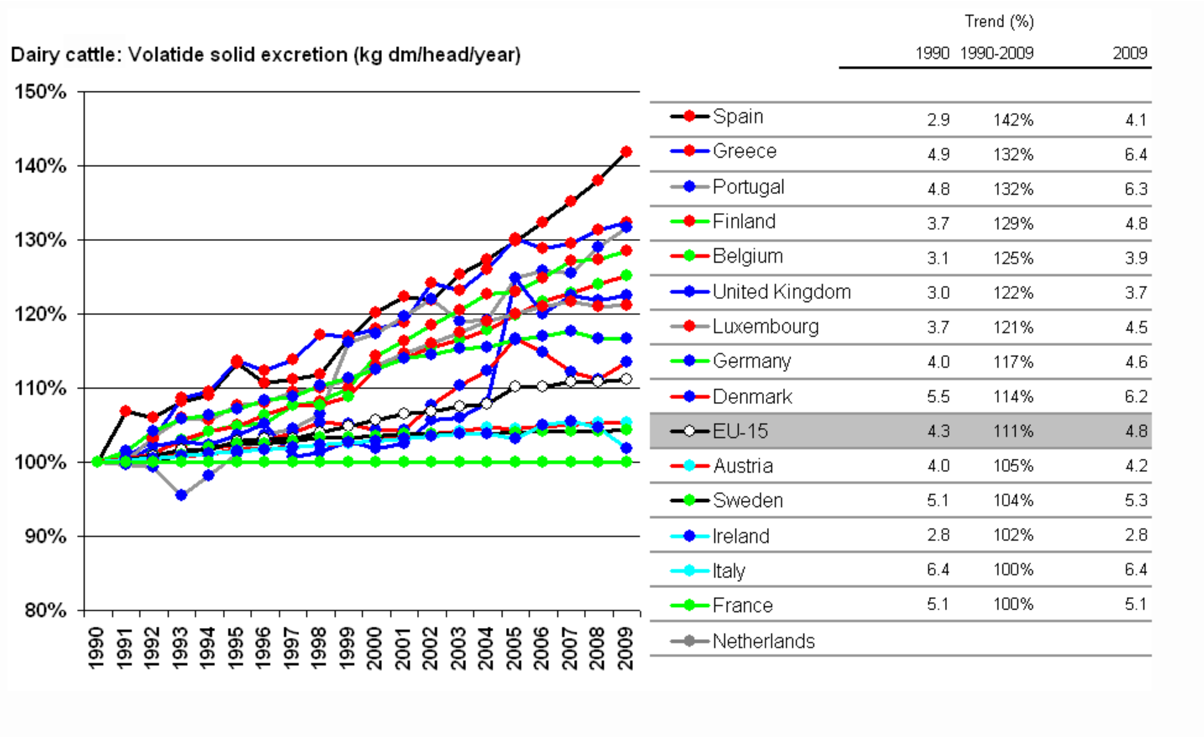
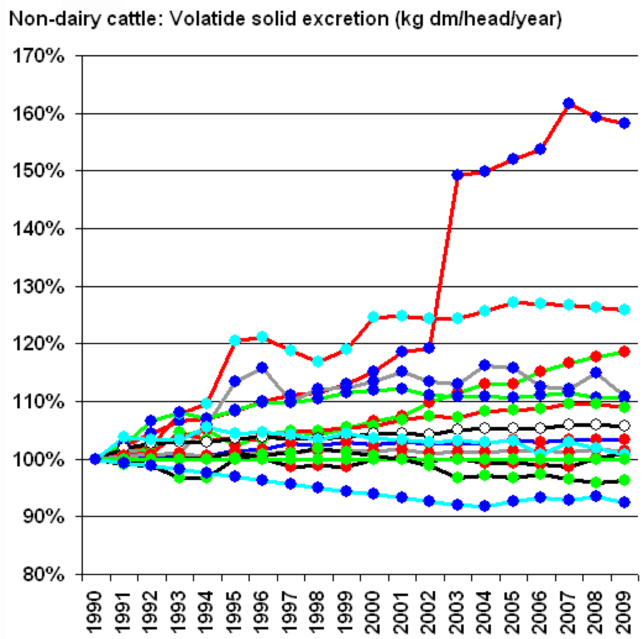
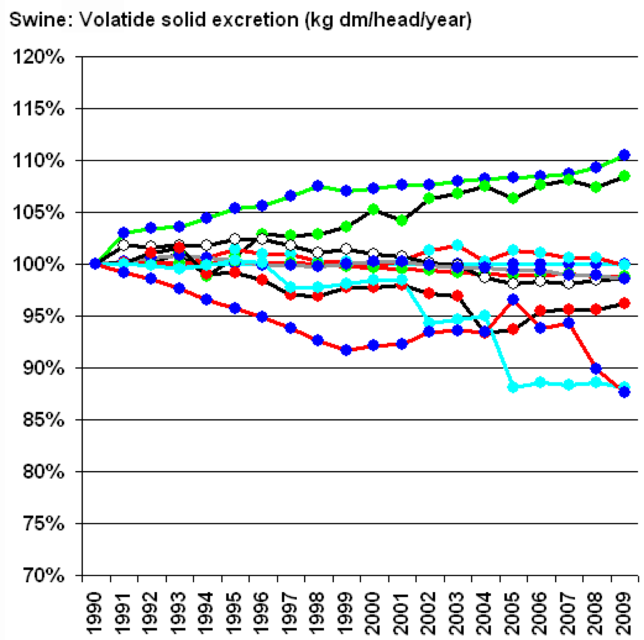


**Figure 6.15 Trend of volatile solid excretion for non-dairy cattle**




| | 1990 | Trend (%) 1990-2009 | 2009 |
|---|---|---|---|
| Denmark | 1.8 | 158% | 2.8 |
| Austria | 1.5 | 126% | 1.9 |
| Finland | 1.5 | 118% | 1.8 |
| Portugal | 2.5 | 111% | 2.8 |
| Germany | 1.3 | 111% | 1.5 |
| Belgium | 1.2 | 109% | 1.4 |
| EU-15 | 2.1 | 106% | 2.3 |
| Greece | 2.7 | 103% | 2.8 |
| Luxembourg | 1.9 | 101% | 1.9 |
| Spain | 2.4 | 101% | 2.4 |
| Italy | 2.8 | 101% | 2.8 |
| United Kingdom | 2.7 | 100% | 2.7 |
| France | 2.7 | 100% | 2.7 |
| Sweden | 1.5 | 96% | 1.4 |
| Ireland | 1.4 | 92% | 1.3 |
| Netherlands | | | |

**Figure 6.16 Trend of volatile solid excretion for swine**




| | 1990 | Trend (%) 1990-2009 | 2009 |
|---|---|---|---|
| Germany | 0.3 | 110% | 0.3 |
| Sweden | 0.3 | 109% | 0.3 |
| Finland | 0.5 | 100% | 0.5 |
| Luxembourg | 0.5 | 100% | 0.5 |
| France | 0.5 | 100% | 0.5 |
| Ireland | 0.5 | 100% | 0.5 |
| Austria | 0.3 | 100% | 0.3 |
| Belgium | 0.5 | 99% | 0.5 |
| EU-15 | 0.3 | 99% | 0.3 |
| Portugal | 0.5 | 99% | 0.5 |
| Spain | 0.3 | 96% | 0.3 |
| Italy | 0.4 | 88% | 0.3 |
| Denmark | 0.2 | 88% | 0.2 |
| Greece | | | |
| United Kingdom | | | |
| Netherlands | | | |

**Figure 6.17 Trend of IEF for $CH_4$ emissions from category 4B(a) for dairy cattle**

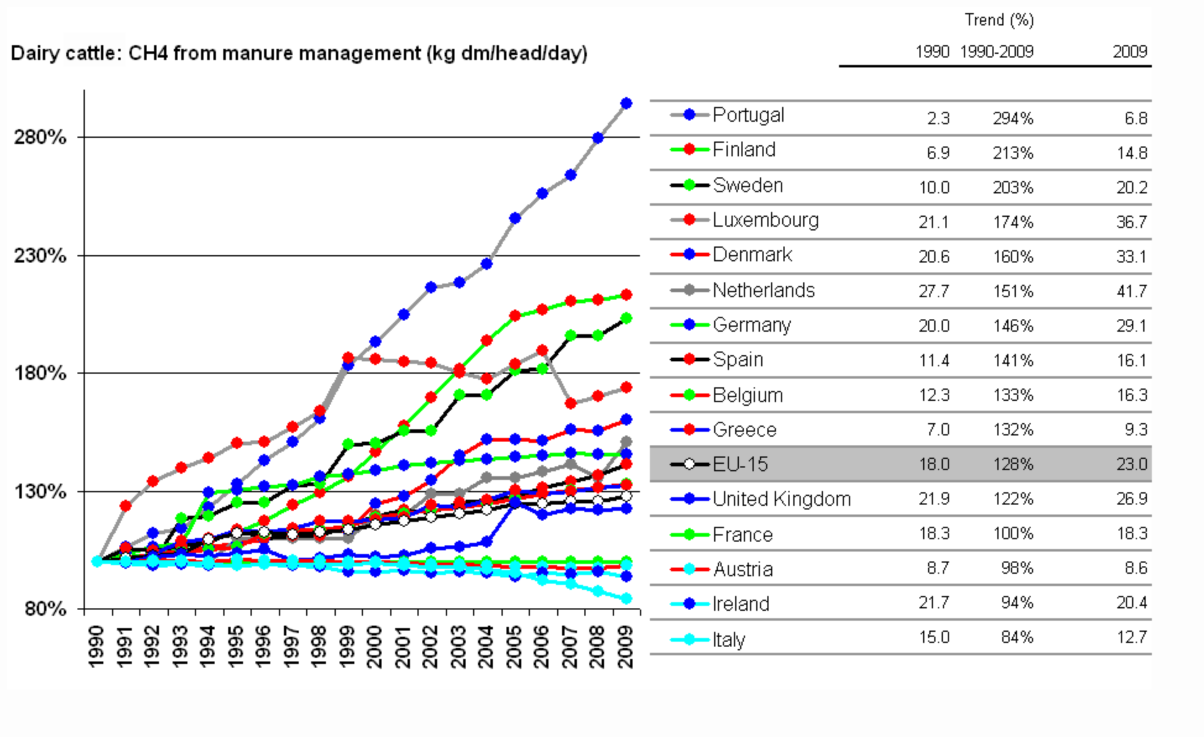



**Figure 6.18 Trend of IEF for $CH_4$ emissions from category 4B(a) for non-dairy cattle**

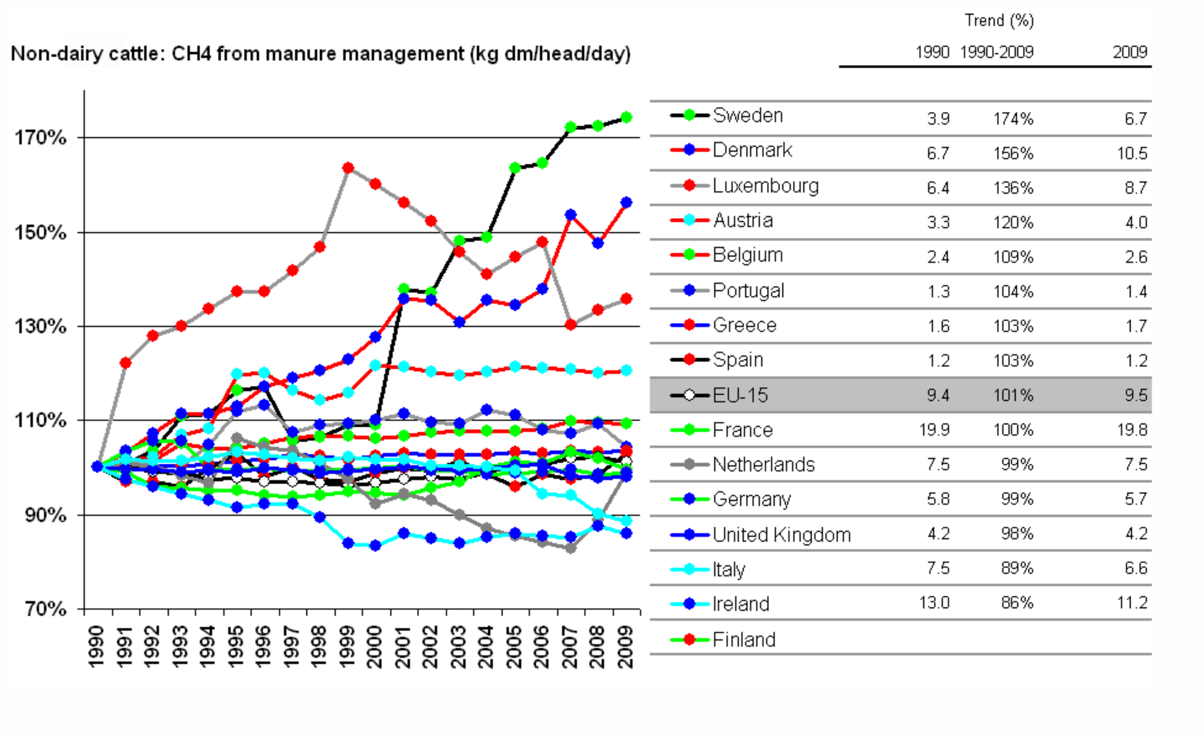
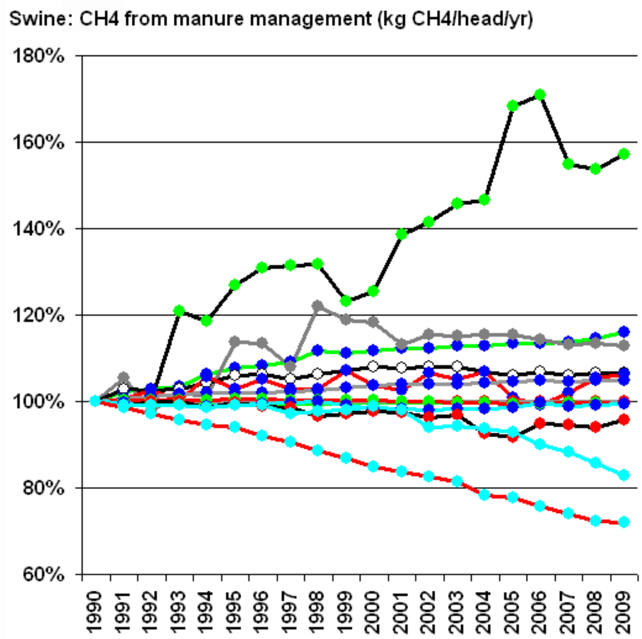


**Figure 6.19** **Trend of IEF for $CH_4$ emissions from category 4B(a) for swine**




| | Trend (%) | | |
|---|---|---|---|
| | 1990 | 1990-2009 | 2009 |
| Sweden | 2.1 | 157% | 3.3 |
| Germany | 4.0 | 116% | 4.6 |
| Netherlands | 3.9 | 113% | 4.4 |
| EU-15 | 7.4 | 107% | 7.9 |
| Denmark | 2.0 | 106% | 2.1 |
| Portugal | 20.4 | 105% | 21.4 |
| France | 20.9 | 100% | 20.9 |
| Greece | 7.0 | 100% | 7.0 |
| United Kingdom | 7.1 | 100% | 7.1 |
| Luxembourg | 19.5 | 100% | 19.5 |
| Belgium | 9.7 | 100% | 9.7 |
| Ireland | 12.8 | 100% | 12.7 |
| Spain | 9.9 | 96% | 9.5 |
| Italy | 8.1 | 83% | 6.7 |
| Austria | 1.6 | 72% | 1.1 |
| Finland | | | |

### 6.3.2.3 Uncertainty and time series consistency

As for enteric fermentation, the activity data in the category 4B(a) are considered to be relatively certain with uncertainty estimates around 10% for most countries. Highest uncertainty for the activity data are estimated by Italy and Sweden (20%). Portugal assigns a high uncertainty to the population data of several animal types.

The uncertainty estimate for the emission factors is higher and ranges between 10% (Spain) and 100%(Italy).

An overview of the uncertainty estimates for activity data and emission factors are given in Table 6.39 and Table 6.40. An overview of uncertainty estimates for agriculture at country and EU15 levels will be given in 6.4

Table 6.41 compiles some background information on the estimates of the uncertainty of the values used as activity data and emission factors to estimate $CH_4$ emissions from manure management. The table lists only information on activity-data uncertainty that is not covered in category 4A.

**Table 6.39 Relative uncertainty estimates for activity data in category 4B(a)**

| Member State 2009 | Total | Cattle | Dairy Cattle | Non-Dairy Cattle | Buffalo | Sheep | Goats | Camels and Llamas | Horses | Mules and Asses | Swine | Poultry | Other |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Austria | | 10.0 | | | | | | | | | 10.0 | | |
| Belgium | 10.0 | | | | | | | | | | | | |
| Denmark | 5.0 | | | | | | | | | | | | |
| Finland | | | | | | | | | | | | | |
| France | 5.0 | | | | | | | | | | | | |
| Germany | | | 6.0 | 4.0 | 8.0 | | | | | | 7.6 | | |
| Greece | 5.0 | | | | | | | | | | | | |
| Ireland | | | 1.0 | 1.0 | | | | | | | | | 1.0 |
| Italy | 20.0 | | | | | | | | | | | | |
| Luxembourg | | | | | | | | | | | | | |
| Netherlands | | 10.0 | | | | | | | | | 10.0 | 10.0 | 10.0 |
| Portugal | | | 6.1 | 6.5 | | 19.1 | 19.1 | | 71.2 | 271.8 | 11.0 | 41.1 | 770.6 |
| Spain | 3.0 | | | | | | | | | | | | |
| Sweden | 20.0 | | | | | | | | | | | | |
| United Kingdom | 0.1 | | | | | | | | | | | | |

**Table 6.40 Relative uncertainty estimates for implied emission factors in category 4B(a)**

| Member State 2009 | Total | Cattle | Dairy Cattle | Non-Dairy Cattle | Buffalo | Sheep | Goats | Camels and Llamas | Horses | Mules and Asses | Swine | Poultry | Other |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Austria | | 50.0 | | | | | | | | | 50.0 | | |
| Belgium | 40.0 | | | | | | | | | | | | |
| Denmark | 20.0 | | | | | | | | | | | | |
| Finland | 16.0 | | | | | | | | | | | | |
| France | 50.0 | | | | | | | | | | | | |
| Germany | | | 40.0 | 26.5 | 18.3 | | | | | | 30.4 | | |
| Greece | 50.0 | | | | | | | | | | | | |
| Ireland | | | 15.0 | 15.0 | | | | | | | | | 30.0 |
| Italy | 100.0 | | | | | | | | | | | | |
| Luxembourg | | | | | | | | | | | | | |
| Netherlands | | 100.0 | | | | | | | | | 100.0 | 100.0 | 100.0 |
| Portugal | | | 60.6 | 46.2 | | 59.3 | 58.4 | | 61.0 | 61.0 | 91.0 | 66.0 | 66.0 |
| Spain | 10.0 | | | | | | | | | | | | |
| Sweden | 50.0 | | | | | | | | | | | | |
| United Kingdom | 30.0 | | | | | | | | | | | | |

**Table 6.41 Member State's background information for uncertainty estimates in category 4.B(a)**

| Member State | Background information to uncertainy estimates |
|---|---|
| Austria | **Emission Factor:** Based on the identical animal numbers, uncertainties of emission factors for $CH_4$ from manure were assessed at 70% (AMON et al. 2002), and for $N_2O$ emissions a lognormal distribution with a low at 50% and a high of 200% of the best estimate was chosen derived from IPCC, 2000. |
| Belgium | **Activity Data:** The activity data are the livestock census, but also the type of animal housing. The type of housing is more difficult to assess than the number of animals. Consequently the uncertainty on the activity data is estimated at 10 %.<br>**Emission Factor:** The $CH_4$ emission factors are based on a regional-specific study. However, given that many assumptions were necessary to calculate these emission factors, the uncertainty on these emission factors is estimated to be similar to the uncertainty on enteric fermentation emission factor. |
| Denmark | **Emission Factor:** The emission factor for $CH_4$ from manure management is 10%. This figure may be underestimated and the uncertainty is, therefore, increased to 100 % until further investigations reveal new data. |
| Finland | **Emission Factor:** The uncertainty estimate of the $CH_4$ emission factor for manure management for all species (±30%) was based on uncertainty estimates of other countries, i.e. Norway, the Netherlands, the USA (Rypdal & Winiwarter 2001) and the UK (Charles et al. 1998), complemented with expert judgement. |
| Germany | **Emission Factor:** 30 % for emission factors for $CH_4$ and $NH_3$. The errors for the other emission factors are not known. Figures for $N_2O$, NO and N2 are taken from IPCC (2006). |
| Netherlands | **Activity Data:** The uncertainty in the annual $CH_4$ and $N_2O$ emissions from manure management from cattle and swine is estimated to be approximately 100%. The uncertainty in the amount of animal manure (10%) is based on a 5% uncertainty in animal numbers and a 5–10% uncertainty in excretion per animal. The resulting uncertainty of 7–11% was rounded off to 10%.<br>**Emission Factor:** The uncertainty in the $CH_4$ emission factors for Manure management, based on the judgments of experts, is estimated to be 100% (Olivier et al.,2009). Of the three factors that together make up the emission factor (emission per amount of manure), MCF (Methane Conversion Factor) is the most uncertain. The factor captures for instance assumptions on temperature (temperature is important to the rate of methane production) on technology of manure systems (e.g., sometimes methane (biogas) is col-lected and used) and on the actual management (e.g. whether a tank is directly cleaned after its use). The microbiology of methane formation itself is relatively well known. Most of the uncertainty is created by the assumptions about 'average' manure manage-ment (Olsthoorn and Pielaat, 2003) |
| Portugal | **Activity Data:** Territorial units under each climate class could easily change as much as 30% in either direction, value that was assumed as representative of uncertainty for this factor.<br>**Emission Factor:** Uncertainty for the quantity excreted, VS parameter, was set at 20%, considering the use of an enhanced livestock characterization. Uncertainty values vary from 10% for horses up to 22% for dairy cows. The uncertainty of the biogas density was assumed not to be determinant of the overall uncertainty value. |

The following issues for time-series consistency have been identified:

- **$CH_4$ Emissions – Dairy cattle, Non-Dairy cattle, Greece**
  The inter-annual decrease in methane emissions of dairy cattle in 2004/2005 is 22% and increase in 2005/2006 is 30%. The inter-annual increase in methane emissions of non-dairy cattle in 2004/2005 is 46% and decrease in 2005/2006 is 27%.
- **$CH_4$ Emissions – Dairy cattle, Non-Dairy cattle, Luxembourg**
  An unexpected interannual increasing of methane emissions in 2004-2005 is 412%.
- **Activity data, Sweden**
  Information on waste management systems is collected from the surveys published in the biannual statistical report on the use of fertilisers and animal manure in agriculture and the interpolated values are used for the intermediate years. National estimates of stable periods for cattle are collected from the statistical report on use of fertilisers and animal manure in agriculture. This information has been available biannually since 1997. Before 1997, the data are extrapolated to 1990.

### *6.3.3 Manure Management $N_2O$ (CRF source category 4.B(b))*

#### 6.3.3.1 Source category description

During storage and management of manure, $N_2O$ can be produced and emitted to the atmosphere. In accordance with the IPCC guidelines, the term 'manure' is used collectively to include both dung and urine (i.e., the solids and the liquids) produced by livestock. As for methane emissions, source category 4.B(b) excludes emissions that originate from burning of manure. Also excluded are emissions from manure deposited on pastures by grazing animals, which are reported under category 4.D2.

Direct $N_2O$ emissions occur via combined nitrification and denitrification of nitrogen contained in the manure, and depend on the availability of nitrogen and carbon. As nitrification requires the presence of oxygen, $N_2O$ emissions are favored by aerobic conditions, which are favored in solid manure storage and treatment systems. Denitrification is an anaerobic process and yields molecular nitrogen next to $N_2O$. Under conditions of reduced moisture, high nitrate concentrations and acidic medium, the emissions of $N_2O$ relative to $N_2$ increase. Losses of other forms of nitrogen ($NH_3$, $NO_x$) are possible and will potentially lead to $N_2O$ emissions once they re-deposit on the surface. These 'indirect' $N_2O$ emissions are reported in source category 4.D3.

Generally, GHG emissions (in $CO_{2\text{-equivalent}}$s) from manure management are predominantly as $CH_4$ rather than as $N_2O$. At the EU-15 level, this ratio is at about a factor of 2.9, ranging from 0.5 (Austria) to 8.8 (Ireland). Values close or smaller to unity are found for example for Italy (1.2).

The differences of the ratio across the countries can partly be explained by the implied emission factor used for $CH_4$ emissions in the manure management category (see discussion above), and partly by the nitrogen excretion factors. Total nitrogen excretion by Member State and manure management system are given in Table 6.42.

Table 6.42 shows that the implied emission factors used for $N_2O$ emission from manure management are IPCC default for all countries are close to the default value and that only small changes in the IEF occurred in the time between 1990 and 2009 with an 1% increase of the IEF for solid systems and of 3% for liquid systems.

**Table 6.42 Total $N_2O$ emissions in category 4B(b) and implied Emission Factor at EU-15 level for the years 1990 and 2009**

| | Anaerobic lagoon | Liquid systems | Solid storage and dry lots |
|---|---|---|---|
| | 1990 | | |
| Total Emissions of $N_2O$ [Gg $N_2O$-N] | 0 | 8 | 65 |
| Total Nitrogen excreted [Gg N] | 20 | 2824 | 2390 |
| Implied Emission Factor [kg $N_2O$-N / kg N] | 0.10% | 0.19% | 1.68% |

| | Anaerobic lagoon | Liquid systems | Solid storage and dry lots |
|---|---|---|---|
| | 2009 | | |
| Total Emissions of $N_2O$ [Gg $N_2O$-N] | 0 | 7 | 54 |
| Total Nitrogen excreted [Gg N] | 24 | 2585 | 1945 |
| Implied Emission Factor [kg $N_2O$-N / kg N] | 0.10% | 0.19% | 1.69% |

| | Anaerobic lagoon | Liquid systems | Solid storage and dry lots |
|---|---|---|---|
| | 2009 value in percent of 1990 | | |
| Total Emissions of N2O [Gg N2O-N] | 119% | 94% | 83% |
| Total Nitrogen excreted [Gg N] | 119% | 92% | 81% |
| Implied Emission Factor [kg N2O-N / kg N] | 100% | 103% | 101% |

### 6.3.3.2 Methodological Issues

**Methods**

Emissions of nitrous oxide are much higher from solid storage systems than from liquid systems; the percentage of emissions from solid storage systems thus varies between 71% in Sweden and 93% in Portugal.

Table 6.43 shows the total emissions in category 4B(b), how this is composed and the methodology used for calculating the emissions for cattle and swine by Member States. The table shows also that 'solid storage' is a key category for all Member States. Activity Data are the excretion of nitrogen per animal and the distribution over the manure management systems. This is done by most Member States at a higher disaggregation level than categories that are reported in the CRF. The emission factor of $N_2O$ per nitrogen managed in a certain manure management system is usually IPCC default.

The quality of the emission estimates is calculated from the Nex factor for the each manure management system (assigning Tier 1 or Tier 2 when comparing to IPCC default), combined with the MEAN-rule (see section 6.4.1.5, Table 6.88 through Table 6.91) and then further combined with the Tier level of the emission factor for the manure storage system by using the MEDIAN rule with weighting factors for Nex and the IEF being 2/3 and 1/3 (for details see Section 6.4.1.3).

As most countries use country-specific nitrogen excretion rates for most animals but use default emission factors, the Tier level of Tier 1.7 is assigned. The combined uncertainty of both solid, liquid, and other systems (12% of total emissions, for which a Tier 1 was assumed) range between Tier 1.1 and Tier 2.0. Nitrogen excretion is reported by animal type and not by manure management system in the CRF tables. To assign nevertheless a Tier level for the nitrogen excretion by manure management system, the allocation of animal waste to manure management systems from the calculation of $CH_4$ emissions from manure management is used.  Netherland does not report nitrogen excretion rates and no allocation of animal waste to manure management systems could be done. However, according to the national inventory report, a Tier 2 approach can be assumed for the Nex values.

For EU-15, the overall Tier level is Tier 1.7 (66% of emissions estimated using country-specific information). This value is somewhat lower for solid systems (Tier 1.6) than for liquid systems (Tier 1.9). A compilation of national methodologies for the estimation of nitrogen excretion can be found in

Table 6.49; most data are based on country-specific information. This is important if we assess the uncertainty of the EU15 emission estimate: given that nitrogen excretion is largely controlling $N_2O$ emissions from manure management, the error of the estimates of the different countries can be assumed to be largely independent one from another. Only two countries are relying on IPCC default values, i.e. Greece using values reported for the Mediterranean region and France (for dairy cattle) using the value for Western Europe.

Additional background information on the methodology, if available, is summarised in

Table 6.44.

**Table 6.43 Total emissions and contribution of the main sub-categories to $N_2O$ emissions in category 4B(b), methodology applied (EF) and key source assessment by Member States for the sub-categories solid storage and liquid systems**

| | Total | | Solid Storage | | | Liquid Systems | |
|---|---|---|---|---|---|---|---|
| | Gg $CO_2$-eq | b | a | b | c | a | b |
| Austria | 923 | Tier 1.8 | 73% | Tier 1.7 | y | 3% | Tier 1.7 |
| Belgium | 774 | Tier 1.7 | 93% | Tier 1.7 | y | 1% | Tier 1.7 |
| Denmark | 426 | Tier 1.9 | 22% | Tier 1.7 | y | 18% | Tier 1.9 |
| Finland | 401 | Tier 1.1 | 79% | Tier 1.6 | y | 5% | Tier 1.1 |
| France | 5,995 | Tier 1.5 | 96% | Tier 1.4 | y | 4% | Tier 1.5 |
| Germany | 2,230 | Tier 2.0 | 37% | Tier 2.0 | y | 63% | Tier 2.0 |
| Greece | 302 | Tier 1.7 | 93% | Tier 1.4 | y | 2% | Tier 1.7 |
| Ireland | 365 | Tier 1.7 | 85% | Tier 1.7 | y | 15% | Tier 1.7 |
| Italy | 3,762 | Tier 1.7 | 88% | Tier 1.6 | y | 4% | Tier 1.7 |
| Luxembourg | 25 | Tier 2.0 | 91% | Tier 2.0 | y | 8% | Tier 2.0 |
| Netherlands | 997 | Tier 1.8 | 84% | Tier 2.0 | y | 16% | Tier 1.7 |
| Portugal | 317 | Tier 1.7 | 93% | Tier 1.6 | y | 3% | Tier 1.7 |
| Spain | 2,484 | Tier 1.8 | 61% | Tier 1.6 | y | 0% | Tier 1.6 |
| Sweden | 442 | Tier 1.7 | 71% | Tier 1.7 | y | 5% | Tier 1.7 |
| United Kingdom | 1,995 | Tier 1.9 | 71% | Tier 2.0 | y | 3% | Tier 2.0 |
| **EU-15** | **21,439** | **Tier 1.7** | **78%** | **Tier 1.6** | **y** | **10%** | **Tier 1.9** |
| EU-15: Tier 1 | 34% | | 37% | | | 12% | |
| EU-15: Tier 2 | 66% | | 63% | | | 88% | |

*a Contribution to $N_2O$ emissions from manure management; b Quality level (between Tier 1 and Tier 2); c Source category is key in the Member State's inventory (y/n); nr: not reported*

**Table 6.44** **Member State's background information on the methodology for estimating $N_2O$ emissions in category 4.B(b)**

| Member State | Methods |
|---|---|
| Austria | For the estimation of $N_2O$ emissions from manure management systems only a Tier 1 approach is available. Young swine from 20 to 50 kg are considered separately. |
| Denmark | Emissions from manure management are calculated in with the model DIEMA (Danish Integrated Emission Model for Agriculture, Mikkelsen et al., 2006). |
| Finland | The nitrogen mass flow model takes into account the volatilisation of ammonia in each step of manure management (animal shelter, filling storage, storing) and the effect of possible abatement measures to volatilisation. This enables to calculate indirect nitrous oxide emissions from AWMS. Urine stored separately is a small adjustment to solid storage emissions (and has EF of liquid). |
| Germany | Calculation of N-excretion is based on the concept of nitrogen-flow in agriculture which considers all nitrogen losses including molecular nitrogen (EMEP, 2003; Daemmgen and Hutchings, 2005; Daemmgen et al., 2007). It considers a differentiation between organic nitrogen and easily decomposable nitrogen (total ammoniacal nitrogen, TAN). TAN is present in the uring of mammals, while poultry excrete uric acid nitrogen (UAN), which is considered as TAN in the calculations. In a first step, both the excretion of total nitrogen and of total ammoniacal nitrogen (TAN) is estimated. Simultaneous NO, N2 and $N_2O$ emissions are calculated on the basis of total nitrogen, but are subtracted from the TAN pool only. Main drivers of the emissions are manure storage system and temperature. Emissions of all N-gases on pasture, range and paddock occur simultaneously, while volatilization in housing systems are subtracted from available TAN for the calculation of emissions from manure management systems. All calculations are done |
| Greece | Dairy cattle, non-dairy cattle and sheep: Tier 2. Other animals: Tier 1. |
| Italy | Tier 1 methodology and IPCC default emission factors were used for the management systems. For sheep and goat, a detailed analysis has been carried out with information from ASSONAPA, the National Association for Sheep Farming. For slurry and solid manure production parameters, specifically for the cattle and buffalo category, updated data have been incorporated, according to new country specific data available. |
| Netherlands | Activity data are collected in compliance with a Tier 2 method. The method used is fully in compliance with the IPCC Good Practice Guidance (IPCC, 2001). Ther N-flows from animal production are assessed by the National Emission Model for Ammonia (NEMA). Results include emissions of ammonia ($NH_3$), nitric oxide (NO), laughing gas ($N_2O$) and nitrogen gas (N2) from stable and storage. |
| Sweden | The methodology for estimating $N_2O$ from manure management is in accordance with the IPCC Guidelines Tier 2 methodology; it is based on emission factors from the IPCC Guidelines in combination with national activity data. |
| United Kingdom | It is assumed that 20% of the total N emitted by livestock volatilises as $NO_x$ and $NH_3$ and does not contribute to $N_2O$ emissions. This is because in the absence of a more detailed split of $NH_3$ losses at the different stages of the manure handling process it has been assumed that $NH_3$ loss occurs prior to major $N_2O$ losses. Emission estimates are made with 20% smaller Nex factors than those reported in the CRF. The methodology for estimating $N_2O$ from manure management is in accordance with the IPCC Guidelines Tier 2 methodology; it is based on emission factors from the IPCC Guidelines in combination with national activity data. |

## Activity Data

In EU-15, a total of 7,876 Gg N was managed in manure management systems or excreted on pasture range and paddock in 2009. The largest share of this manure-nitrogen was excreted by grazing animals, followed by manure managed in liquid and solid storage systems. Compared with 1990, this was a decrease of manure-nitrogen by 12%. The decreases were similar for the different manure management systems with a smallest decrease for liquid systems (-8%). The decrease of nitrogen was particularly pronounced in the Netherlands, where total nitrogen decreased by 30%. At the same time, the manure managed on solid storage systems increased by 7% indicating a strong shift from pasture to solid systems in the Netherlands. This is a consequence of the increase of the time period dairy cattle are kept indoors. Firstly this is done to increase cost-effectiveness of milk production and secondly to increase the efficiency of manure application as an effect of Dutch manure-policy.

The nitrogen managed in the various manure management systems in 2009 is given in Table 6.45. Background information on the allocation to manure management systems is given in Table 6.31. Nitrogen excretion data per head will be discussed below.

**Table 6.45** **Member State's nitrogen managed in the manure managed systems anaerobic lagoon, liquid systems, daily spread, and other systems, manure excreted on pasture range and paddock, and total nitrogen excreted in 2009**

| Member State 2009 | Anaerobic lagoon | Liquid systems | Daily Spread | Solid storage and dry lot | Other | Pasture range paddock | Total |
|---|---|---|---|---|---|---|---|
| Austria | | 54 | | 69 | 35 | 10 | 169 |
| Belgium | | 19 | 2 | 74 | 85 | 80 | 260 |
| Denmark | | 198 | | 10 | 32 | 23 | 263 |
| Finland | | 38 | | 40 | 7 | 19 | 103 |
| France | | 482 | | 591 | | 758 | 1,831 |
| Germany | | 849 | | 330 | | 162 | 1,341 |
| Greece | | 13 | 1 | 29 | 6 | 183 | 231 |
| Ireland | | 111 | | 32 | | 279 | 422 |
| Italy | | 326 | | 339 | 31 | 158 | 854 |
| Luxembourg | | 4 | | 2 | 1 | 6 | 13 |
| Netherlands | | 323 | | 95 | | 81 | 499 |
| Portugal | 24 | 20 | | 30 | | 84 | 158 |
| Spain | | 10 | 17 | 155 | 306 | 317 | 805 |
| Sweden | | 49 | | 32 | 11 | 44 | 135 |
| United Kingdor | | 89 | 110 | 116 | 54 | 423 | 792 |
| EU-15 | 24 | 2,585 | 130 | 1,945 | 567 | 2,626 | 7,876 |

Information source: CRF Table 4.B(b) for 2009, submitted in 2011. Abbreviations explained in the Chapter 'Units and abbreviations'.

## Emission Factors and other parameters

As most countries are using IPCC default values for the IEF or values that are close to it, these numbers apply also for the EC-$N_2O$ inventory for manure management. An overview of the implied emission factors is given in Table 6.46.

**Table 6.46** **Implied Emission factors for $N_2O$ emissions from manure management used in Member State's inventory 2009**

| Member State | Implied EF (kg $N_2O$-N / kg N) | | | |
|---|---|---|---|---|
| 2009 | Anaerobic lagoon | Liquid system | Solid storage and dry lot | Other |
| Austria | NO | 0.10% | 2.0% | 1.3% |
| Belgium | NO | 0.10% | 2.0% | 0.1% |
| Denmark | NO | 0.08% | 2.0% | 1.6% |
| Finland | NO | 0.10% | 1.6% | 2.0% |
| France | NA | 0.10% | 2.0% | NA |
| Germany | NO | 0.34% | 0.5% | NO |
| Greece | NA | 0.10% | 2.0% | 0.5% |
| Ireland | NO | 0.10% | 2.0% | NO |
| Italy | NO | 0.10% | 2.0% | 2.0% |
| Luxembourg | NO | 0.10% | 2.0% | 0.1% |
| Netherlands | NO | 0.10% | 1.8% | NO |
| Portugal | 0.10% | 0.10% | 2.0% | NO |
| Spain | NO | 0.10% | 2.0% | 0.6% |
| Sweden | NO | 0.10% | 2.0% | 2.0% |
| United Kingdom | NO | 0.12% | 2.5% | 2.0% |
| EU-15 | 0.10% | 0.19% | 1.7% | 0.9% |

Information source: CRF Table 4.B(b) for 2009, submitted in 2011
Abbreviations explained in the Chapter 'Units and abbreviations'.

An important parameter in the calculation of $N_2O$ emissions from manure management is the nitrogen excretion rate per head and year, which is given in Table 6.47 for EU15-countries and the main animal types. The table shows a range by a factor of up to 3.5 between the highest and the lowest value used is found. For example, for dairy cattle, we have a range from about 70 kg N head$^{-1}$ y$^{-1}$ for Spain to 138 kg N head$^{-1}$ y$^{-1}$ for Denmark. Large ranges are found for non-dairy cattle with values between 41 (Germany) and 58 kg N head$^{-1}$ y$^{-1}$ (France) and sheep with values between 5.2 kg N head$^{-1}$ y$^{-1}$ (Spain) and 18.3 kg N head$^{-1}$ y$^{-1}$ (France).

Additional information on the development of the emission factor is available for some Member States and is summarized in

Table 6.48. Additional background information on the calculation of nitrogen excretion rates are summarised in

Table 6.49.

**Table 6.47** **Total Nitrogen excretion by AWMS [Gg N] for dairy and non-dairy cattle, sheep, swine, and poultry in 2009**

| Member State 2009 | Dairy | Non-Dairy | Sheep | Swine | Poultry |
|---|---|---|---|---|---|
| Austria | 97.1 | 46.6 | 13.1 | 9.6 | 0.5 |
| Belgium | 115.1 | 54.3 | 7.5 | 10.1 | 0.6 |
| Denmark | 138.1 | 47.8 | 17.0 | 8.4 | 0.5 |
| Finland | 126.9 | 50.2 | 10.0 | IE | 0.6 |
| France | 100.0 | 57.5 | 18.3 | 16.5 | 0.6 |
| Germany | 131.5 | 40.8 | 7.4 | 12.1 | 0.8 |
| Greece | 100.0 | 45.4 | 10.7 | 16.0 | 0.6 |
| Ireland | 85.0 | 48.9 | 6.3 | 8.5 | 0.3 |
| Italy | 116.0 | 48.7 | 16.2 | 11.8 | 0.5 |
| Luxembourg | 102.0 | 47.2 | 17.0 | 11.9 | 0.7 |
| Netherlands | 127.0 | 41.8 | 6.7 | 8.9 | 0.7 |
| Portugal | 115.0 | 51.2 | 7.1 | 9.5 | 0.6 |
| Spain | 67.7 | 52.6 | 5.2 | 9.4 | 0.5 |
| Sweden | 126.4 | 41.7 | 6.1 | 9.1 | 0.4 |
| United Kingdom | 110.0 | 55.3 | 5.2 | 10.6 | 0.6 |
| EU-15 | 112.5 | 49.2 | 7.8 | 10.6 | 0.6 |

*Information source: CRF Table 4.B(b) for 2009, submitted in 2011*
*Abbreviations explained in the Chapter 'Units and abbreviations'.*

**Table 6.48 Member State's background information on the emission factor for calculation of $N_2O$ emissions in category 4.B(b)**

| Member State | Emission Factors |
|---|---|
| Denmark | IEF for "Solid Storage and dry lot" is a weighted value: 0.005 for poultry manure without bedding and 0.02. Other manure default. Effects from biogas-treated slurry are included in the $N_2O$ emissions. |
| Germany | $N_2O$ - default (IPCC 2006). Emission factors for NO and N2 are taken in accordance to results in the UK (Jarvis and Pain, 1994) and are used also in the inventories of the UK, CH, and DK. They are derived from the $N_2O$-EF as follows: EF-$N_2O$ = 10 EF-NO = 1/3 EF-N2. The IEF for solid manure solidconsiders also the nitrogen in the bedding material and is thus higher than reported default factors. The application of $NH_3$ and $N_2O$ emission factors from IPCC1996 shows that they exceed the size of the TAN pools. For $N_2O$, IPCC 2006 partial emission factors were taken into account, as they can be assigned to the storage systems used in Germany (see also Amon et al., 2001). For cattle, these emission factors allow for a differentiation between slurry stored with and without a natural crust cover in particular. The mean $N_2O$ emission factor is strongly depending on the emission factor chosen for solid storage. Here, the IPCC 1996 factor unduly extrapolates from the dry lot storage systems (0.02 kg kg-1 $N_2O$) to straw based systems used in Germany, see comment in IPCC 2006, Table 10.21 ("Judgement of IPCC Expert Group in combination with Amon et al. (2001), which shows emissions ranging from 0.0027 to 0.01 kg $N_2O$-N (kg N)-1."). In Germany the system of dry lot is not practised. Only the two straw based systems of solid storage (EF of 0.005 kg/kg) and deep litter (EF of 0.01 kg/kg) are used. Therefore, the IPCC1996 factor is not used. IPCC 2006 allows that partial emission factors can be assigned to the systems used in Germany. For cattle, these EFs allow for a differentiation between slurry stored with and without a natural crust cover in particular. EFs of 2006 have been shown to correspond with German conditions for slurry and solid manure (Freibauer, 2003). |
| Italy | Liquid system, solid storage and other management systems (chicken-dung drying process system since 1995 when it became widespread in poultry breeding) have been considered according to their significance and major application in Italy. |
| Netherlands | Emission factors for $N_2O$ from Manure management represent the IPCC default values for liquid and solid systems. |
| Sweden | Default values from the IPCC Guidelines. IEFs may change over the years, depending on the relative size of the respective subgroups aggregated. |
| United Kingdom | The assigning of manure 'stored in house' manure to 'daily spread' is acceptable only if emissions from the housing phase are thought to be very small. For farmyard manure, storage capacity within the house or yard might comprise between 7 weeks - 12 months (poultry) or several months (cattle) (Smith, 2002, pers. comm.). Calculations were performed with the $N_2O$ Inventory of Farmed Livestock to compare housing and storage phases (Sneath et al. 1997). For pigs and poultry, the emission factor for housing is the same as or greater than that of storage. It would therefore lead to significant underestimation to use the daily spread emission factor. The FYM in this case has therefore been reallocated to SSD or 'other' as appropriate. For dairy and non-dairy cattle, the emission factor for the housing phase is around 10% of the storage phase, so the non-stored FYM has been split between SSD and DS to account for this. |

**Table 6.49 Member State's background information for the development of nitrogen excretion rates used in the calculation of $N_2O$ emissions in category 4.B(b)**

| Member State | Nitrogen excretion rates |
|---|---|
| Austria | N-excretion data are calculated following the guidelines of the European Commissions according to the requirements of the European Nitrate Directive based on feed rations which are estimated on the basis of field studies on representative grassland and dairy farm areas for cattle and take into consideration the daily gain of weight, nitrogen and energy uptake, efficiency, etc. Similar level of detail for pigs. (Gruber & Poetsch, 2005; Poetsch et al., 2005; Steinwidder & Guggenberger, 2003). Piglets are not considered in N-excretion data separately (included in sows). However, there are included in the population data, which gives rise to an inconsistency in the CRF table. |
| Belgium | $N_2O$ emissions from manure storage are based on N excretion data estimated through local production factors. In Wallonia, emissions are calculated using the model developed by (Siterem, 2001) also used for $CH_4$ and $NH_3$ emissions. It includes emissions from animal husbandry, excreta deposited in buildings and collected as liuid slurry or solid manure, and application of mineral fertilizer and manure nitrogen to land. Such factors were first determined for the implementation of the CE Nitrates Directive 91/676 on http://www.nitrawal.be/pdf/arretenitrates_mb2.pdf, but were representing the nitrogen after deduction of the atmospheric losses, so new factors were calculated on this basis for the purposes of estimating atmospheric emissions. For Flanders, nitrogen excretion factors are from the Manure Bank of the Flamish Land Agency (www.vlm.be) and are based on the regional situation. The nitrogen excretion factors for cattle, horses, sheep, goats and rabbits are used as described in the Manure Action Plans (MAP2bis |
| Denmark | N-excretion (kg N/head/yr) is weighted values from the following categorisation: Non-dairy cattle: Calves, Bulls, Heifers and Suckling Cattle, Sheeps, Goats, Swine: Piglets, Slaugthering pigs, Fur animals, Poultry: Broilers, Hens, Ducks, etc. The variations in N-excretion in the time-series reflect changes in feed intake, fodder efficiency and allocation of subcategories. The Danish N-excretion levels are generally lower than IPCC default values. This is due to the highly skilled, professional and trained farmers in Denmark, with access to a highly competent advisory system. |
| Finland | Annual N excretion per animal for cattle, sheep, swine, horses, poultry and fur animals has been calculated by animal nutrition experts of MTT Agrifood Research Finland (Nousiainen, J. pers.comm.). Values for annual N excretion (Nex) are based on calculations on N intake-N retention for typical animal species in typical forage system. Annual nitrogen excretion per animal and in the case when animals are kept less than one year in farms (swine, poultry), replacement of animals with new ones has been taken account in the calculations. For reindeer, values for goats have been used. N-excretion for Fur animals is average of two sub-categories: Minks and Fitches and Fox and Racoon. |
| Germany | *Dairy cattle*: N-excretion factors are calculated on the basis of milk productivity, protein content of the milk, the weight, number of births and the composition of the rations. *Non-dairy cattle*: feed compisition, daily weight gain and live weight. *Swine and hens*: N-excretion is calculated on the basis of productivity (number of births or weight gain), the weight and the feed composition. For Dairy cattle and national data for other animals. Country-specific data for other animal categories. Values for the content of total ammoniacal nitrogan (TAN) were estimated for Cattle, Swine, Sheep, Horses, and Poultry. Other parameter required for the estimation of $N_2O$ emission (the effective surface area, the ventilation conditions and the temperature during storage) are not available. |
| Greece | N excretion for dairy cattle value referring to West Europe countries was used taking into account that the dairy milk production in Greece has increased to levels similar to those of Western Europe. Moreover, for other cattle and buffalo N excretion values for dairy cattle referring to West Europe countries were used. For the rest of the animals N excretion value referring to Mediterranean countries was used. Finally, for the estimation of other cattle and sheep N excretion, the adjustment factors for young animals proposed by IPCC guidelines (Table 4.14, IPCC 1997) were used. |
| Ireland | For Cattle, the excretion rates are consistent with the nitrogen content of Cattle feeds and the quantities excreted by the animal, as analysed in conjunction with the determination of Tier 2 $CH_4$ emission factors for Cattle. The published nitrogen excretion rates are used along with the information on the allocation of animal manures to each applicable animal waste management system from the Farm Fatility Survey. The nitrogen excretion rates of 92.5 and 50 kg/N for Dairy Cattle and Other Cattle, respectively, taken from the REPS survey data are close to the upper end of the range reported for typical Irish farming systems (Mulligan, 2002; Hynds, 1994). These findings indicate that Dairy Cows producing 4,200, 5,600 and 7,000 kg of milk per year in Ireland excrete 82, 89 and 96 kg N, respectively while excretion rates for beef cattle are highly variable and range from 27 kg N to 69 kg N per year depending on performance level and age. The IPCC default nitrogen excretion rates of 8, 12 and 0.6 kg are used for S |
| Italy | Country-specific N-excretion data (Inter-regional nitrogen balance project results, CRPA, 2006; Xiccato et al., 2005). The nitrogen balance project involved Emilia Romagna, Lombardia, Piemonte and Veneto regions, where animal breeding is concentrated. The nitrogen balance methodology was followed, as suggested by IPCC. N-excretion rates are time-dependent for cattle, buffalo, and pigs. |
| Luxembourg | The nitrogen excretion per AWMS cannot be calculated since the nitrogen excretion per head of animal is not yet estimated for Luxembourg. The default factors suggested for Western Europe in the IPCC Guidelines have to be further investigated to decide whether or not they might be applied to Luxembourg's situation as regards manure management of animals. |
| Netherlands | Standard factors for manure production and manure N-excretion per animal per animal category and per manure management system are calculated by Netherlands Statistics and decided on by WUM (Working group for Uniform calculations on Manure- and minerals) annually, based on specific data such as milk yield. More specified data on manure management are based on statistical information on management systems and is documented (Van der Hoek, 2006). http://www.greenhousegases.nl/documents/4B_N$_2$O_manure.pdf |
| Portugal | Country-specific nitrogen excretion factors (Ministry of Agriuclture). The nitrogen excretion rates reflect the analysis results obtained in the Laboratory Rebelo da Silva, complement with international sources such as (Ryser, 1994) and data submitted by other countries. These rates are considered more representative of the national conditions than those that were formely submitted and which was set from information received from the Agriculture Ministry (Seixas, 2000). The nitrogen rates are presented in next table together with the default nitrogen excretion rates from IPCC for Western Europe. There is an acceptable agreement between country-specific values and IPCC defaults for all species other than Sheep, Goats and Equines. |

| | |
|---|---|
| Spain | National N-excretion factors for cattle, sheep, swine and poultry. For the other animal types IPCC facotr for the "Near East & Mediterranean" climate region and applying age-related correction factors. |
| Sweden | The Swedish Board of Agriculture publishes data on manure production from most of the aniumal subgroups included in the inventory. The given values are according to the STANK model, which is the official model for input/output accounting on farm level (Linder, 2001). They are a function e. g. of milk productivity for dairy cattle, age and number of production cycles for pigs etc. |
| United Kingdom | Nitrogen excretion factors for dairy cattle take into account the animal weight. |

The following outliers can be identified:

- **IEF – Solid Manure, Germany**
  Nitrogen in bedding material is considered when calculating $N_2O$ emissions from solid manure. The IEF is therefore higher than each partial EF by management system.

**Trends**

The decreases in $N_2O$ emissions of 13% (total; 6% in liquid systems and 17% for solid systems) are mainly due to decreases in nitrogen excretion. For liquid systems, the implied emission factor increases (a decrease by 19% is estimated for Denmark and an increase for Germany by 7% and for the Netherlands by -14%); so that the decrease in $N_2O$ emissions is buffered. For solid systems, a change in the IEF between 1990 and 2009 has been reported for Finland (increase of 8%), Germany (decrease of 12%), and the Netherlands (decrease of 4%).

Figure 6.20 through Figure 6.26 show the trend of the nitrogen excretion rate per head and the nitrogen managed in solid storage and dry lot systems. The trend in emissions is driven by animal numbers, animal performance (nitrogen excretion) and the distribution of manure over the manure management systems, which have been discussed above. The effect of the AWMS is contrary to that observed for the methane emissions.

The category “other“ animal waste management systems for Italy is reported for the years 1995 onwards only in the Italian inventory. This nitrogen excretion refers to poultry manure that is undergoing a drying-process. This system has been widely used from 1995 (CRPA, 2000).

Nitrogen excretion for buffalo is reported for Germany (buffalo are occurring from 1996 onwards), Italy and Greece only. While Greece and Germany use a constant excretion factor of 70.0 and 82.0 kg N $head^{-1}$ year-1, respectively, the N excretion of buffalo varies significantly in Italy with values between 92 and 107 kg N $head^{-1}$ year-1. The N-excretion values result from the weighted average of cow buffalo and other buffaloes and the variability is due to the interannual variation of the proportion of the two livestock number as published by the National Institute of statistics. Cow buffaloes have a higher N excretion, comparable with dairy cows, because they are prevalently breeded for milk production (mozzarelle di bufala).

Table 6.50 gives additional information on the trend in category 4B(b) as reported in the national inventory reports.

**Table 6.50 Member State's background information on the trend for $N_2O$ emissions in category 4B(b).**

| Member State | Trend in category 4B(b) |
|---|---|
| Austria | Emissions of Cattle dominate the trend. From 1990 to 2007 the $N_2O$ emissions from Manure Management decreased by 12.7% to 2.8 Gg. The reduction of diary cows is partly counterbalanced by an increase in emissions per animal (because of the increasing gross energy intake, milk production and N excretion of diary cattle since 1990). |
| Denmark | This reduction in the total amount of nitrogen in manure despite the increasing production of pigs and poultry is particularly due to an improvement in fodder efficiency, especially for slaughter pigs. An increase of the EF for swine has been observed between 2007 and 2008 (6%). This is due to changes in the allocation between the subcategories sows, slaughter pigs and piglets. Looking at the time serie for EF similar changes is seen, for example between 1993 and 1994 (increase by 7%), 2000-2001 (decrease by 5%) and 2004-2005 (decrease by 6%). |
| Finland | The fluctuation in $N_2O$ emissions is related to both changes in animal numbers, which is largely dependent on agricultural policy, as well as changes in the distribution of manure management systems used. Slurry-based systems increase methane emissions per animal tenfold compared to the solid storage or pasture. |
| Italy | N-excretion in the category Other has been not reported in 1990-1994. The chicken-dung drying process system has been widely used only since 1995 onwards. |
| Netherlands | The relatively large decrease in $N_2O$ emissions of solid manure in 2003 is a direct result of the decrease in poultry animal manure. This decrease was due to the reduction in the number of poultry animals that followed the avian flu epidemic. In 2004 and 2005, $N_2O$ emissions increased once again following the recovery of poultry animal numbers, while in 2006 the emission decreased as a consequence of lower poultry numbers. In 2007 emissions increased as a result of increasing animal population and higher N excretion per animal. The slightly increase $N_2O$ emissions from manure management over the whole time series is explained by a higher IEF partly counteracted by a decrease in N excretion in the stable. The interannual decrease of N-excretion in 2008/2009 is 6%. Technical information on the composition of rations and their mineral content are taken into consideration, and therefore N-excretion can vary from year to year. In 2009 considerably more maize silage was available, filling in almost equal energy requirements replacing grass (which has more than double the N-content of maize). |
| Sweden | The $N_2O$ emissions have decreased since 1990, mainly because of a change from solid manure management to slurry management in dairy and pork production. An increase in the production cycles per year from 2.5 to 3 for pigs for meat production causes an increase in the nitrogen excretion for swine in 2001-2002 by 16%. |

**Figure 6.20 Trend of nitrogen excretion rates for dairy cattle**

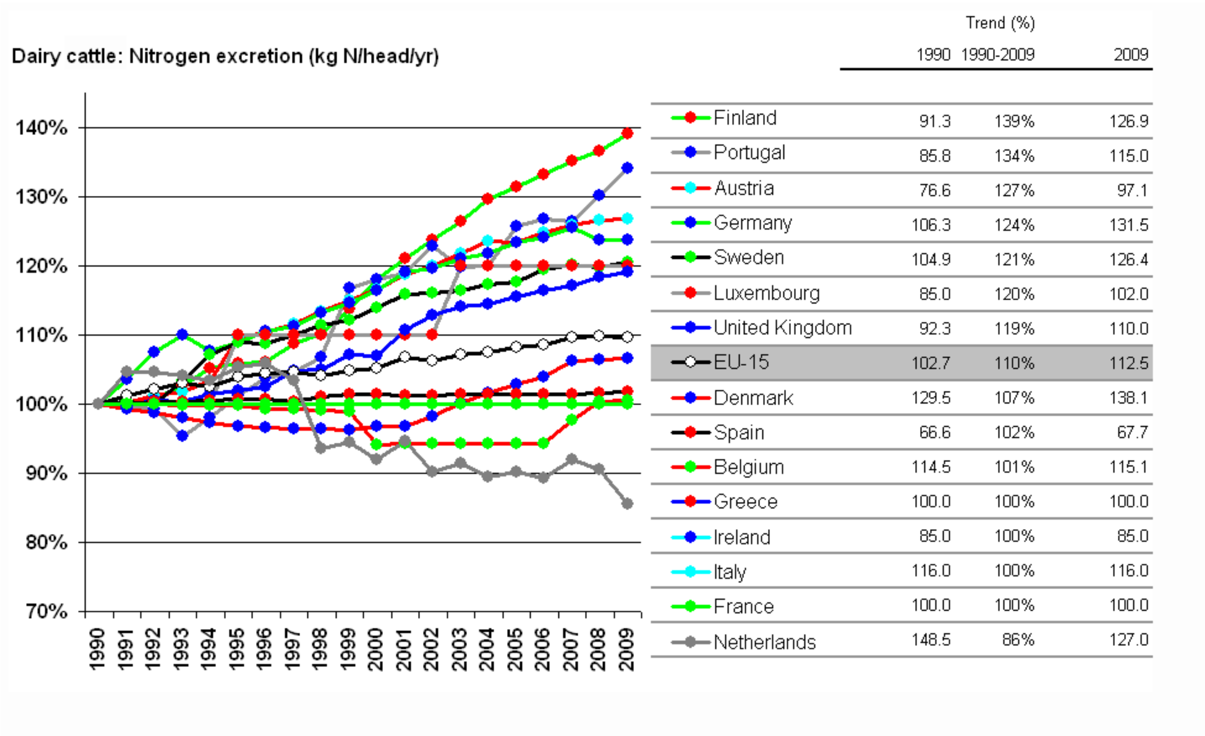
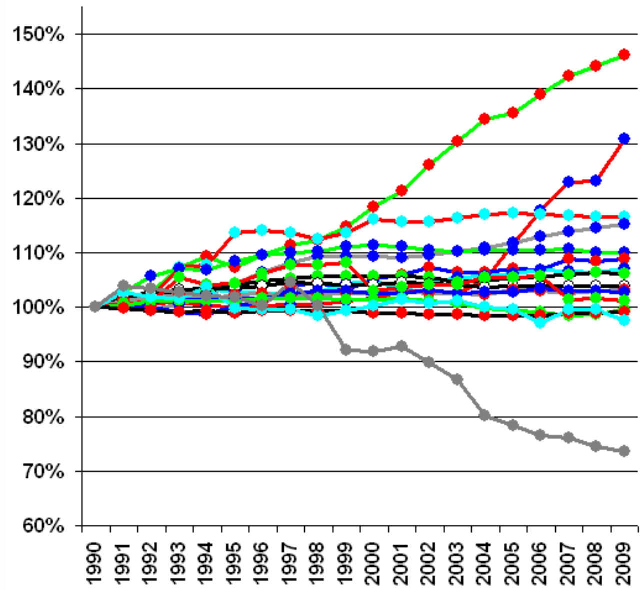


**Figure 6.21 Trend of nitrogen excretion rates for non-dairy cattle:**

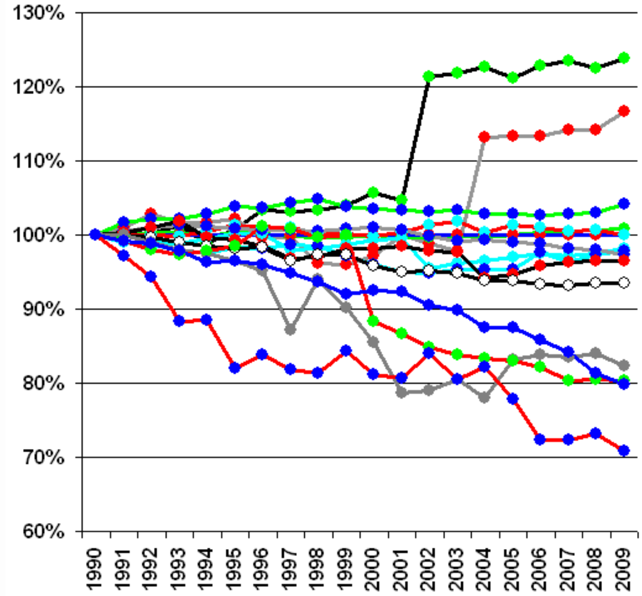
Non-dairy cattle: Nitrogen excretion (kg N/head/yr)




| | 1990 | Trend (%) 1990-2009 | 2009 |
|---|---|---|---|
| Finland | 34.3 | 146% | 50.2 |
| Denmark | 36.6 | 131% | 47.8 |
| Austria | 40.0 | 117% | 46.6 |
| Portugal | 44.4 | 115% | 51.2 |
| Germany | 37.1 | 110% | 40.8 |
| Greece | 41.7 | 109% | 45.4 |
| Ireland | 45.6 | 107% | 48.9 |
| Sweden | 39.3 | 106% | 41.7 |
| EU-15 | 47.4 | 104% | 49.2 |
| Luxembourg | 45.8 | 103% | 47.2 |
| United Kingdom | 53.8 | 103% | 55.3 |
| Belgium | 53.7 | 101% | 54.3 |
| France | 57.8 | 100% | 57.5 |
| Spain | 53.1 | 99% | 52.6 |
| Italy | 50.0 | 97% | 48.7 |
| Netherlands | 56.9 | 74% | 41.8 |

**Figure 6.22 Trend of nitrogen excretion rates for swine**

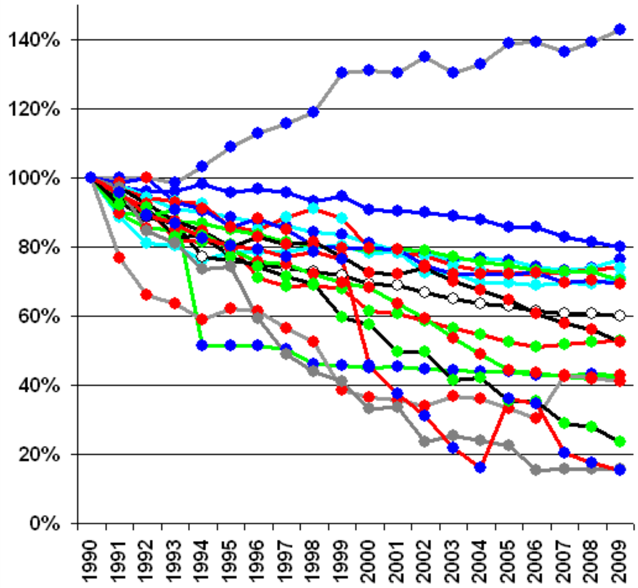
Swine: Nitrogen excretion (kg N/head/yr)




| | 1990 | Trend (%) 1990-2009 | 2009 |
|---|---|---|---|
| Sweden | 7.4 | 124% | 9.1 |
| Luxembourg | 10.2 | 117% | 11.9 |
| Germany | 11.7 | 104% | 12.1 |
| France | 16.3 | 101% | 16.5 |
| Greece | 16.0 | 100% | 16.0 |
| Austria | 9.6 | 100% | 9.6 |
| Italy | 12.0 | 98% | 11.8 |
| Ireland | 8.7 | 98% | 8.5 |
| Portugal | 9.8 | 97% | 9.5 |
| Spain | 9.7 | 97% | 9.4 |
| EU-15 | 11.4 | 93% | 10.6 |
| Netherlands | 10.8 | 82% | 8.9 |
| Belgium | 12.5 | 80% | 10.1 |
| United Kingdom | 13.3 | 80% | 10.6 |
| Denmark | 11.8 | 71% | 8.4 |
| Finland | | | |

**Figure 6.23 Trend of N managed in solid storage and dry lot, dairy cattle**

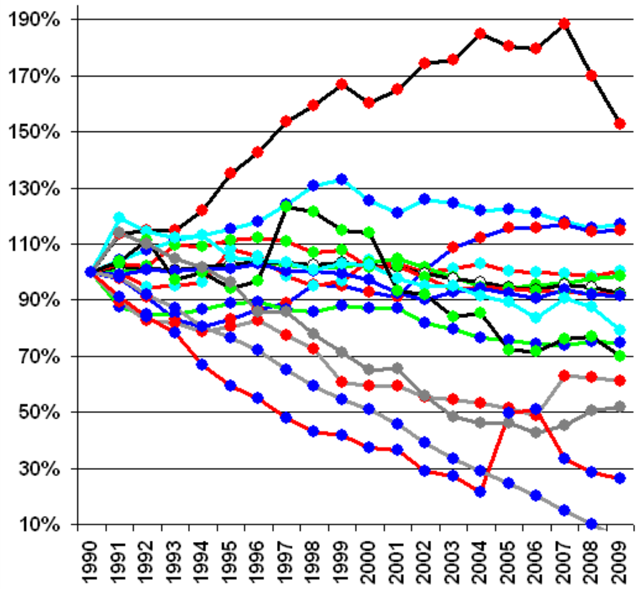
Dairy cattle: Nitrogen managed in solid storage systems (Gg N/yr)




| | 1990 | Trend (%) 1990-2009 | 2009 |
|---|---|---|---|
| Portugal | 11.8 | 143% | 16.9 |
| United Kingdom | 24.5 | 80% | 19.6 |
| Ireland | 2.3 | 76% | 1.8 |
| Austria | 34.3 | 74% | 25.4 |
| Italy | 174.9 | 71% | 124.4 |
| France | 225.1 | 70% | 158.5 |
| Greece | 19.1 | 69% | 13.2 |
| EU-15 | 845.4 | 60% | 506.6 |
| Belgium | 25.9 | 53% | 13.7 |
| Spain | 64.3 | 53% | 33.9 |
| Germany | 180.7 | 43% | 77.3 |
| Finland | 22.9 | 43% | 9.8 |
| Luxembourg | 1.6 | 41% | 0.7 |
| Sweden | 31.4 | 24% | 7.4 |
| Netherlands | 13.6 | 16% | 2.1 |
| Denmark | 13.0 | 15% | 2.0 |

**Figure 6.24 Trend of N managed in solid storage and dry lot, non-dairy cattle**

Non-Dairy cattle: Nitrogen managed in solid storage systems (Gg N/yr)




| | 1990 | Trend (%) 1990-2009 | 2009 |
|---|---|---|---|
| Spain | 57.7 | 153% | 88.1 |
| Ireland | 19.2 | 117% | 22.5 |
| Greece | 12.4 | 115% | 14.2 |
| Austria | 29.8 | 100% | 29.9 |
| France | 273.5 | 99% | 270.0 |
| EU-15 | 806.5 | 92% | 745.2 |
| Belgium | 48.2 | 92% | 44.4 |
| United Kingdom | 78.4 | 91% | 71.7 |
| Italy | 101.8 | 79% | 80.7 |
| Germany | 130.0 | 75% | 97.1 |
| Sweden | 15.0 | 70% | 10.5 |
| Luxembourg | 2.3 | 61% | 1.4 |
| Netherlands | 26.5 | 52% | 13.7 |
| Denmark | 1.9 | 27% | 0.5 |
| Portugal | 9.7 | 5% | 0.5 |
| Finland | | | |

**Figure 6.25** **Trend of N managed in solid storage and dry lot, swine**

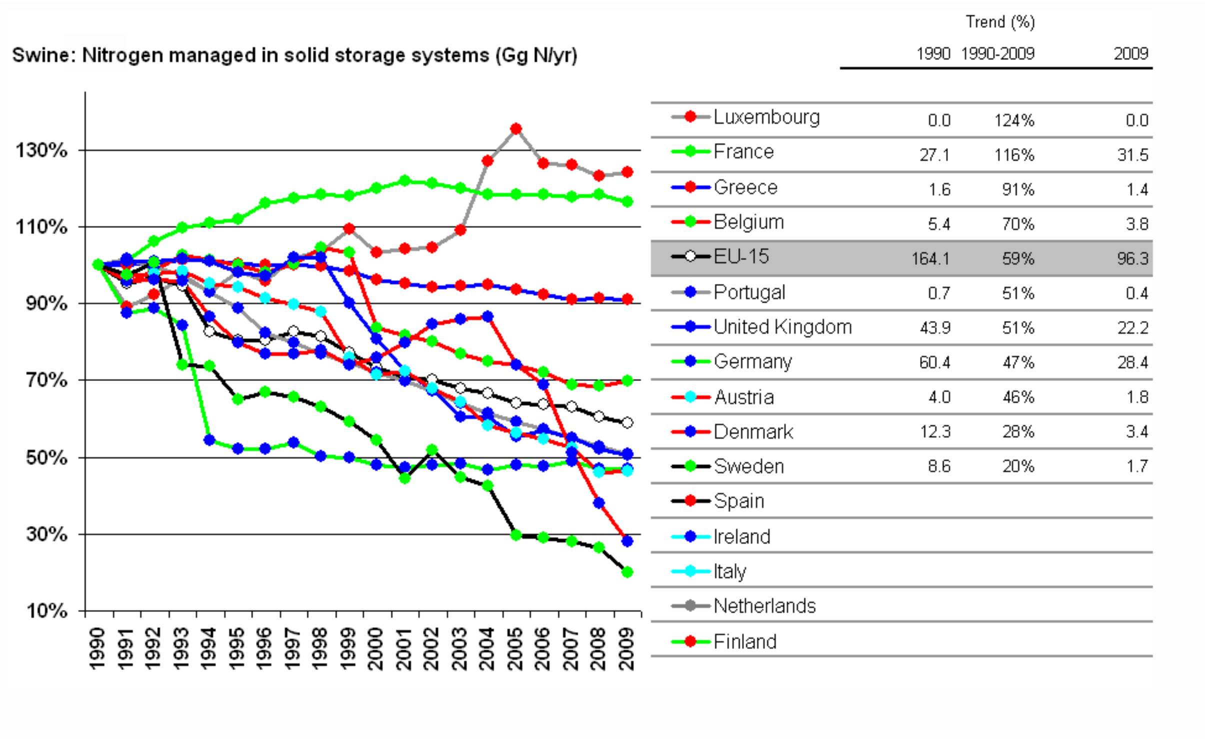
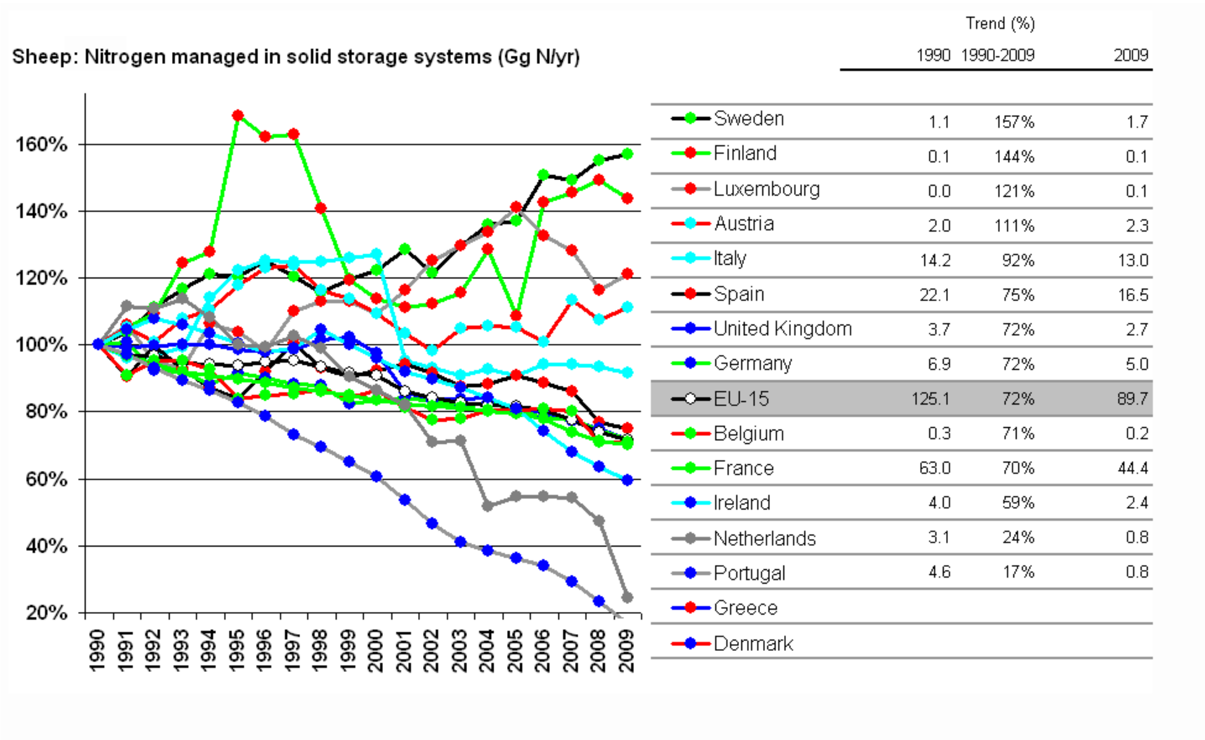



**Figure 6.26** **Trend of N managed in solid storage and dry lot, sheep**



### 6.3.3.3 Uncertainty and time series consistency

Activity data used for the estimation of $N_2O$ emissions from manure management are generally analog to those used for the estimation of $CH_4$ emissions, and consequently also the uncertainty estimates are similar. The uncertainty of the emission factor is much higher than the uncertainty of the activity data, and only Germany has estimated an uncertainty lower than 50%. Generally an uncertainty of 100% is assumed, the United Kingdom assume high uncertainty with 414%.

Nevertheless, $N_2O$ emissions from manure management are representing only a small fraction in most inventories, so that the contribution to the overall uncertainty remains in most cases small, i. e. 0.5% of total emissions or less. Only Austria and United Kingdom report a higher contribution of $N_2O$ emissions from manure management to the overall uncertainty with 1.2% and 1.5% of total emissions, respectively.

An overview of the uncertainty estimates for activity data and emission factors are given in Table 6.51. An overview of uncertainty estimates for agriculture at country and EU15 levels will be given in 6.4

Table 6.52 compiles some background information on the estimates of the uncertainty of the values used as activity data and emission factors to estimate $N_2O$ emissions from manure management.

**Table 6.51 Relative uncertainty estimates for activity data and implied emission factors in category 4B(b) (data from 2007 submission)**

| Member State 2009 | AD | IEF |
|---|---|---|
| Austria | 10.0 | 100.0 |
| Belgium | 10.0 | 90.0 |
| Denmark | 22.4 | 50.0 |
| Finland | | 82.0 |
| France | 5.0 | 50.0 |
| Germany | 4.7 | 40.3 |
| Greece | 50.0 | 100.0 |
| Ireland | 11.2 | 86.3 |
| Italy | 20.0 | 100.0 |
| Luxembourg | | |
| Netherlands | 10.0 | 100.0 |
| Portugal | 38.9 | 97.1 |
| Spain | 16.0 | 100.0 |
| Sw eden | 20.0 | 50.0 |
| United Kingdom | 1.0 | 414.0 |

**Table 6.52 Member State's background information for uncertainty estimates in category 4.B(b)**

| Member State | Background information to uncertainy estimates |
|---|---|
| Austria | **Emission Factor:** Based on the identical animal numbers, uncertainties of emission factors for $CH_4$ from manure were assessed at 70% (AMON et al. 2002), and for $N_2O$ emissions a lognormal distribution with a low at 50% and a high of 200% of the best estimate was chosen derived from IPCC, 2000. |
| Belgium | **Emission Factor:** The IPCC emission factors are used to calculate the emissions of $N_2O$. Consequently, the IPCC uncertainty in combination with information of the Finnish emission inventory, are used in the uncertainty calculation. |
| Denmark | **Activity Data:** The normative figures (Poulsen et al. 2001) are arithmetic means. Based on the feeding plans, the standard deviation in N-excretion rates between farms can be estimated to ±20 % for all animal types (Hanne D. Poulsen, FAS, pers. comm). |
| Finland | **Activity Data:** The amount of N excreted annually by the reindeer is very uncertain. Currently, because of lack of data, the value for goats has been used.<br>**Emission Factor:** The uncertainty estimate for $N_2O$ emissions from manure management used a negatively skewed distribution based on different studies (Amon et al., 2001; Huether, 1999). The uncertainty of the $N_2O$ emission factor could probably be reduced by gathering more national data from gas flux measurements. |
| Portugal | **Activity Data:** The uncertainty in N-excretion rate was set at 37.5 per cent, considering an intermediate situation between the |

| | |
|---|---|
| | uncertainty values recommended by GPG for default N-excretion rates (50 per cent) and the lower uncertainty when country-specific values are based on accurate national statistics (25 per cent).<br>**Emission Factor:** The uncertainty in $N_2O$ emission factors was set in accordance with the maximum values, 100 per cent for all MMS. |

The following issues related to time-series consistency are identified:

- **Denmark: N-excretion rate increases by 18% from 2006 to 2007**
  Adjustment of N ab animal is done by FAS and it is only done for the year 2007. In cooperation with FAS we will attempt to adjust the prior years to ensure time-series consistency.

## *6.3.4 Rice Cultivation*

### 6.3.4.1 Source category description

Anaerobic decomposition of organic material in flooded rice fields produces methane ($CH_4$), which escapes to the atmosphere primarily by transport through the rice plants. The annual amount emitted from an area of rice acreage is a function of rice cultivar, number and duration of crops grown, soil type and temperature, water management practices, and the use of fertilisers and other organic and inorganic amendments.

Rice cultivation is occurring in five EU-15 countries: France, Greece, Italy, Portugal, and Spain. All countries but Italy are reporting rice production under a continuously flooding regime, while in Italy the practice of multiple aeration is predominant. In Italy rice paddies are flooded with 15-25 cm of water usually from April-May to August. During this field submersion time two or three water drainage periods, 2 to 4 days each, can happen in 85% of rice paddies, a clearly uninterrupted submersion in 13-14% and about one month delayed submersion in 1-2%.

At EU-15 level, the implied emission factors amounts to 24 g $m^{-2}$ in 2003 for continuous flooded rice fields, which represents an increase in the implied emission factor by 31% since 1990 (see Table 6.53), which can be explained by the higher contribution of Portugal with an implied EF of 70.1 g $CH_4$ $m^{-2}$ in 2009 compared to 31.9 g $CH_4$ $m^{-2}$ in 1990 . Note that the implied emission factors for intermittently flooded field are stemming from the Italian inventory only. Here it is smaller than the emissions from continuously flooded fields. At the EU-15 level and with the given choices of emission factors by the different countries, however, the average emission from continuous flooded fields appears to be only half of those from single-aerated rice fields.

**Table 6.53 Total $CH_4$ emissions, area harvested and implied Emission Factor for category 4C at EU-15 level for 2009**

| | Continuously Flooded | Intermittently flooded: single aeration | Intermittently flooded: multiple aeration |
|---|---|---|---|
| | 1990 | | |
| Total Emissions of CH4 [Gg CH4] | 29.7 | 0.6 | 73.8 |
| Total Area harvested [$10^9$ $m^2$ $y^{-1}$] | 1.64 | 0.02 | 2.13 |
| Implied Emission Factor [g CH4 / $m^2$] | 18 | 27 | 35 |

| | Continuously Flooded | Intermittently flooded: single aeration | Intermittently flooded: multiple aeration |
|---|---|---|---|
| | 2009 | | |
| Total Emissions of CH4 [Gg CH4] | 41.9 | 14.6 | 60.5 |
| Total Area harvested [$10^9$ $m^2$ $y^{-1}$] | 1.78 | 0.59 | 1.80 |
| Implied Emission Factor [g CH4 / $m^2$] | 24 | 25 | 34 |

| | Continuously Flooded | Intermittently flooded: single aeration | Intermittently flooded: multiple aeration |
|---|---|---|---|
| | 2009 value in percent of 1990 | | |
| Total Emissions of CH4 [Gg CH4] | 141% | 2407% | 82% |
| Total Area harvested [$10^9$ $m^2$ $y^{-1}$] | 108% | 2618% | 84% |
| Implied Emission Factor [g CH4 / $m^2$] | 131% | 92% | 97% |

### 6.3.4.2 Methodological Issues

#### Methods

A summary of the methodologies used for the calculation of $CH_4$ emissions from rice cultivation is given in Table 6.54. More detailed data are given in the section on the emission factors.

**Table 6.54 Additional information in the methodology used for the calculation of $CH_4$ emissions in category 4.C in 2009**

| Member State | Method |
|---|---|
| France | Default EF, non key source, IPCC methodology. Statistic from the Ministry of Agriculture. |
| Greece | In order to estimate methane emissions from rice cultivation, the default methodology suggested by the IPCC Good Practice Guidance was followed. The cultivated areas provided by the NSSG and the default emission factor (20 g $CH_4$ / $m^2$) were used for the emissions calculation. Rice cultivated in Greece is grown in continuously flooded fields without the use of organic amendments and one cropping period is considered annually. |
| Italy | According to specific characteristics of rice cultivation in Italy, methane emissions from rice cultivation are estimated only for an irrigated regime, other categories suggested by IPCC (rainfed, deep water and “other”) are not present. Methane emission factor has been adjusted with the following parameters: daily integrated emission factor for continuously flooded fields without organic fertilisers, scaling factor to account for the differences in water regime in the rice growing season (SFw), scaling factor to account for the differences in water regime in the preseason status (SFp) and scaling factor which varies for both types and amount of amendment applied (SFo) (Yan et al., 2005). Futher, the following national cirumstances are considered: cultivation period of rice (days) and annual harvested area under specific condictions. In Italy, rice is sown from mid-April to the end of May and harvested from mid-September to the end of October; the only practised system is the controlled flooding system, with variations in water regimes (Tossato and Regis, 2002; Mannini, 2004; Confalonieri and bocchi, 2005; Regione Emilia Romagna ,2005)<br>In Italy, three types of rice cultivation are distinguished: Wet-seeded "classic" cultivation, Wet-seeded "red rice control" cultivation and dry-seeded with delayed flooding. The wet-seeded cultivation methods fall into the IPCC category of 'multiple aeration' while the dry-seeded cultivation method is intermittently aerated one once. A detailed description of the management is given in the national inventory report. |
| Portugal | Methane emissions from rice production were estimated following the GPG, but simplified because there are no appreciable differentiation in Portugal in what concerns water management regimes or any other conditions that are known to affect emissions from this source sector. A regional specific seasonally integrated emission factor for continuously flooded fields without organic amendments (Efc) of 31.9 $g/m^2/yr$ was used, based on Schuetz (1989). Rice culture in Portugal is almost homogeneous, in what concerns hydrologic management regime and characterized by cultivation being done under irrigated continuous flooded areas (SFw is set to 1). Traditionally, stubbles and straw were burnt between crops, the use of rice straw as fodder or bedding is not significant (Portuguese Ministry of Agriculture). More recently the agricultural practices have changed. It became more common to left the straw on ground and incorporate it into soil by plowing. This is the only procedure allowed for rice cultivation subject to the "Techniques of Integrated Production and Protection"), which occupied about 60 per cent of rice paddies in 2004. A time series for the scaling factor reflecting organic amendments S0 was developed assuming that, in 1990, 100% of rice paddies were burnt and no organic amendments were added to soil. In 2008 the area subjected to burning was reduced to only about 33 per cent. |
| Spain | The rice cultivation is not key source, EFs: IPCC default, methodology default. |

#### Activity Data

Italy is by far the largest producer of rice in Europe, with 2385 $km^2$ of rice cultivation, followed by Spain with an area of 955 $km^2$ (2009 data). The other three countries have rice producing areas around 200 $km^2$, as shown in Table 6.55 for the rice cultivation practices continuously flooded, intermittently flooded with single aeration, and intermittently flooded with multiple aerations.

**Table 6.55** **Harvested Area Rice in the Member States in 2009 and 1990**

| Member State 2009 | Harvested area [$10^9$ $m^2$] | | |
|---|---|---|---|
| | Continuously Flooded | Intermittently flooded: single aeration | Intermittently flooded: multiple aeration |
| France | 0.26 | NO | NO |
| Greece | 0.28 | NO | NO |
| Italy | NO | 0.59 | 1.80 |
| Portugal | 0.28 | NO | NO |
| Spain | 0.95 | NO | NO |
| EU-15 | 1.78 | 0.59 | 1.80 |

| Member State 1990 | Harvested area [$10^9$ $m^2$] | | |
|---|---|---|---|
| | Continuously Flooded | Intermittently flooded: single aeration | Intermittently flooded: multiple aeration |
| France | 0.24 | NO | NO |
| Greece | 0.16 | NO | NO |
| Italy | NO | 0.02 | 2.13 |
| Portugal | 0.34 | NO | NO |
| Spain | 0.90 | NO | NO |
| EU-15 | 1.64 | 0.02 | 2.13 |

Information source: CRF Table 4.C for 2009 and 1990, submitted in 2011
Abbreviations explained in the Chapter 'Units and abbreviations'.

## Emission Factors and other parameters

A summary of the implied emission factors used by these countries is given in Table 6.56. France and Greece are using IPCC default emission factors presented in the IPCC *Good Practice Guidance*. This value is the arithmetic mean of the seasonally integrated emission factors presented in Table 4-13 of the IPCC *Guidelines*. In this Table, a value from Schuetz et al (1989) is also presented (36 g $m^{-2}$, range 17-54 g $m^{-2}$, representing a seasonally averaged emission factor). In Italy, a daily integrated emission factor for continuously flooded fields without organic fertiliser (Schuetz et al., 1989; Leip et al., 2002) have been adjusted to account for differences for three different cultivation types (see Table 6.54) Spain uses a seasonal emission factor of 12 g $m^{-2}$, which has been obtained from Table 4-9 of the IPCC *Guidelines* reporting a study carried out in Spain (Seiler et al., 1984); the value used by Portugal in 1990 and 200 are the above-mentioned value of 36 g $m^{-2}$ measured by Schuetz et al. (1989).

**Table 6.56** **Implied Emission factors for $CH_4$ emissions from rice cultivation used in Member State's inventory**

| Member State 2009 | Implied EF (g $CH_4 \cdot m^{-2}$) | | |
|---|---|---|---|
| | Continuously Flooded | Intermittently flooded: single aeration | Intermittently flooded: multiple aeration |
| France | 20.00 | NO | NO |
| Greece | 20.00 | NO | NO |
| Italy | NO | 24.96 | 33.67 |
| Portugal | 70.1 | NO | NO |
| Spain | 12.00 | NO | NO |
| EU-15 | 23.57 | 24.96 | 33.67 |

| Member State 1990 | Implied EF (g $CH_4 \cdot m^{-2}$) | | |
|---|---|---|---|
| | Continuously Flooded | Intermittently flooded: single aeration | Intermittently flooded: multiple aeration |
| France | 20.00 | NO | NO |
| Greece | 20.00 | NO | NO |
| Italy | NO | 27.14 | 34.60 |
| Netherlands | NO | NO | NO |
| Portugal | 31.9 | NO | NO |
| Spain | 12.00 | NO | NO |
| EU-15 | 18.06 | 27.14 | 34.60 |

Information source: CRF Table 4.C for 2009 and 1990, submitted in 2011
Abbreviations explained in the Chapter 'Units and abbreviations'.

## Trend

The trend in rice growing areas in these countries is divers: while in Italy, the area cultivated with rice fluctuated since 1990, its level was in 200 was 11% larger than in 1990. The harvested area in Spain increased from 1990 to 200 by 6%, but around 1993-1995 rice production was only half of the area in 1990; also Greece increased its rice production since 1990 by 70%. The trend was opposite in France with peaks in rice production during 1993-1995 and in 200 the level was about 10% lower than in 1990. Finally, Portugal saw a decline in rice production by 17% since 1990.

There was a considerable increase in the implied emission factor used by Portugal from 31.9 g $CH_4$ $m^{-2}$ $yr^{-1}$ in 1990 to 70.1 g $CH_4$ $m^{-2}$ $yr^{-1}$ in 2009. The reason is the increase of organic amendment to rice paddies in this time period. In 1990 it can be assumed that 100% of the rice paddies were burned and no organic amendment was added to the soils. However, the "Techniques of Integrated Production and Protection" allow only to incorporate the straw by ploughing. In 2004, 60% of the rice cultivation area was subject to these "Techniques"

**Figure 6.27 Trend of continuous flooded rice cultivation – area harvested**

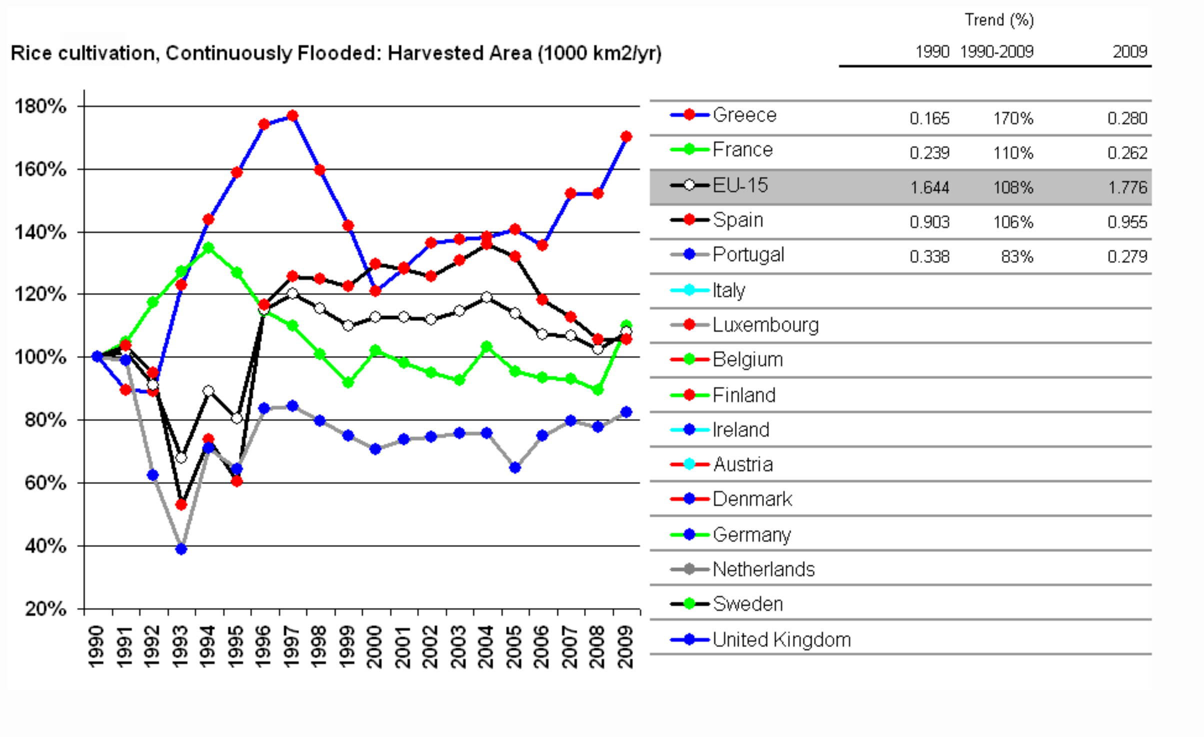



**Figure 6.28 Trend of intermittently flooded (single aeration) rice cultivation – area harvested**

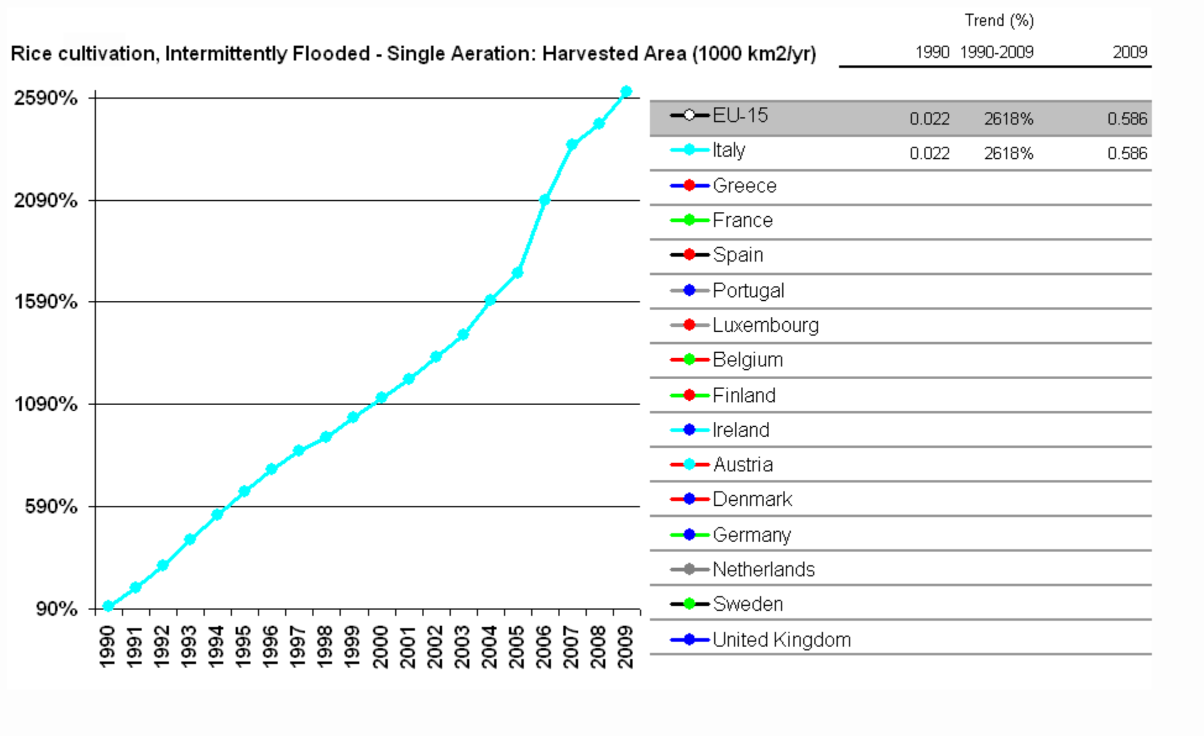


**Figure 6.29 Trend of intermittently flooded (multiple aeration) rice cultivation – area harvested**

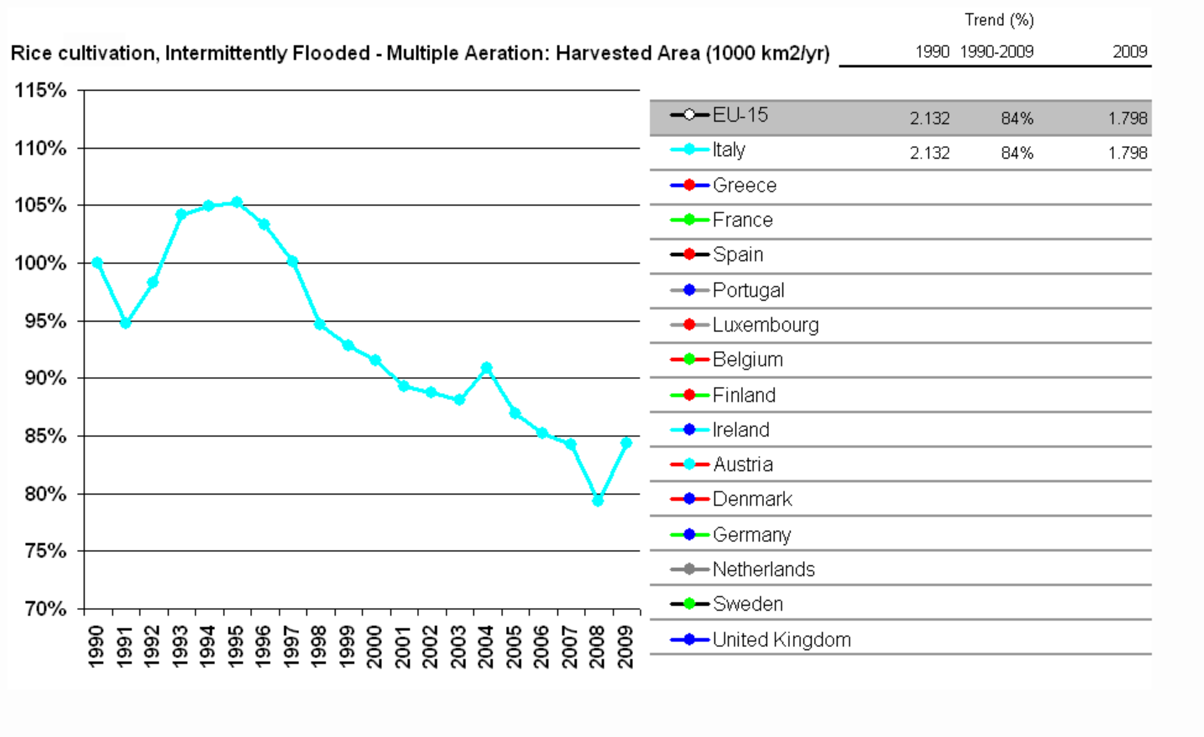



**Figure 6.30 Trend of continuous flooded rice cultivation – implied emission factor**

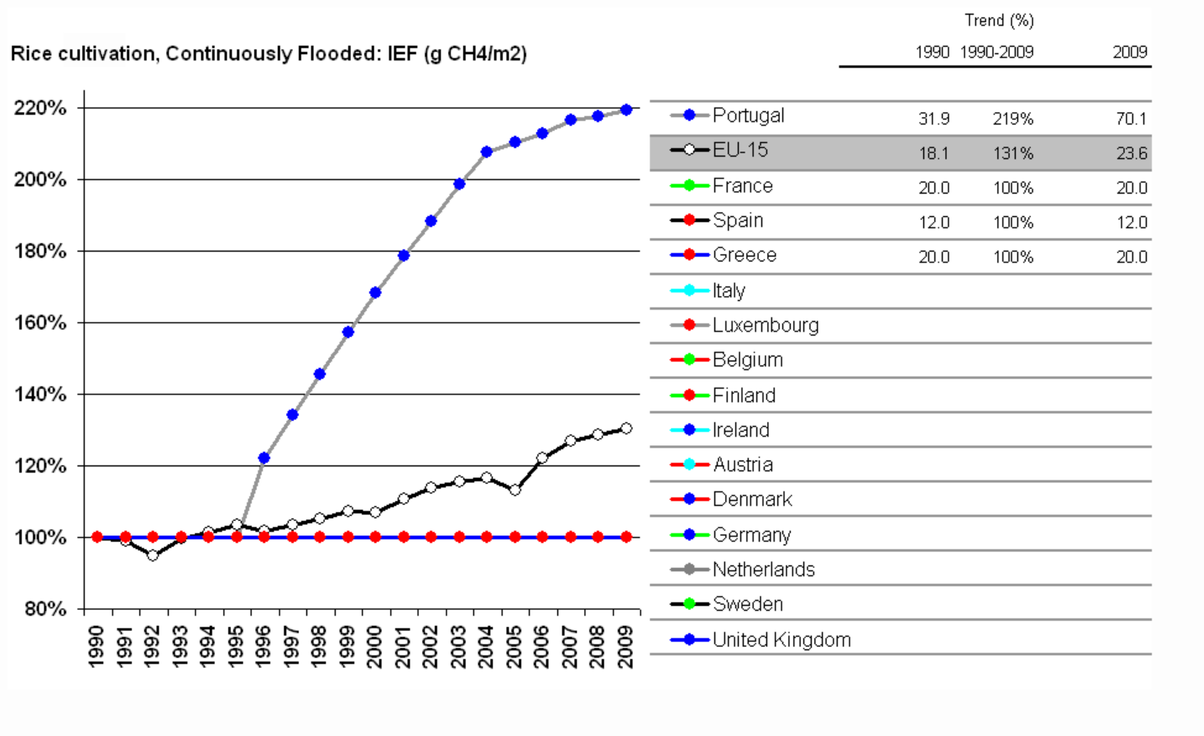


**Figure 6.31 Trend of intermittently flooded (single aeration) rice cultivation – implied emission factor**

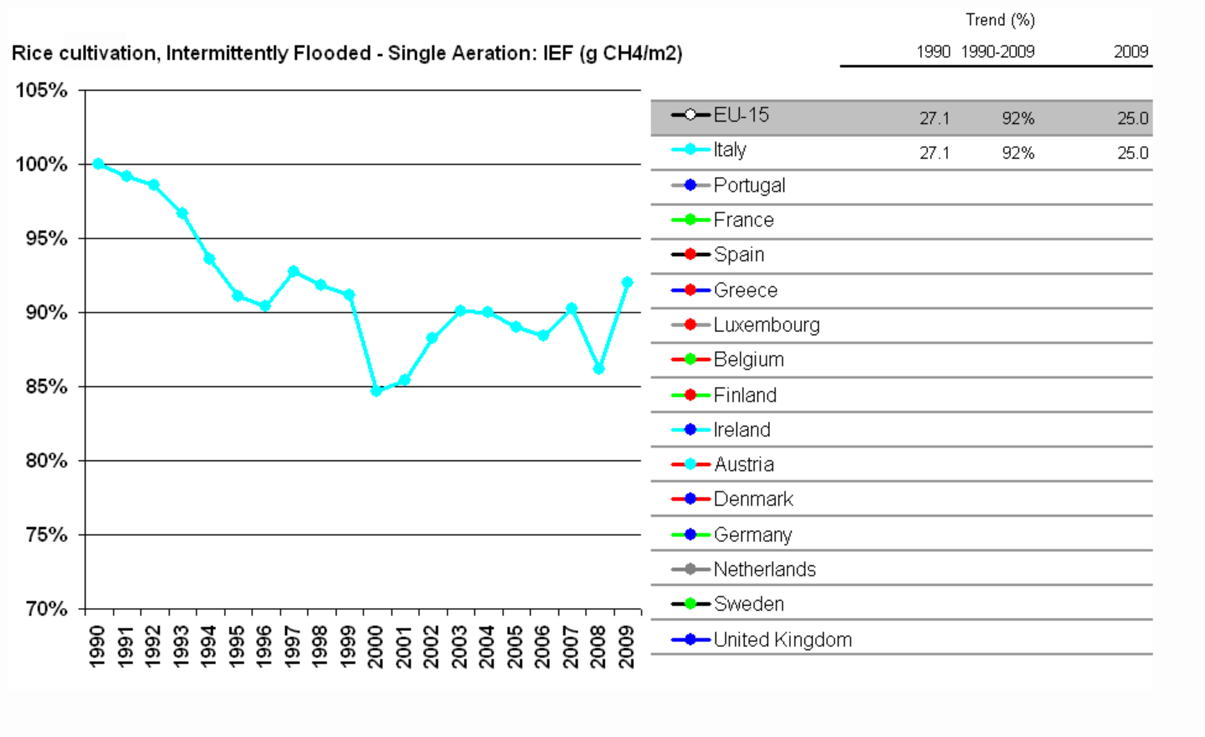
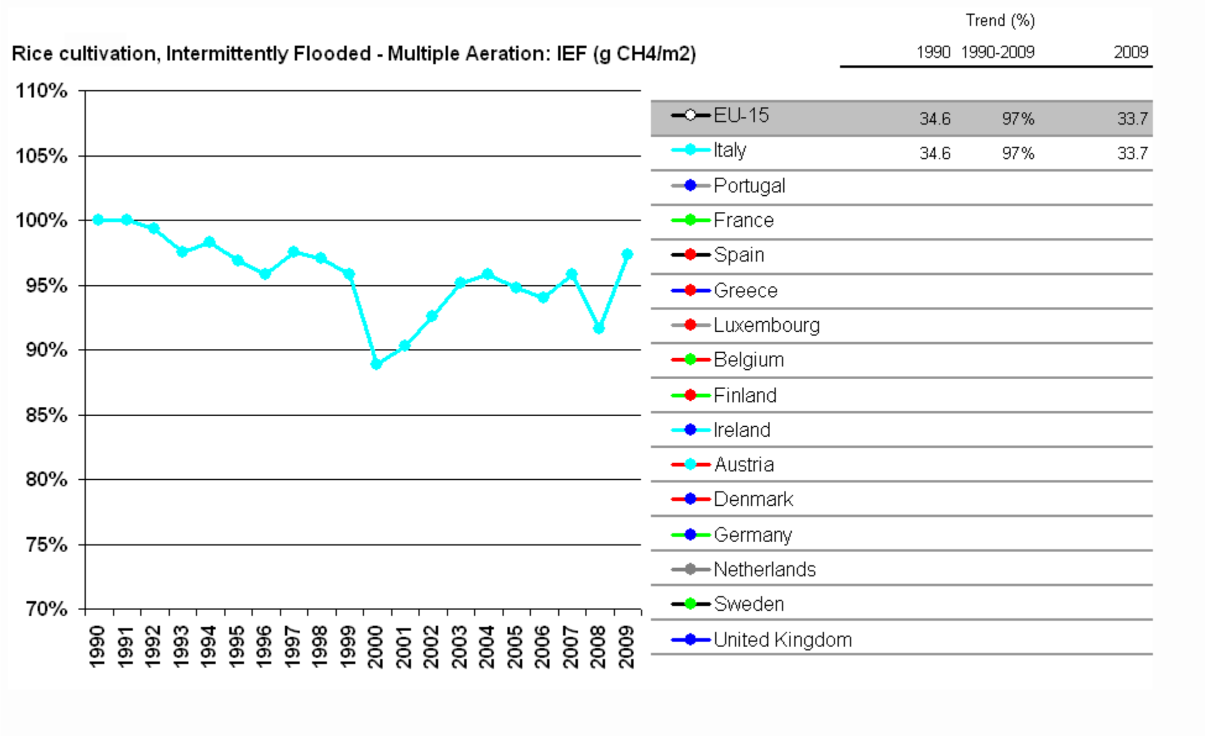



**Figure 6.32 Trend of intermittently flooded (multiple aeration) rice cultivation – implied emission factor**



### 6.3.4.3 Uncertainty and time series consistency

Uncertainty estimates for $CH_4$ emissions from rice cultivation are reported by three countries (Greece, Italy, and Portugal). The area used for the cultivation of rice is generally well known, only Portugal reports an uncertainty of 37.2%. The uncertainty of the implied emission factor is 40%, Italy uses a national methodology and estimates an uncertainty of 20%. An overview of the estimates is given in Table 6.57.

Table 6.58 compiles some background information on the estimates of the uncertainty of the values used as activity data and emission factors to estimate $CH_4$ emissions from rice cultivation.

**Table 6.57 Relative uncertainty estimates for activity data and implied emission factors in category 4C (data from 2007 submission)**

| Member State<br>2009 | AD | IEF |
|---|---|---|
| Greece | 2.0 | 40.0 |
| Italy | 3.0 | 20.0 |
| Portugal | 37.2 | 40.0 |

**Table 6.58 Member State's background information for uncertainty estimates in category 4.C**

| Member State | Background information to uncertainy estimates |
|---|---|
| Italy | Uncertainty of emissions from rice cultivation has been estimated equal to 20% as a combination of 3% and 20% for activity data and emissions factor, respectively. |
| Portugal | The uncertainty in the adjusted seasonally integrated emission factor was considered to be 40 per cent, according to the range proposed in table 4.22 of the GPG. For activity data, the standard deviation of inter-annual area under rice cultivation was considered, also 40 per cent. |

## *6.3.5 Agricultural Soils - $N_2O$ (Source category 4.D)*

### 6.3.5.1 Source category description

Nitrous oxide is produced naturally in soils through the processes of nitrification and denitrification. Nitrification is the aerobic microbial oxidation of ammonium to nitrate, and denitrification is the anaerobic microbial reduction of nitrate to nitrogen gas (N2). Nitrous oxide is a gaseous intermediate in the reaction sequence of denitrification and a by-product of nitrification that leaks from microbial cells into the soil and ultimately into the atmosphere. One of the main controlling factors in this reaction is the availability of inorganic N in the soil. Therefore, $N_2O$ emissions are reported separately for the main anthropogenic input pathways of nitrogen to the soil, i.e., application of mineral fertilizer nitrogen or nitrogen contained in applied manure, biological nitrogen fixation and nitrogen returned to the soil by the process of mineraliztion of crop residues. Additionally, the emissions of $N_2O$ from manure deposited by grazing animals on pasture, range and paddock are reported here. The emissions of $N_2O$ that result from anthropogenic N inputs or N mineralisation occur through both a direct pathway (i.e., directly from the soils to which the N is added/released), and through two indirect pathways: (i) following volatilisation of $NH_3$ and $NO_x$ from manure managegement and managed soils, and the subsequent redeposition of these gases and their products NH4 + and $NO_3$ - to soils and waters; and (ii) after leaching and runoff of N, mainly as $NO_3$ -, from managed soils.

For EU-15, emissions from all sub-categories in the category 4.D have decreased since 1990 (see Table 6.59). This was most significant for direct emissions from the application of synthetic fertiliser (-31%), followed by indirect emissions from leaching and run-off (-20%) and volatilisation of $NH_3$+$NO_x$ (-22%). In the latter two cases, the reduction of emissions can be explained by a reduction of nitrogen input, as the implied emission factor was not or only slightly (leaching) changing during the reporting period. The reduction of animal manure applied to soils more than counterbalanced the increase in the implied emission factor for animal wastes application so that emission decreased by 6%.

At the aggregated EU-15 level, the implied emission factor for $N_2O$ emissions from the application of manure increased by 4%, caused by strong increase by 132% of the implied emission factor for this source in the Netherlands during 1990 to 2009. This increase is explained from a shift from surface spreading of manure to the incorporation of manure into the soil. In the inventory of the Netherlands, incorporation of manure into soils is accounted for with a higher emission factor of $N_2O$. Incorporation into the soil reduces $NH_3$ emissions.

The decrease in the input of nitrogen to agricultural soils was significant for all sub-categories and was 31% for synthetic fertilizer application, 10% for application of manure, 0% (on average) of the area of histosols cultivated and 13% of nitrogen excreted by grazing animals. This translated to a reduction of volatilized and re-deposited nitrogen by 22% and of the amount of nitrogen leached by 20%.

**Table 6.59 Total $N_2O$ emissions, Total Nitrogen input into agricultural soils and implied Emission Factor for category 4D at EU-15 level in 2009 and 1990 and relative changes**

| 1990 | Synthetic Fertilizer | Animal Wastes appl. | Cultiv. of Histosols[1)] | Animal Production | Atmospheric Deposition | Nitrogen Leaching and run-off |
|---|---|---|---|---|---|---|
| | Direct | | | | Indirect | |
| Total Emissions of $N_2O$ [Gg $N_2O$] | 199 | 79 | 25 | 98 | 48 | 216 |
| Total Nitrogen input [Gg N] | 10244 | 4287 | 21011 | 3006 | 3082 | 5561 |
| Implied Emission Factor [kg $N_2O$-N / kg N] | 1.23% | 1.17% | 7.6 | 2.07% | 1.00% | 2.47% |

| 2009 | Synthetic Fertilizer | Animal Wastes appl. | Cultiv. of Histosols[1)] | Animal Production | Atmospheric Deposition | Nitrogen Leaching and run-off |
|---|---|---|---|---|---|---|
| | Direct | | | | Indirect | |
| Total Emissions of $N_2O$ [Gg $N_2O$] | 137 | 74 | 25 | 82 | 38 | 172 |
| Total Nitrogen input [Gg N] | 7078 | 3857 | 20960 | 2619 | 2407 | 4425 |
| Implied Emission Factor [kg $N_2O$-N / kg N] | 1.23% | 1.22% | 7.7 | 2.00% | 1.00% | 2.48% |

| 2009 value in percent of 1990 | Synthetic Fertilizer | Animal Wastes appl. | Cultiv. of Histosols | Animal Production | Atmospheric Deposition | Nitrogen Leaching and run-off |
|---|---|---|---|---|---|---|
| | Direct | | | | Indirect | |
| Total Emissions of $N_2O$ | 69% | 94% | 101% | 84% | 78% | 80% |
| Total Nitrogen input | 69% | 90% | 100% | 87% | 78% | 80% |
| Implied Emission Factor | 100% | 104% | 102% | 97% | 100% | 100% |

Source of information: Tables 4.D for 1990 and 2009, submitted in 2011

[1)] Histosols unit AD: $km^2$; Unit for IEF: kg $N_2O$-N/ha

### 6.3.5.2 Methodological Issues

**Methods**

Due to the large uncertainty associated with the emission factors in this category and the lack of well-established alternatives, most Member States rely on the IPCC default emission factors (see below). For other parameters used in the calculation of $N_2O$ emissions from agricultural soils, however, many Member States use country-specific methodologies, linking the $N_2O$ inventory with the CORINAIR $NH_3$ inventory or using simulation models. A more specific discussion of emission factors and parameters used is presented below.

Table 6.60 gives an overview of the total $N_2O$ emissions in category 4D and the contribution of the main sub-categories. For direct $N_2O$ emissions from the application of fertilizer and from emissions from animal production activity data are multiplied with the emission factor, which is for most countries the IPCC default factor. Thus, the vast majority of the emissions are calculated with the Tier 1 approach for the emission from synthetic fertilizer. However, emissions depend also the fraction of nitrogen that volatilises is subtracted from the applied nitrogen for the calculation of $N_2O$ emissions and – for manure applied – also from the method that is used to estimate nitrogen excretion, which has already been discussed above. Additionally, nitrogen in crop residues and nitrogen fixed by biological nitrogen fixation might be estimated using country-specific data.

For each single sub-category we calculated a 'Tier-level' scoring between 1 and 2 according to the methodology described in 6.4.1.5 (Table 6.92 through Table 6.95, for details see 6.4.1.5).

The Tier level for direct $N_2O$ emissions is calculated from the Tier level for emissions from mineral fertilizer input, manure application, crop residues and N-fixing crops on the basis of the MEAN rule. The Tier level for the estimation of $N_2O$ emissions from mineral fertilizer is done by comparing the IEF with the IPCC default value. For emissions from manure applications, the Tier level of the nitrogen excretion rates estimated for $N_2O$ emissions from manure management are combined with the Tier level of the IEF using the MEDIAN rule. The Tier level for $N_2O$ emissions from crop residues and N-fixing crops are combined from the qulity level of the emission factor used and the Tier level of the N-input, which is done by expert judgement on the basis of the information contained in the national inventory reports (see Table 6.68 and Table 6.69). A "Tier 2" level has been assigned only if country-specific data have been used; the use of Tier 1b with default IPCC parameters counted as Tier 1 level. An analogue approach is followed to determine the Tier level for $N_2O$ emissions from the cultivation of histosols.

The Tier level of $N_2O$ emissions from grazing animals is derived from the quality of N excretion factors, the implied emission factor, and a factor based on the information given in the national inventory report on the fraction of manure deposited to grazing land. The share of nitrogen that is deposited on pasture/range and paddock was only considered to be "Tier 2" if the estimate is based on a more is based on a more elaborate approach than purely the length of the grazing season.

The Tier level for indirect $N_2O$ emissions is a combination of the Tier levels for $N_2O$ emissions from volatilised $NH_3$+$NO_x$ and from leached/run-off nitrogen. In either case the Tier level is derived from the emission factor used and the respective fraction of nitrogen with weighing factors being 1/3 and 2/3. In the case of N-volatilization the Tier level of the amount of nitrogen is derived from both voliatilization of mineral nitrogen and manure nitrogen (MEAN rule), whereby the quality of the latter is obtained from $Frac_{GASM}$ and nitrogen excretion factors (equal weights) using the MEDIAN rule.

As a result, we estimate that a minimum of 36% of the emissions reported in category 4D are estimated with country-specific information. Highest quality was obtained for emissions from volatilised nitrogen (35%), which reflects the direct impact of the calculation of N-excretion rates and the fact that several countries link this calculation to the $NH_3$ inventory, where fertilizer-specific volatilisation fractions are given.

A summary of the main methodological issues, as presented in the respective national greenhouse gas inventory reports, is given in Table 6.61. Note however, that most information will be summarized in specific tables on the emission factors and parameters used.

**Table 6.60 Total emissions and contribution of the main sub-categories to $N_2O$ emissions in category 4D, methodology and key source assessment by Member States for the sub-categories direct emissions, animal production and indirect emissions for the year 2009.**

| | Total | | Direct | | | Animal Production | | | Indirect | | | Volatilization | | Leaching | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Member State | Gg $CO_2$-eq | b | a | b | c | a | b | c | a | b | c | a | b | a | b |
| Austria | 3,097 | Tier 1.3 | 59% | Tier 1.3 | y | 3% | Tier 1.4 | y | 38% | Tier 1.2 | y | 8% | Tier 1.6 | 30% | Tier 1.1 |
| Belgium | 3,674 | Tier 1.4 | 55% | Tier 1.2 | y | 21% | Tier 1.4 | y | 23% | Tier 2.0 | y | 7% | Tier 2.0 | 16% | Tier 2.0 |
| Denmark | 5,088 | Tier 1.6 | 62% | Tier 1.4 | y | 4% | Tier 1.4 | y | 34% | Tier 1.9 | y | 6% | Tier 1.6 | 28% | Tier 2.0 |
| Finland | 3,442 | Tier 1.5 | 78% | Tier 1.5 | y | 5% | Tier 1.1 | y | 17% | Tier 1.5 | y | 4% | Tier 1.6 | 13% | Tier 1.5 |
| France | 46,400 | Tier 1.2 | 47% | Tier 1.1 | y | 16% | Tier 1.6 | y | 37% | Tier 1.1 | y | 6% | Tier 1.0 | 31% | Tier 1.1 |
| Germany | 43,493 | Tier 1.5 | 62% | Tier 1.5 | y | 4% | Tier 1.7 | y | 34% | Tier 1.6 | y | 6% | Tier 1.6 | 28% | Tier 1.7 |
| Greece | 4,915 | Tier 1.2 | 28% | Tier 1.1 | y | 36% | Tier 1.4 | y | 36% | Tier 1.1 | y | 6% | Tier 1.0 | 30% | Tier 1.1 |
| Ireland | 6,287 | Tier 1.3 | 37% | Tier 1.1 | y | 43% | Tier 1.4 | y | 20% | Tier 1.6 | y | 7% | Tier 1.6 | 13% | Tier 1.6 |
| Italy | 15,459 | Tier 1.3 | 48% | Tier 1.3 | y | 10% | Tier 1.4 | y | 42% | Tier 1.2 | y | 10% | Tier 1.3 | 33% | Tier 1.1 |
| Luxembourg | 308 | Tier 1.2 | 44% | Tier 1.2 | y | 18% | Tier 1.4 | y | 38% | Tier 1.2 | y | 6% | Tier 1.0 | 32% | Tier 1.2 |
| Netherlands | 6,350 | Tier 1.9 | 55% | Tier 1.9 | y | 20% | Tier 1.7 | y | 24% | Tier 2.0 | y | 8% | Tier 2.0 | 16% | Tier 2.0 |
| Portugal | 2,904 | Tier 1.4 | 34% | Tier 1.1 | y | 28% | Tier 1.4 | y | 37% | Tier 1.6 | y | 6% | Tier 1.6 | 31% | Tier 1.6 |
| Spain | 17,466 | Tier 1.6 | 48% | Tier 1.8 | y | 15% | Tier 1.7 | y | 37% | Tier 1.2 | y | 5% | Tier 1.6 | 32% | Tier 1.1 |
| Sw eden | 4,589 | Tier 1.6 | 53% | Tier 1.8 | y | 9% | Tier 1.7 | y | 23% | Tier 1.3 | y | 4% | Tier 2.0 | 19% | Tier 1.1 |
| United Kingdom | 24,905 | Tier 1.2 | 45% | Tier 1.1 | y | 17% | Tier 1.4 | y | 36% | Tier 1.1 | y | 6% | Tier 1.0 | 30% | Tier 1.2 |
| EU-15 | **188,378** | **Tier 1.4** | **51%** | **Tier 1.3** | **y** | **14%** | **Tier 1.5** | **y** | **35%** | **Tier 1.3** | **y** | **6%** | **Tier 1.4** | **28%** | **Tier 1.3** |
| EU-15: Tier 1 | 64% | | 65% | | | 45% | | | 69% | | | 65% | | 69% | |
| EU-15: Tier 2 | 36% | | 35% | | | 55% | | | 31% | | | 35% | | 31% | |

a Contribution to N2O emissions from agricultural soils
b Tier 1: default methodology; Tier 2: country-specific methodology
c Source category is key in the Member State's inventory (y/n)

**Table 6.61 Member State's background information for the calculation of $N_2O$ emissions in category 4.D**

| Member State | Methods |
|---|---|
| Austria | Emissions are estimated within an N-flow model fofr agriculture. The IPCC Tier 1a and – where applicable – Tier 1b with Austria specific consideration of nitrogen losses ($NH_3$-N, $NO_x$-N, $N_2O$-N). These losses are subtracted from the amount of mineral fertilizer N sales in the CRF table. |
| Denmark | The IPCC Tier 1a methodology is used to calculate the $N_2O$ emission. Emissions of $N_2O$ are closely related to the nitrogen balance (DIEMA). Indirect emissions from atmospheric deposition includes all emission sources of ammonia, i. e., livestock manure, use of synthetic fertilizer, crops, ammonia-treated straw used as feed, and sewage sludge and sludge from industrial production applied to agricultural soils. |
| Finland | Emissions are esteimated within a mass-flow approach in order to avoid double-counting. The nitrogen mass flow model (except for N-fixing, crop residue and sewage sludge) accounts for nitrogen losses as ammonia and nitrous oxide emissions during manure management in animal houses, during storage and application; for $NH_3$ volatilisation of pasture manure, urine and dung volatilisation are now taken into account separately; for synthetic fertilizers fertilizer type field type and placement fertilisation are considered; atmospheric deposition from manure is calculated from the ammonia volatilised during the whole management/application process. |
| Germany | Nitrogen emissions are calculated with the mass-flow approach, taking generally the simple methodology of the CORINAIR guidebook (EMEP, 2003). Application rates are dis-aggregated to the district level on the basis of the acreage of crops in the districts and fertilizer recommendations (LWK-WE, 2003). A national approach is used for calculating $N_2O$ emissions from atmospheric deposition of $NH_3$+$NO_x$ taking into consideration *total volatilization* fluxes of $NH_3$ and $NO_x$, including those from N-fixing crops, crop-residues, bedding material and imported manure. |
| Ireland | Direct Soil Emissions: calculated in a Tier 1 approach take into account the nitrogen inputs from all these sources, except that due to the cultivation of organic soils. For $N_2O$ emissions from manure applilcation, also $N_2O$ emissions during housing and storage is subtracted from the N-input. |
| Italy | IPCC default Tier 1 methodology. |
| Luxembourg | Nitrous oxide emissions from agricultural soils are estimated by using emission factors in relation with the mass of fertilizers used. For fallows (cultures without fertilizer use) an area-based emission factor is used in relation with the respective agricultural surface areas. |
| Netherlands | The IPCC Tier 1b/2 methodology is used to estimate direct $N_2O$ emissions for two soil types (organic and inorganic soils) and to estimate direct $N_2O$ emissions from animal production. The IPCC Tier 1 method is used to estimate indirect $N_2O$ emissions. For emissions from crop residues and N-fixing crops, only crops from arable farming and horticulture in the full soil (not in tubs) are included. All relevant documents concerning methodology, emission factors and activity data are published on www.greenhousegases.nl. The LEI (Dutch agricultural economic institute) performs these calculations based on the methodology described in Van der Hoek et al. (2007). Ammonia emissions are published by CBS/Statline (website www.cbs.nl). About 80–85% of the manure N collected in the stable and in storage is applied to soils. A small portion of the manure N (approximately 1–4%) is exported; while approximately 13-15% is emitted as ammonia during storage. |
| Portugal | Manure managed as liquid systems and solid storage is fully applied to agricultural soil as a fertilizer, irrespective of the animal species considered, whereas only 80% of manure handled in anaerobic lagoons is placed in soil (Bicudo & Albuquerque, 1995). The remaining 20 per cent wastewater flow and nitrogen is rejected directly to water |

| | |
|---|---|
| | systems. This fraction, however, is included in the determination of $N_2O$ indirect emissions from agricultural soils.The activity data for applied organic nitrogen is obtained after subtracing not only $NH_3$ and $NO_x$ volatilization from housing and manure management systems, but also $N_2O$ emissions in manure management systems. |
| Spain | The activity data for applied organic nitrogen is obtained after subtracing not only $NH_3$ and $NO_x$ volatilization from housing and manure management systems, but also $N_2O$ emissions in manure management systems. |
| Sweden | Background emissions from agricultural soils are reported both for organic and mineral soils in the Swedish inventory. For mineral soils, a national emission factor has been developed (Kasimir-Klemedtsson, 2001). |
| United Kingdom | Indirect emissions of $N_2O$ from the atmospheric deposition of ammonia and $NO_x$ are estimated according to the IPCC (1997) methodology but with corrections to avoid double counting N. The sources of ammonia and $NO_x$ considered are synthetic fertiliser application and animal manures applied as fertiliser. The method used corrects for the N content of manures used as fuel but no longer for the N lost in the direct emission of $N_2O$ from animal manures as previously. |

## Activity Data

For the estimation of $N_2O$ emissions from N-fixing crops and crop residues, most Member States use the amount of N input (in Gg N) as activity data in the CRF table; but some countries give the emission factor in kilogram of nitrogen emitted per kg of dry crop production (N-fixing crop or other crops, respectively). Therefore, the data given in Table 6.62 in the respective columns are not comparable.

Additional background information on the source of the data used in the Member States's inventories is given in Table 6.63.

**Table 6.62 Member State's activity data to calculate direct and indirect $N_2O$ emissions in category 4D**

| Member States | Synthetic Fertilizer (Gg N) | Animal Wastes appl. (Gg N) | N-fixing crops (Gg N) | Crop residue (Gg N) | Cultiv. of Histosols ($km^2$) | Animal Production (Gg N) | Atmosph. Deposition (Gg N) | Nitrogen Leaching and run-off (Gg N) |
|---|---|---|---|---|---|---|---|---|
| 2009 | Direct | | | | | | Indirect | |
| Austria | 106 | 112 | 21 | 58 | NO | 10 | 50 | 77 |
| Belgium | 129 | 124 | 6 | 72 | 25 | 80 | 54 | 49 |
| Denmark | 196 | 191 | 41 | 51 | 420 | 22 | 61 | 155 |
| Finland | 134 | 58 | 0.8 | 28 | 3,325 | 18 | 28 | 36 |
| France | 1,910 | 854 | 289 | 489 | NO | 758 | 580 | 1,191 |
| Germany | 1,467 | 791 | 79 | 1,274 | 12,871 | 162 | 513 | 1,006 |
| Greece | 153 | 39 | 1 | 26 | 67 | 183 | 63 | 120 |
| Ireland | 301 | 72 | 1 | 10 | NO | 279 | 87 | 66 |
| Italy | 469 | 446 | 164 | 114 | 90 | 158 | 309 | 415 |
| Luxembourg | 12 | 6 | 0 | 4 | NO | 6 | 4 | 8 |
| Netherlands | 238 | 300 | 4 | 26 | 2,230 | 79 | 103 | 84 |
| Portugal | 91 | 45 | 2 | 25 | NO | 84 | 36 | 75 |
| Spain | 763 | 388 | 190 | 132 | NO | 317 | 180 | 454 |
| Sweden | 141 | 62 | 35 | 47 | 1,540 | 40 | 35 | 72 |
| United Kingdom | 966 | 367 | 47 | 431 | 392 | 423 | 303 | 616 |
| EU-15 | 7,078 | 3,857 | 881 | 2,789 | 20,960 | 2,619 | 2,407 | 4,425 |

Source of information: Tables 4.D for 2009, submitted in 2011. Abbreviations explained in the Chapter 'Units and abbreviations'.

**Table 6.63 Member State's background information on the activity data used for the calculation of $N_2O$ emissions in category 4.D**

| Member State | Activity data |
|---|---|

| | |
|---|---|
| Austria | Mineral Fertilizer application detailed data about the use of different kind of fertilizers are available until 1994, because until then, a fertilizer tax („Düngemittelabgabe“) had been collected. Data about the total synthetic fertilizer consumption are available for amounts (but not for fertilizer types) from the statistical office (Statistic Austria) and from an agricultural marketing association (Agrarmarkt Austria, AMA). The yearly numbers of the legume cropping areas were taken from official statistics (BMLFUW 2007). Harvest data were taken from (BMLFUW) and the datapool of (Bundesanstat fuer Agrarwirtschaft). Agriculturally applied Sewage sludge data were taken from Water Quality Report, 2000 (Philippitsch, 2001), For 2001 to 2006 data from the National Austrian Waste Water Database operated by the Umweltbundesamt was used. The yearly numbers of the legume cropping areas were taken from official statistics (BMLFUW). Harvest data were taken from (BMLFUW) and the datapool of (Bundesanstalt fuer Agrarwirtschaft). |
| Belgium | In 2006 Wallonia has 55% of the land used for agriculture, but 67% of agricultural businesses are situated in Flanders. |
| Denmark | The amount of nitrogen (N) applied on soil by use of synthetic fertiliser is estimated from sale estimates by the Danish Plant Directorate, which is source to the FAO database. Data for crop yield is based on Statistics Denmark. For nitrogen content in the plants the data is taken from Danish feed stuff tables (Danish Agricultural Advisory Centre). |
| Finland | The amount of synthetic fertilisers sold annually has been received from the annual agricultural statistics of the Ministry of the Agriculture and Forestry. The amount of sewage sludge applied annually has been received from the VAHTI database of Finland's environmental administration. Area of cultivated organic soils are from MTT Agrifood Research Finland. Crop yields of cultivated plants have been received from agricultural statistics. |
| France | National statistics of fertilizer consumption are from UNIFA. Crop production statistics are obtained from the Ministry of agriculture (SCEES/ AGRESTE). For animal production, the difference between table 4.D and table 4B(b) is due to the oversea territories that are accounted separately in table 4D. |
| Greece | The data regarding the annual quantities of synthetic fertilizers consumed in the country derive from FAO. The data for the last two years result from extrapolation based on the trend of the last five years. Data on agricultural crop production used for the calculation of emissions was obtained from the annual national statistics of the NSSG. |
| Ireland | The annual statistics on nitrogen fertilizer use (Nfert) are obtained from the Department of Agriculture and Food. |
| Italy | Fertilizer application rates are from ISTAT. |
| Luxembourg | AD from national statistical data (Statistical Yearbook, tables C.2100 and C.2104) and ASTA (Administration des Services Techniques de l'Agriculture) |
| Portugal | Apparent Consumption of Fertilizers in the Agriculture activity (ACFA) by a simple mass balance, from sales and international market information data not accounting for losses and stock changes. The data are compared to the more complete time-series that is available at FAO (http://faostat.fao.org), with sales information for “Nitrogenous Fertilizers” from 1961 up to 2002. However, and although its completeness, the Ministry of Agriculture and the National Statistical Institute, shown concerns about the origin of the information behind the final time series, and consider that it did not reflect clearly the situation that existed in Portugal in the period. Nevertheless, both series agree quite well near the base year, although the values in this series appear to be over-estimating the rate of decrease of synthetic fertilizers in Portugal. |
| Spain | Mineral fertilizer statistics are obtained from 'Anuario de Estadistica Agroalimentario' (MARM) |
| Sweden | Sales of fertilisers, recalculated into nitrogen quantities, are published annually by Statistics Sweden and the national estimates are considered to be accurate, according to the quality declaration in the statistical report. The fertiliser sales values are however a bit higher than the estimated use of fertilisers, which is estimated from telephone interviews with farmers. The difference can partly be explained by the use of fertiliser in other sectors such as in horticulture. Statistics on the use of sewage sludge have been published irregularly and in different reports, but a time series has been created through interpolation and the emissions are reported for the first time in the current submission of the GHG inventory. Estimated standard yields for different crops are published annually by the Swedish Board of Agriculture/Statistics Sweden and are a function of crop yields estimated by surveys conducted over the last 15 years. The area of arable land in the agricultural sector is taken from the National Forest Inventory to harminize the Swedish National Froest Inventory with the agrictulral sector. |
| United Kingdom | Annual consumption of synthetic fertilizer is estimated based on crop areas (Defra) and fertilizer application rates (BSFP, 2006). Crop production data are taken from Defra (2006). |

## Emission Factors and other parameters

Table 6.64 and Table 6.65 give an overview of the emission factors and other parameters used for the calculation of $N_2O$ emissions from agricultural soil in 2009. As discussed already above, emission factors are largely IPCC default, while other parameters are more frequently country-specific. Also, while the emission factors are static in the time series, some parameters are dynamically calculated on the basis of national input data, for example the mix of mineral fertilizer types with different volatilization fractions associated.

In the following, country-specific elements in the calculation of $N_2O$ emissions from agricultural soils as reported in the National Inventory Reports are given in Table 6.67 for direct $N_2O$ emissions from fertilizer application, Table 6.68 and Table 6.69 for $N_2O$ emissions from N-fixing crops and crop residues, Table 6.70 for the $N_2O$ emissions from animal production and Table 6.71 for $N_2O$ emissions from cultivated histosols.

Furthermore, background information on the development of national parameters is given in

Table 6.72 for $Frac_{GASF}$, Table 6.73 for $Frac_{GASM,}$ and Table 6.74 for $Frac_{LEACH}$.

Most Member States use the IPCC default emission factors for the calculation of $N_2O$ emissions from the application of mineral and organic fertiliser. A differentiation between organic and inorganic fertiliser has been made by the Netherlands and Sweden. The Swedish EF of 0.8% is based on a study on $N_2O$ emissions in Sweden and other countries of northern Europe and in Canada (Kasimir-Klemedtsson, 2001), supported by a study in Norway suggesting a lower emission factor for emitted fertiliser N than the IPCC default value (Laegreid and Aastveit, 2002). The Netherlands distinguish also between mineral fertiliser application on mineral soils and on organic soils, with the EFs being twice as high for the application on organic soils; for the application of manure, differentiation is made between surface spreading and incorporation of the fertiliser. As more nitrogen is locally available if the fertiliser is incorporated into the soil, this application system is assumed to result in higher emissions of $N_2O$ in mineral soils. For organic soils, the same, higher, EF is applied for both application systems. An overview of the Dutch emission factors is given in Table 6.66. Additional background information on the emission factors used is given in Table 6.67.

All countries are reporting $N_2O$ emissions from manure excreted by animals during grazing and the implied EF is the default factor of 2% $N_2O$-N per kg N excreted and year, except of the emission inventories of the Spain and the Netherlands and Sweden, which use an EF of 1.7% and 3.4%, respectively.

**Table 6.64 Implied Emission Factors for the category 4D - $N_2O$ emissions from agricultural soils in 2009**

| Member States | Synthetic Fertilizer | Animal Wastes appl. | N-fixing crops | Crop residue | Cultiv. of Histosols | Animal Production | Atmosph. Deposition | Nitrogen Leaching and run-off |
|---|---|---|---|---|---|---|---|---|
| 2009 | Direct | | | | | | Indirect | |
| Austria | 1.25% | 1.25% | 1.25% | 1.25% | NO | 2.0% | 1.00% | 2.50% |
| Belgium | 1.25% | 1.25% | 1.25% | 1.25% | 8.0 | 2.0% | 1.00% | 2.50% |
| Denmark | 1.25% | 1.25% | 1.25% | 1.25% | 8.0 | 2.0% | 1.00% | 1.88% |
| Finland | 1.25% | 1.25% | 1.25% | 1.25% | 8.3 | 2.0% | 1.00% | 2.50% |
| France | 1.25% | 1.25% | 1.25% | 1.25% | NO | 2.0% | 1.00% | 2.50% |
| Germany | 1.25% | 1.25% | 1.25% | 1.25% | 8.0 | 2.0% | 1.00% | 2.50% |
| Greece | 1.25% | 1.25% | 1.25% | 1.25% | 8.0 | 2.0% | 1.00% | 2.50% |
| Ireland | 1.25% | 1.25% | 1.25% | 1.25% | NO | 2.0% | 1.00% | 2.50% |
| Italy | 1.25% | 1.25% | 1.25% | 1.25% | 8.0 | 2.0% | 1.00% | 2.50% |
| Luxembourg | 1.25% | 1.25% | 1.25% | 1.25% | NO | 2.0% | 1.00% | 2.50% |
| Netherlands | 1.30% | 0.93% | 1.00% | 1.00% | 4.7 | 3.4% | 1.00% | 2.50% |
| Portugal | 1.25% | 1.25% | 1.25% | 1.25% | NO | 2.0% | 1.00% | 2.50% |
| Spain | 1.16% | 1.01% | 1.25% | 1.25% | NO | 1.7% | 1.00% | 2.50% |
| Sweden | 0.8% | 2.50% | 1.25% | 1.25% | 8.0 | 2.0% | 1.02% | 2.50% |
| United Kingdom | 1.25% | 1.25% | 1.25% | 1.25% | 8.0 | 2.0% | 1.00% | 2.50% |
| EU-15 | 1.23% | 1.22% | 1.25% | 1.25% | 7.7 | 2.0% | 1.00% | 2.48% |

Source of information: Tables 4.D for 2009, submitted in 2011. Abbreviations explained in the Chapter 'Units and abbreviations'.

**Table 6.65** **Relevant parameters for the calculation of $N_2O$ emissions from agricultural soils in 2009**

| Member States | FracBURN | FracFUEL | FracGASF | FracGASM | FracGRAZ | FracLEACH | FracNCRBF | FracNCRO | FracR |
|---|---|---|---|---|---|---|---|---|---|
| Austria | 0.32% | | 3.9% | 27% | 6% | 30% | 2.6% | 0.9% | 34% |
| Belgium | NO | NO | | | | | | | |
| Denmark | 1.03% | NE | 1.9% | 19% | 9% | 33% | 3.9% | 1.7% | 87% |
| Finland | 0.13% | NA | 1.7% | 25% | 18% | 15% | 4.2% | 0.6% | 45% |
| France | NA | NO | 10.0% | 20% | 41% | 30% | 3.0% | 0.9% | NA |
| Germany | NO | NO | 5.4% | 30% | 12% | 30% | 4.3% | 2.0% | 55% |
| Greece | 10% | | 10.0% | 20% | 79% | 30% | 1.4% | 0.5% | 53% |
| Ireland | NO | NO | 1.8% | 19% | 66% | 10% | NO | NO | NO |
| Italy | 10% | NO | 9.6% | 29% | 19% | 30% | 3.0% | 1.5% | 45% |
| Luxembourg | NO | NO | 10.0% | 20% | 45% | 30% | 3.0% | 1.5% | 45% |
| Netherlands | NO | NO | 5.0% | 10% | 16% | 12% | NE | NE | NE |
| Portugal | 5.2% | NO | 5.7% | 19% | 53% | 33% | 2.2% | 1.3% | 71% |
| Spain | 15.4% | NO | 7.1% | 19% | 39% | 30% | 2.3% | 0.5% | NA |
| Sweden | NO | NO | 0.9% | 33% | 32% | 30% | NE | 0.5% | 63% |
| United Kingdom | | 35.00% | 10.0% | 20% | 52% | 30% | 3.0% | 1.5% | 45% |
| EU-15[1)] | NA | NA | 5.9% | 22% | 35% | 27% | 3.0% | 1.2% | 54% |

Source of information: Tables 4.D for 2009, submitted in 2011. Abbreviations explained in the Chapter 'Units and abbreviations'.
[1)] Arithmetic average over the MS that reported.

The following outliers could be identified:

- **IEF for synthetic fertilizer, Sweden**
  Used $N_2O$ IEF (0.08 kg/kg) is the lowest among EU27 and out of IPCC range. Sweden uses a country specific EF (Klemedtsson, 2001) derived from a literature study requested by the Swedish EPA.
- **IEF for animal manure fertilizer, Sweden**
  Used $N_2O$ IEF (0,025 kg/kg) is the highest among EU27 and out of IPCC range. Sweden uses a country specific EF (Klemedtsson, 2001) derived from a literature study requested by the Swedish EPA.

*Direct emissions from application of fertiliser*

Only few countries use country-specific emission factors to estimate $N_2O$ emissions caused by the application of mineral fertilizer. The reason is the extreme high spatial and temporal variability of this emission source, which makes the generation of a robust database with observations, based on which national emission factors can be derived, extremely difficult. National methodologies are summarized in Table 6.67. Table 6.68 through Table 6.70 give additional information on the methodologies used to estimate $N_2O$ emissions from crop residues, biological N-fixation, and animal production.

Table 6.66 shows the methodology used in the Netherlands in detail.

**Table 6.66** $N_2O$ emission factors for agricultural soils used in Netherlands' inventory (from the NL protocol for direct $N_2O$ emissions; www.greenhousegases.nl )

| Supply source | EF (kg $N_2O$–N per kg N supply) Mineral soil | Organic soil | Reference |
|---|---|---|---|
| Using fertiliser | | | |
| - ammonia-retaining (no nitrate) | 0.005 | 0.01 | 2 |
| - other types of fertiliser | 0.01 | 0.02 | 1 |
| Using animal manure | | | |
| - above-ground usage | 0.01 | 0.02 | 1 |
| - low-emission use | 0.02 | 0.02 | 1 |
| Grazing agricultural pets | | | |
| - faeces | 0.01 | 0.01 | 1 |
| - urine | 0.02 | 0.02 | 1 |
| Nitrogen fixation | 0.01 | | 1 |
| Remaining crop residues | 0.01 | | 2 |
| Agricultural use of histosols | | 0.02 | 2 |

references: 1= Kroeze, 1994; 2= Van der Hoek et al., 2005

**Table 6.67** Member State's background information for the calculation of $N_2O$ emissions from the application of fertilizer in category 4.D

| Member State | Direct emissions from fertilizer application |
|---|---|
| Finland | IPCC default with the exceptoin of emission factors for organic soils on grass and other crops which are based on national data (Monni et al. 2007) (cereals 11.08 kg $N_2O$-N $ha^{-1}$ $y^{-1}$, grass 5.7 kg $N_2O$-N $ha^{-1}$ $y^{-1}$). |
| Germany | Default emission factors. For emissions from leaching, default factor from IPCC 2006. The IPCC 1996 factor represents poor klnowledge available at the time. The new data set used for the development for the IPCC 2006 guidelines agrees with the German situation (Weymann et al., 2008). |
| Netherlands | Distinction is made between fertiliser type (ammonia-retaining-no nitrate fertiliser and other fertiliser), application to mineral or organic soils, and manure incorporation. The country specific emission factors for mineral soils are lower than IPCC defaults and for organic soils they are higher. A fixed distribution of the total amount of nitrogen in fertiliser and animal manure is used over the Netherlands areas of mineral and organic agricultural soils. For fertiliser use, 90% is attributed to mineral soils, and 10% to organic soils; for animal manures this is 87% and 13% respectively (Kroeze, 1994). For incorporation into soil also a higher emission factor than the IPCC default is used. A recent survey on $N_2O$ emission factors for the field-scale application of animal manure (Kuikman et al., 2006) showed that on the basis of available data it was not possible to make an update of the $N_2O$ emission factors applied in the past (Kroeze et al., 1994). Very few comparative trials between surface spreading and incorporation have been carried out in The Netherlands to date, resulting in very low emission rates for both techniques. Field-scale comparative experiments carried out in other countries show that, in most cases, $N_2O$ emissions increased and seldom were lower in comparison with surface application. However, it was not possible to deduce long-term average $N_2O$ emission factor from these findings and to translate these to the Dutch circumstances. Therefore, it was not possible to underpin an update of the $N_2O$ emission factor for the application of animal manure. More research is needed in order to be able to take the specific circumstances of The Netherlands into account. |
| Sweden | National emission factor for direct emissions based on a study by (Klemedtsson, 2001). For nitrogen supply from fertilizers, a national emission factor, 0.8% $N_2O$-N of N-supply, is used. For nitrogen supply from manure, a national emission factor of 2.5% emissions of N-supply is used. The background emissions from the cultivation of mineral soils have also been included in the inventory with the national emission factor of 0.5 kg $N_2O$-N $ha^{-1}$. For other direct soil emissions, default values from the IPCC Guidelines are used. The background emissions from organic soils vary with different crops. They are considered to be higher from ploughed soils than from pasture or lay lands and the suggested emission factors are 1 and 6 kg $N_2O$-N $ha^{-1}$, respectively. The IPCC guidelines' default value is implemented in the inventory since a Swedish/Finnish research group concluded that not enough data exists to generate different emission factors for different management and soil types (Klemedsson et al., 1999). |

**Table 6.68** Member State's background information for the calculation of $N_2O$ emissions from crop residues in category 4.D

| Member State | Direct emissions from crop residues |
|---|---|
| Austria | Country-specific data for average crop residues/crop products ratio, dry matter fraction, N in crop residues (Goetz, 1998) and fraction of crop residues removed (Loehr 1990). Emissions from field burning have been calculated on a crop by crop basis. |
| Belgium | The dry matter content of the crops in Flanders are region specific. |
| Denmark | $N_2O$ emissions from crop residues are calculated as the total above-ground amount of crop residues returned to soil. For cereals the aboveground residues are calculated as the amount of straw plus stubble and husks. The total amount of straw is given in the annual census and reduced with the amount used for feeding, bedding and biofuel in power plants. Straw for feeding and bedding is subtracted in the calculation because this amount of removed nitrogen returns to the soil via manure. Data for |

| | |
|---|---|
| | nitrogen content in stubble and husks are provided by the Danish Institute of Agricultural Sciences (Djurhuus,and Hansen, 2003). Burning of plant residues has been prohibited since 1990 and may only take place in connection with continuous cultivation of seed grass. It is assumed that the emissions are insignificant. |
| Germany | Germany makes use of statistically available nitrogen contents in crop residues. Factors used in the Tier 2 calculation for emissions from crop residues is given in (Daemmgen et al., 2007). |
| Italy | Country-specific methodology; N-content in crop residues calcualted using the protein content in dry matter, and dividing by the factor 6.25. |
| Netherlands | A fixed countryspecific value in kg N per hectare is used for the nitrogen content of the above-ground crop residues (Velthof and Kuikman, 2000). Country-specific values for removal of crop residues show that during the period 1990-2003, only grains and corn were removed (90%) from the fields (Van der Hoek et al., 2005). |
| Portugal | Crop residues not only annual crops were considered but also permanent crops, such as orchards and pastures. Crop residues are not used as combustible or building material in Portugal. |
| Spain | Regulations on burning of cereal residues vary between regions (zones A and B). Data are listed by year, crop category and zone. |
| Sweden | N-content in crop residues from cereals are based on national measurement data (Mattson, 2005). For other crops, a combination of national factors and IPCC default values was used (Swedish EPA/SMED, 2005). |
| United Kingdom | Production data of crops are taken from Defra (2006a, 2006b). Field burning has ceased to be legal in the UK since 1993, and none is assume to occur after this date. For years prior to 1993, field-burning data were taken from the annual MAFF Straw Disposal Survey (MAFF, 1995). |

**Table 6.69 Member State's background information for the calculation of $N_2O$ emissions from N-fixing crops in category 4.D**

| Member State | Direct emissions from N-fixing crops |
|---|---|
| Austria | Values for biological fixation for peas, soja beans adn horse/field beans (120 kg N/ha) and clover-hey (160 kg N/ha) are country-specific (Goetz, 1998); these values are constant over the time series. |
| Denmark | The estimates for the amount of fixed nitrogen in crops are estimated by Danish Institute of Agricultural Science (Swedish Board of Agriculture, 2005) from literature (Kristensen, 2003; Høgh-Jensen et al, 1998; Kyllingsbæk, 2000). Emissions from clover-grass are included (not mentionen in IPCC). Area with grass and clover covered approx.17% of the total agricultural area and represent thus a significant part of N-fixing crops emissions. |
| Finland | Vegetables grown in the open have been included into the emission estimate of crop residues for the first time in 2005 submission. Vegetable yields have been received from literature (Yearbook of Farm Statistics, 2006). Values for the residue/product fraction, dry matter content and nitrogen fraction are IPCC with amendments where appropriate values were missing (turnip rape/rape; sugar beet; clover seed) or where more values based on expert judgement were used (N-fraction for peas of 3.5%; DM and residue/product fraction from sugar beet used for vegetables). |
| Germany | The quantity of N fixes by leguminous crops is estiamted on the basis of cultivated area and national average N-fixing rates of 250 kg N $ha^{-1}$ (pulses), 300 kg N $ha^{-1}$ (alfalfa), and 200 kg N $ha^{-1}$ (mixed alfalfa, clover; improved grassland) (DÄMMGEN et al., 2007). |
| Italy | Country-specific methodology considering also legume forage. Nitrogen fixed per hectare is taken from Erdamn, 1959 in Giardini (1983). |
| Netherlands | Country-specific value for nitrogen fixation per hectare (Mineralen Boekhouding, 1993) (Lucerne: 422 kg N per hectare; Green peas (harvested dry) and field peas, marrowfat peas en grey peas, brown beans, peas (harvested green): 164 kg N per hectare; Field beans: 325 kg N per hectare; Stem beans (harvested green), scarlet runner-/salad-/common beans: 75 kg N per hectare; Broad beans: 164 kg N per hectare. |
| Portugal | N fixed by crops includes both annual crops and a permanent crop (carob tree, Ceratonia siliqua) production. Factors are IPCC defaults and from other sources (Jarrige, 1988; INRA, AFRC). |
| Spain | A literature review was made to obtain N-fixing data relevant for cultures grown in Spain. This resulted in a detailed list containing data on crop residue/yield fracion, dry matter, carbon and nitrogen content for more than 100 crop types. |
| Sweden | To estimate nitrogen fixation from the atmosphere, a model according to Høgh-Jensen has been used since submission 2006 The model covers fixation from root and stubble as well as trensmission to other plants. It has been adapted to Swedish conditions (Frankow-Lindberg, 2005). According to the model, the amount of fixed nitrogen is estimated as a part of the total amount of N in the plant's biomass, which varies depending on th ekind of leguminous plant, the age of the pasture, the number of harvests and, to some extent, the amount of fertiliser applied. |
| United Kingdom | The total nitrous oxide emission reported also includes a contribution from improved grass calculated using a fixation rate of 4 kg N/ha/year (Lord, 1997). Crop production data are taken from Defra (2006). |

**Table 6.70 Member State's background information for the calculation of $N_2O$ emissions from animal production in category 4.D**

| Member State | Grazing animals |
|---|---|
| Austria | During the summer months, 14.1% of Austrian Dairy cows and Suckling cows are on alpine pastures 24 hours a day. 43.6 % are on pasture for 4 hours a day and 42.3 % stay in the housing for the whole year (Konrad, 1995). |
| Belgium | The nitrogen from grazing is estimated, taking into account the number of days in pasture and the nitrogen excreted by each animal category. Available nitrogen is the difference between the manure nitrogen content and the manure nitrogen volatilisation in $NH_3$ and NO form. |

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|---|---|
| Denmark | $Frac_{GRAZ}$ is based on expert judgement (DAAC - Poulsen et al., 2001) assuming that 5%, on average, of the nitrogen from dairy cattle and heifers is excreted on grass. |
| Finland | The length of pasture season has been estimated as 130 days for suckler cows, 120 days for dairy cows, heifers, calves, shepp, goats and horses, 365 days for reindeer, and 0 for bulls, swine, poultry and fur animals. |
| Germany | Grazing animals: N input calculated with the mass-flow approach taking into consideration all relevant housing systems occurring in Germany and is based on the length of the grazing period, the average time per day spent grazing and in milking yards. The share of grazing varies with subcategory, region, and time. |
| Ireland | The amount of organic nitrogen input concerned from the equations above, is large in Ireland due to the relatively short period that cattle remain in housing and the contribution from large *Sheep* populations, the majority of which are not housed. |
| Netherlands | National emission factor. A distinction is made between nitrogen in urine and in faeces. The distribution of nitrogen over faeces and urine depends on the nitrogen content in the meadow grass, and in turn this depends on the fertilisation level. For the period 1990-1999 a distribution of 30/70 was assumed, and for the period from 2000 onwards, a ratio of 35/65 is used (calculated on the basis of Valk et al., 2002).For the calculation of $N_2O$ emissions, the nitrogen excreted is corrected for $NH_3$ volatilization. |
| Portugal | Emissions of $N_2O$ due to the input of nitrogen to soils from pasture, range and paddock were estimated with a methodology similar to that used to estimate emissions of $N_2O$ from Manure Management. The emission factor of $N_2O$ for Pasture, Range and Paddock (EF3) was set at 0.02 kg $N_2O$-N/kg N which is the default IPCC96 emission factor. |
| Sweden | The fraction of manure deposited that volatilises as ammonia is model-based. A different fraction for manure deposited by grazing animals is used (FracGASG) then for manure applied to soils. FracGASG is time dependent. $N_2O$ emissions from grazing animals are calculated after subtracting the nitrogen that volatilises as ammonia. Due to lack of data concerning reindeer, the nitrogen production by sheep is also applied to reindeer. Stable periods are obtained from Statistics Sweden per year and animal. |
| United Kingdom | The fraction of livestock N excreted and deposited onto soil during grazing is a country specific value of 0.52, much larger than the IPCC recommended value (0.23), based on country specific data. |

*Direct emissions from the cultivation of histosols.*

$N_2O$ emissions from the cultivation of histosols reported as not occurring in Austria, France, and Spain, and as not estimated in Portugal. Also, no emissions from the cultivation of histosols are reported by Ireland, because tillage farming in Ireland is concentrated in the south-east of the country while the bulk of organic soils occur in the middle and western part of the country. Consequently, nitrogen inputs due to the cultivation of organic soils have been taken as negligible.

The cultivation of histosols represents the biggest share of emissions from agricultural soils in Finland (39%), Sweden (16%) and a substantial source for $N_2O$ emissions in Germany (12% - almost as large as emission from application of manure) and the Netherlands (8%). The emission factor proposed in the IPCC GPG of 8 kg $N_2O$-N per hectare and year (IPCC, 2000) is used in most countries. Netherlands uses 4.7 kg $N_2O$-N $ha^{-1}$; national emission factors are further used in Denmark (8.0 kg $N_2O$-N $ha^{-1}$) and Finland (8.3 kg $N_2O$-N $ha^{-1}$).

On absolute terms, the estimated emissions of $N_2O$ from the cultivation of histosols are largest for Germany (16.2 Gg $N_2O$), followed by Finland (4.3 Gg $N_2O$) and Sweden (1.9 Gg $N_2O$).

**Table 6.71 Member State's background information for the calculation of $N_2O$ emissions from the cultivation of histosols in category 4.D**

| Member State | Histosols |
|---|---|
| Belgium | The area histosols is calculated on the basis of an intersection between the CORINE Land Cover Geodataset from 1990 and the Belgian 'Soilassociationmap'. The area is held constant for the entire time series. No histosol cultivation occurs in Wallonia, where the only recorded organic soils are part of a nature reserve. |
| Denmark | National IEF for histosols. $N_2O$ emissions from histosols are based on the area with organic soils multiplied with a national emission factor for C, the C:N relationship for the organic matter in the histosols and an emission factor of 1.25 of the total amount of released N. Danish organic soils are defined as soils having >10% SOM in contradiction to the IPCC definition where organic soils has >20% SOM. For 1998 the distribution of the agricultural area between mineral soils and organic soils is subdivided into cropland and permanent grassland based on a GIS analysis. Set-a-side, grass in rotation and permanent grass is more common on organic soils than on mineral soils. |
| Finland | The area of cultivated organic soils has been received from MTT Agrifood Research Finland and has been updated for the 2006 submission on the basis of (Myllys, 2004; Kähäri, 1987). The area of cultivated organic soils is poorly known in Finland. Current area estimate is based on the results of soil analysis. The emission factors for organic soils on grass and other crops are based on national data (Monni et al. 2007). The emission factors were calculated on the basis of published results on annual fluxes measured with flux chambers on five different peat fields. |
| Germany | Estimation of the are of cultivated histosols on the basis of an overlay of a land-use map and a soil map (Daemmgen et al., 2006). The area is considered proportional to the total cultivated area. |

| | |
|---|---|
| Greece | Data for the areas of organic soils derive from a relevant research conducted by the Soil Science Institute of Athens (SSIA, 2001). |
| Ireland | Not estimated. Tillage farming in Ireland is concentrated in the south-east of the country while the bulk of organic soils occur in the midlands and west. Consequently, nitrogen inputs due to the cultivation of organic soils can be taken as negligible. |
| Italy | Area of organic soils from the national soil map of the year 1961. These values have been verified with related data for Emilia Romagna region, where this type of soil is the most prevalent. |
| Netherlands | A fixed country-specific emission factor of 4.7 kg $N_2O$-N per hectare is used for this calculation. This value is based on an average mineralisation of around 235 kg N per hectare histosol (Kuikman et al., 2005). Using an emission factor of 0.02 (largely taken from Dutch research projects conducted in the first half of the 1990s and reported in Kroeze, 1994), the laughing gas emission of histosols amounts to 4.7 kg $N_2O$–N per hectare. |
| Portugal | Histosols represent at most a negligible emission quantity in Portugal, and they may be reported as not occurring for all practical purposes. |
| Sweden | The area of organic soils is around 252 600 hectares according to a recent mapping of cultivated organic soils in Sweden (Berglund, 2005). |
| United Kingdom | The area of cultivated Histosols is assumed to be equal to that of eutric organic soils in the UK and is based on a FAO soil map figure supplied by SSLRC (now NSRI). |

*Indirect emissions.*

All Member States report indirect emissions of nitrous oxide induced by the atmospheric deposition of $NH_3$ and $NO_x$ volatilised and nitrate leached to the groundwater using the default IPCC emission factors. Only Denmark uses a smaller emission factor for $N_2O$ from nitrogen leached or run-off (1.88%).

Country-specific methodologies, however, are used by most Member States for the calculation of nitrogen volatilisation and nitrate leaching, with only 3 Member States using the IPCC default values for the volatilisation fractions of mineral and organic fertilizer ($Frac_{GASF}$ and $Frac_{GASM}$), respectively, and 9 countries are using the default IPCC values for the leaching fraction ($Frac_{LEACH}$). The Netherlands reports the fractions as NE.

The latest edition of the EMEP/EEA Emission Inventory Guidebook (EMEP/EEA, 2009) gives in the section '4.D Crop production and agricultural soils' the emission factors for $NH_3$ volatilization from mineral fertilizers if the Tier 2 'technology specific approach' can be used (Table 3-2). The method considers soil pH and the mean spring temperature as factors influencing the magnitude of $NH_3$ volatilizations. For example, the application of ammonium nitrate on soils with a pH≤7 and a mean spring temperature of 6ºC would lead to a $NH_3$ volatilization of 0.014 or 1.4%, which is considerably lower than the IPCC default factor. Volatilizations higher than the IPCC default factor of 10% are only achieved when using this methodology for the application of urea, nitrogen solutions at high temperatures, or ammonium sulphates or ammonium phosphates on soils with a high pH>7. Accordingly, the estimates volatilization fraction of $NH_3$ and $NO_x$ from the application of mineral fertiliser is considered by all Member States to be lower as the IPCC default values (range of national factors 1.5% to 10%, with 4 countries using the default value of 10%).

In contract, most of the Member States with country-specific volatilisation rates for organic fertiliser are estimating larger losses of $NH_3$ + $NO_x$ than proposed by the IPCC (range 25% to 33%) with 4 countries using the default $Frac_{GASM}$ of 20% and the lowest volatilization fraction used being 9.7%. The country-specific methodology for the estimation of $NH_3$ volatilization is in some cases based on the $NH_3$ inventory using the CORINAIR methodology thus differentiating between different kinds of synthetic fertilisers.

Also, model-based estimations for the fraction of nitrogen volatilised from applied animal wastes have been used. The fraction of nitrogen lost by leaching ranges from 12.0% to 33% with 9 countries using the default FracLEACH of 30% and 44 countries using a smaller value. They are in some cases based on a nitrogen-leaching model (e.g., Denmark, Sweden) and in some cases based on national studies (e.g., Finland, Ireland).

**Table 6.72 Member State's background information on the fraction of $NH_3$ and $NO_x$ volatilized from applied mineral fertilizer, $Frac_{GASF}$ for the calculation of $N_2O$ emissions in category 4.D**

| Member State | $Frac_{GASF}$ |
|---|---|
| Austria | $Frac_{GASF}$ 23% for mineral fertilizers and 15.3% for urea fertilizers (CORINAIR). |
| Belgium | $Frac_{GASF}$ 2.3% in Wallonia (recommended by IIASA for different fertiliser types); in Flanders an average rate for $NH_3$ volatilisation is calculated by the model that estimates the $NH_3$ emissions from synthetic fertiliser as developed by ILVO. The rate for NO volatilisation in Flanders is 1.5%. |
| Denmark | The Danish value for the $Frac_{GASF}$ is an average of national estimates of $NH_3$ emissions from each fertilizer type (Sommer and Christensen, 1992; Sommer and Jensen, 1994; Sommer and Ersbøll, 1996) in accordance with the CLRTAP guidebook. This average is with 0.02 considerably lower than given in IPCC, i.e. 0.10. The major part of the Danish emission is related to the use of calcium ammonium nitrate and NPK fertiliser, where the emission factor is 0.02 kg $NH_3$-N/kg N. The low Danish $Frac_{GASF}$ is also probably due to a small consumption of urea (<1%), which has a high emission factor. |
| Finland | The country-specific $Frac_{GASF}$ value is based on the $NH_3$ emission factor given in the report by (ECETOC, 1994) for NPK fertilisers, which is 1% of the nitrogen content in the fertilisers. In Finland, about 90% of the fertilisers are NPK fertilizers. Urea is used only in small amounts. 80% of the nitrogen in synthetic fertilisers in Finland is applied using the placement method - placing the fertilizer approximately 7-8 cm below the soil surface (urea application is place on the surface). A conservative estimate of 50% surface application has been used. A project to measure ammonia emissions from fertilisation may lead to a revision of the $Frac_{GASF}$ values. |
| Germany | $Frac_{GASF}$ dynamically calculated using default emission factors for the application of mineral fertilizers (EMEP/CORINAIR, 2003). $NH_3$ emissions consider different fertilizer types, temperature during fertilizer application, and makes a distinction between arable and grassland. To this purpose, the total fertilizer application is distributed to grassland and arable land under the assumption that no preference for fertilizer types exists and under application of fertilizer application recommendations. |
| Ireland | The volatilization rates for Ireland are however determined from an elaborate new $NH_3$ inventory for agriculture and it is assumed that nitrogen lost as $NO_X$ is negligible in comparison to $NH_3$. |
| Netherlands | Indirect $N_2O$ emissions resulting from atmospheric deposition are estimated using country-specific data on ammonia emissions. The extent of the $NO_x$ emission as a result of fertiliser and animal manure is estimated at 15% of the ammonia emission (De Vries et al., 2003). The supply source, deposits of $NO_x$ as a result of using fertiliser and animal manure, is not (yet) included in the annual calculations under the framework of the Emission Registration, and is therefore not included when determining the nitrogen balance. |
| Portugal | Product specific volatilization rates from EMEP/CORINAIR (EEA,2003) were used for each nitrogen fertilizer type. The weighted average varies between 0.053 and 0.064 kg $NH_3$-N/kg N, and which are almost half the default value. |
| Spain | $Frac_{GASF}$ is calculated according to the EMEP/CORINAIR methodology. |
| Sweden | The proportions of emitted N-content of fertilisers sold in different years varie because of changes in the sold quantities of different types of fertilisers. Ammonia emission fractions after CORINAIR. |

**Table 6.73 Member State's background information on the fraction of $NH_3$ and $NO_x$ volatilized from applied manure, $Frac_{GASM}$ for the calculation of $N_2O$ emissions in category 4.D**

| Member State | $Frac_{GASM}$ |
|---|---|
| Austria | The amount of manure left for spreading was calculated within source category 4B (Amon et al., 2002). With regard to a coprehensive treatment of the nitrogen budget, the emission inventory of $N_2O$ is linked with the Austrian inventory of $NH_3$. This procedure enables the use of country specific data, which is more accurate than the use of the default value for $Frac_{GASM}$. Nitrogen left for spreading is calculated subtracting the following losses: N-excreted during grazing, $NH_3$-N losses from housing, $NH_3$-N losses during manure storage and $N_2O$-N losses from manure management. $\underline{NH_3 \text{ emissions from housing:}}$ according to CORINAIR guidelines 1999 (Swiss or German default factors); $\underline{NH_3 \text{ emissions from manure management}}$: TAN content accroding to Schlechtner 1991 (cattle and pigs) + emissions factors default CORINAIR; other animals CORINAIR simple methodology; $\underline{NH_3 \text{ emissions during manure application}}$: CORINAIR default factors; $\underline{NO_X\text{-emissions during manure application}}$: a conservative emission factor for $NO_x$-N of 1% was used (Fre |
| Belgium | In Wallonia and Flanders no animal manure is burned.In Flanders the animal manure nitrogen used as fertiliser is also corrected for the amount of manure transported outside Flanders or to a fertiliser processing company. |
| Denmark | The $Frac_{GASM}$ is estimated as the total N-excretion (N ab animal) minus the ammonia emission in stables, storage and application. They are based on national estimations and are calculated in the ammonia emission inventory. The $Frac_{GASM}$ has decreased since 1990 0.26 to 0.20. This is a result of an active strategy to improve the utilization of the nitrogen in manure. It is assumed that 1.9% of the N-input from sewage sludge or industrial sludge applied to soil volatilises as ammonia. An ammonia emission factor of 7% is used for all animal categories based on investigations from the Netherlands and the United Kingdom (Jarvis et al. 1989a, Jarvis et al., 1989b and Bussink 1994). |
| Finland | Value for $Frac_{GASM}$ has been obtained from the ammonia model of VTT Technical Research Centre of Finland (Savolainen, 1996). In the model, annual N excreted by each animal type has been distributed into different manure management systems typical for each animal group. Ammonia volatilisation during stable, storage and application were included with specific emission factor in each phase. $Frac_{GASM}$ is the proportion of total $NH_3$-N of the total N excreted. Emission factors for the amount of $NH_3$ volatilised in each phase has been taken from (ECETOC, 1994; Grönroos et al., 1998). References that support the values used are cited in the NIR. For grazing animals, an ammonia emission factor of 7% is used for all animal categories based on investigations from the Netherlands and the United Kingdom (Jarvis et al., 1989a; Jarvis et al., 1989b; Bussink 1994). |
| Germany | $Frac_{GASM}$ dynamically calculated using default emission factors for the application of organic fertilizers (EMEP/CORINAIR, 2003). Germany considers broadcasting,and for slurry additionally trailing hose and trailing shoe for slurry. Distinction is made between arable land and grassland. Incorporation timing is considered (< 1 h, < 4 h, < 6 h, < 12 h, < 24 h, and without incorporation). $Frac_{GASM}$ is calculated considering also the input of nitrogen with straw and imported manure. However, $Frac_{GASM}$ does not consider volatilizations or N-input from bedding material, leguminous crops, which are calculated separately for estimating total indirect $N_2O$ emissions from volatilization. |

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|---|---|
| Ireland | The volatilization rates for Ireland are however determined from an elaborate new $NH_3$ inventory for agriculture and it is assumed that nitrogen lost as $NO_X$ is negligible in comparison to $NH_3$. In addition, $Frac_{GASM}$ is split into $Frac_{GASM}1$ and $Frac_{GASM}^2$ with $Frac_{GASM}1$ referring to $NH_3$-N losses from animal manures in housing, storage and landspreading and $Frac_{GASM}^2$ being the proportion of nitrogen excreted at pasture that is volatilised as $NH_3$. |
| Italy | $Frac_{GASM}$ country-specific |
| Netherlands | Indirect $N_2O$ emissions resulting from atmospheric deposition are estimated using country-specific data on ammonia emissions (estimated at a tier 3 level; LEI-MAM). |
| Portugal | The use of emission factors of ammonia volatilisation from EMEP/UNECE results, therefore, in obtaining a value for $Frac_{GASM}$ that is different and slightly higher than the default value for $Frac_{GASM}$. The resultant implied $Frac_{GASM}$ oscilates between 0.22 to 0.23 kg N-$NH_3$ + N-$NO_x$/ kg of N excreted. |
| Spain | National $Frac_{GASM}$ |
| Sweden | The estimates of the fraction of nitrogen supply in emitted as ammonium-N are model-based and take into account many factors that influence gas emissions. The methodology, based on data collected on the use of manure from telephone interviews with farmers, was developed in the early 1990s. Later, the methodology was extended to take into account more detailed information on the use of manure and manure storage. $Frac_{GASM}$ varies from year to year. |

**Table 6.74 Member State's background information on the fraction of nitrogen input leached or run-off, $Frac_{LEACH}$ for the calculation of $N_2O$ emissions in category 4.D**

| Member State | FracLEACH and EF5 |
|---|---|
| Austria | Default value applied to nitrogen inputs from synthetic fertilizer use, livestock excretion, and sewage sludge application. |
| Belgium | FracLEACH is estimated from local studies (Pauwelyn, 1997) and falls into the IPCC range (0.17 kg N / kg N available). In Flanders, the nitrogen leaching ($N_2O$ model) comes from the SENTWA model (System for the Evaluation of Nutrient Transport to Water) that is yearly updated. |
| Denmark | The calculation of N to the groundwater is based on two different models– SKEP/Daisy and N-LES (Børgesen & Grant, 2003) carried out by DJF and NERI. SKEP/DAISY is a dynamical crop growth model taking into account the growth factors, whereas N-LES is an empirical leaching model based on more than 1500 leaching studies performed in Denmark during the last 15 years. The models produce rather similar results for nitrogen leaching on a national basis (Waagepetersen et al., 2008). Data concerning the N-leaching to rivers and estuaries is based on data from NOVANA (National Monitoring program of the Water Environment and Nature) received from NERI the department of Freshwater Ecology. NOVANA is a monitoring program which includes monitoring of the ecologic, physic and chemical condition of water areas and transport of water and a range of substances, including N, to lakes and the sea (Wiberg-Larsen et al., 2010). These studies include measurements from 223 monitoring stations in all parts of Denmark and have been go |
| Finland | It is estimated that nitrogen leaching is less than IPCC default value in Finnish conditions (Rekolainen, 1993) value is 15% and this has been used in the inventory). |
| Germany | |
| Ireland | The expressions for $N_2O$ indirect-dep and $N_2O$ indirect-leach are slightly modified to be consistent with those for estimating direct emissions above and to account for the two separate volatilisation fractions $Frac_{GASM}1$ and $Frac_{GASM}^2$. Estimates of the nitrogen loads in Irish rivers reported under the OSPAR Convention (NEUT, 1999) suggest that approximately 10 percent of all applied nitrogen in Irish agriculture is lost through leaching. This level of leaching is also indicated by farm budget studies where the nitrogen runoff equivalent to 60 kg N/ha has been measured in streams adjoining farmland receiving 200 kg N/ha from chemical fertilizer and 100 kg N/ha from animal manures per year. The value of 0.1 is considered to be a more realistic estimate of FracLEACH than the default value of 0.3. |
| Netherlands | Default $Frac_{GASM}$. Any manure that is exported to other countries is not included in the calculation. The nitrogen in exported manure is determined annually by CBS. The sewage sludge supply source is not included in the calculation of indirect $N_2O$ emissions from agricultural soil. Indirect $N_2O$ emissions resulting from leaching and run-off N emissions are estimated using country-specific data on total N-input into soil (estimated at a Tier 2 level). IPCC default values are used for the fraction of N-input to soil that leaches from the soil and ends up partly as $N_2O$ emissions from groundwater and surface water (Frac-leach) and for the $N_2O$ emission factors. |
| Portugal | Default FracLEACH for nitrogen applied to soil. For 20% of manure managed in anaerobic lagoons, which are directly discharged to the wastewater system, with agreement of the ERT, the $N_2O$ emissions are calculated directly from the total amount of manure discharged, without considering volatilization losses are a leaching fraction. |
| Sweden | The national estimates of nitrogen leaching are calculated from the SOILNDB model , which is a part of the SOIL/SOILN model (Johnsson, 1990; Swedish EPA, 2002). The simulation model SOIL/SOILN was developed during the 1980s in order to describe nitrogen processes in agricultural soils. Since then the model has been developed and tested on data from controlled leaching experiments, and these tests show that the model estimates leachign from soils with good precision (Swedish EPA, 2002b). By using national data on crops, yields, soil, use of fertilizer/manure and spreading time, the leaching is estimated for 22 regions. These regions are based on similarities in agricultural production. For calculating nitrogen leaching in the inventory, the average N leaching per hectare, calculated by the SOILNDB model, is multiplied by the total Swedish area of agricultural soil. To estimate the implied FracLEACH,the leached nitrogen, according to the national model, is divided by the sum of nitrogen in fertilisers and anim |
| United Kingdom | Indirect emissions of $N_2O$ from leaching and runoff are estimated according the IPCC methodology but with corrections for $N_2O$ emissions to avoid double counting N. The sources of nitrogen considered, are synthetic fertiliser application and animal manures applied as fertiliser. |

*$N_2O$ emissions from other sources.*

Seven countries report emissions of $N_2O$ from the application of sewage sludge, according to the IPCC GPG. The emission factors used are in six cases the IPCC default factor for direct $N_2O$ emissions, one Member States used a different value. An overview of the emissions from sewage sludge and the specified other 'other' sources in category 4D is given in Table 6.75. Furthermore, other $N_2O$ emissions are reported bu the Netherlands, Portugal and the United Kingdom.

**Table 6.75 Member State's emissions from "other" sources in category 4D**

| Member States 2009 | Description | Value kg N/yr | IEF kg $N_2O$-N / kg N | EMISSIONS $N_2O$ (Gg) | Value kg N/yr | IEF kg $N_2O$-N / kg N | EMISSIONS $N_2O$ (Gg) |
|---|---|---|---|---|---|---|---|
| | | 1990 | | | 2009 | | |
| Austria | Sewage Sludge Spreading | 1,034,480 | 0.0125 | 0.0203 | 1,310,432 | 0.0125 | 0.0257 |
| Denmark | Industrial waste used as fertilizer | 1,528,720 | 0.0125 | 0.0300 | 11,000,000 | 0.0125 | 0.2161 |
| Denmark | Use of sewage sludge as fertilizers | 3,056,918 | 0.0125 | 0.0600 | 2,330,469 | 0.0125 | 0.0458 |
| Finland | Municipal sewage sludge applied to soils | 1,642,680 | 0.0125 | 0.0323 | 192,266 | 0.0125 | 0.0038 |
| France | 4.D.1.6.1 Sewage Sludge Spreading | 15,411,141 | 0.0125 | 0.3027 | 18,575,912 | 0.0125 | 0.3649 |
| France | 4.D.1.6.2 Compost Spreading | 21,362 | 0.0125 | 0.0004 | 178,069 | 0.0125 | 0.0035 |
| Germany | Agricultural crops | 1,170,480,000 | 0.0250 | 45.9754 | 1,006,080,000 | 0.0250 | 39.5074 |
| Luxembourg | Sewage Sludge Spreading | 377,061 | 0.0125 | 0.0074 | | | |
| Netherlands | 4. Other (please specify) | | | 0.0786 | | | 0.0157 |
| Spain | Domestic Wastewater Sludge | 8,321,005 | 0.0125 | 0.1630 | 39,802,576 | 0.0125 | 0.7795 |
| Spain | Municipal Solid Wastes Compost | 8,506,498 | 0.0125 | 0.1666 | 6,704,295 | 0.0125 | 0.1313 |
| Sweden | Use of sewage sludge as fertilizers | 1,180,000 | 0.0087 | 0.0162 | 2,205,198 | 0.0087 | 0.0303 |
| United Kingdom | 4. Other (please specify) | | | 0.6952 | | | 2.0163 |

Additional information on $N_2O$ emissions estimated from the application of sewage sludge it given in Table 6.76.

**Table 6.76 Member State's background information on $N_2O$ emissions estimated under the category 'other' in category 4.D**

| Member State | |
|---|---|
| Austria | Country-specific data on N-content (Scharf et al., 1997). |
| Denmark | The category, "Other", includes emission from sewage sludge and sludge from the industrial production applied to agricultural soils as fer-tiliser. Information about industrial waste, sewage sludge applied on ag-ricultural soil and the content of nitrogen is provided by the Danish Environmental Protection Agency. |
| Ireland | Published estimates of sludge production (Smith et al, 2007) and the proportion applied on agricultural lands are used to estimate FS on the basis of 3 percent nitrogen content in sewage sludge with typical dry solids content of 25 percent (Fehily Timoney, 1985). The estimate of FS is included in $N_2O$direct without deduction for volatilisation and the value is added to FAM for reporting purposes. |
| Spain | Data on the application of sewage sludge are available for the years 1989, 1993 and 1997. For the other years these data are linearly interpolated. |
| Sweden | $N_2O$ from sewage sludge used as fertiliser is a part of the $N_2O$ emissions from agricultural soils and may be reported, according to the IPCC Good Practice Guidance, if sufficient information is available. Statistics on the use of sewage sludge have been published irregularly and in different reports, but a time series has been created through interpolation and the emissions are reported for the first time in submission 2006 of the GHG inventory. |

## Trends

Consistent with the decrease of animal numbers in Europe and the decrease of nitrogen in manure (see above), also the input of nitrogen to agricultural soils decreased considerably in the time between 1990 and 2009, as shown in Table 6.62. The input of manure decreased by 10%, and the input of mineral fertilizer decreased even more, by 31%. Accordingly, also the amount of nitrogen volatilized or leached decreased by 22% and 20%, respectively.

Figure 6.33 through Figure 6.46 show the trend of direct $N_2O$ emissions from the source categories mineral and organic fertilizer application and indirect emissions from atmospheric deposition and nitrogen leaching and run-off.

In several countries the fraction of mineral fertilizer that volatilises as $NH_3$ or $NO_x$ is showing considerable fluctuation (see for example Sweden and Ireland). This is a direct consequence of the varying composition of the types of mineral fertilizer used and the $NH_3$ emission factors taken from the more detailed ammonia-inventory.

The fraction of livestock N excretion that volitilises as $NH_3$ or $NO_x$ is reported to be more stable. A descreasing trend can be observed for Denmark and Belgium.

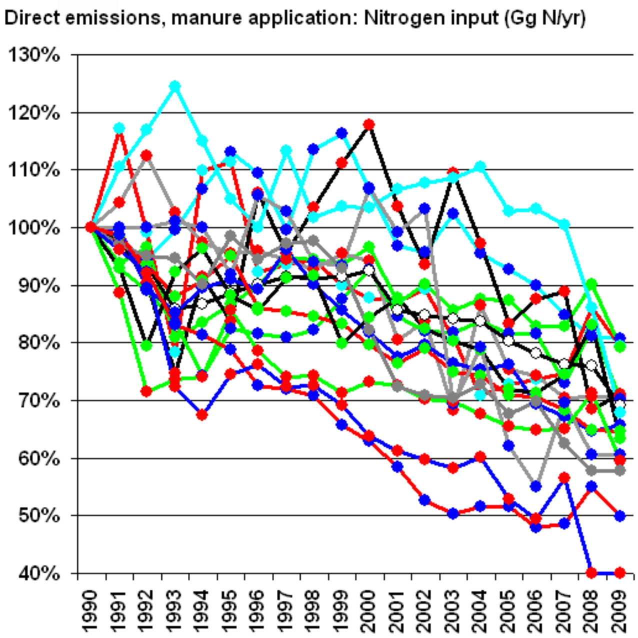
Table 6.77 gives additional information on the trend in category 4D as reported in the national inventory reports.

**Table 6.77 Member State's background information on the trend for $N_2O$ emissions in category 4D.**

| Member State | Trend in category 4B(b) |
|---|---|
| Austria | High inter-annual variations in $N_2O$ emissions are caused by fluctuations in mineral fertilizer sales. These variations are caused by the effect of storage. As fertilizers have a high elasticity to prices, sales data are changing due to changing market prices very rapidly. Not the whole amount purchased is applied in the year of purchase. The fertilizer tax intensified this effect at the beginning of the 1990s. In the in-country review 2007 it was recommended to consider revising the time series by determining actual fertilizer use in accordance with the IPCC good practice guidance. Investigations showed that data on the actual fertilizer use are not available in Austria. Therefore it has been decided to continue to use the official fertilizer sales data as input data for the emission inventory. |
| Belgium | The fraction volatilised as $NH_3$ and NO in Flanders ($Frac_{GASM}$) decreased from a value of 0.36 kg($NH_3$-N+NO-N)/kg Nex in 1990 to 0.20 kg($NH_3$-N+NO-N)/kg Nex in 2006 due to the implementation of different successive Manure Action Plans in Flanders. |
| Denmark | The total $N_2O$ emission from 1990-2006 has decreased by 24%. This reduction is due to a proactive national environmental policy over the last twenty years. The national emission from crop residues has decreased 12% since 1990, which is a result of a decrease in the cultivated area of beets for feeding, which has been replaced by cultivation of green maize. Another reason is a fall in the agricultural area and a greater part of the straw is harvest (52% in 1990 and 60% in 2007). FracLEACH is decreasing since the 1990s, when manure was often applied in autumn. The decrease in FracLEACH over time is caused by sharpened environmental requirements, banning manure application after harvest. The major part of manure application is made in spring and summer, where there is a precipitation deficit. The interannual decrease of indirect $N_2O$ emissions in 2008/2009 is 8%. This is due to a decrease in the emission from leaching and run off, which is decreased because of a decrease in N-input mainly from synthetic fertilizer. |
| Finland | The emissions have decreased by 25%, from 13.9 Gg in 1990 to 10.4 Gg in 2006. The main reasons causing this reduction are the reduction in animal numbers, which affects the amount of nitrogen excreted annually to soils, the fall in the amount of synthetic fertilisers sold annually and the decrease in the area of cultivated organic soils. Some parameters, such as the annual crop yields affecting the amount of crop residues produced, cause the fluctuation in the time series but this fluctuation does not have much effect on the overall $N_2O$ emissions trend. The interannual decrease of indirect $N_2O$ emissions in 2008/2009 is 9%. This decrease is due to reduction in the amount of N subject to leaching and run-off as a result of decrease in the use of synthetic fertilizers and less N applied in soils in manure in 2009 compared to 2008. |
| France | The interannual decrease of indirect $N_2O$ emissions in 2008/2009 is 7%. This sharp decrease is mainly due to an important decrease of mineral fertilisation (-12% from 2008 to 2009). |
| Greece | The interannual decrease of $N_2O$ emissions from direct soil in 2007/2008 is 21%. The reduction of synthetic nitrogen fertilizers use is attributed mainly to increase on the price of fertilizer as well as to increase in organic farming and to the impact of initiatives to promote good practice in fertilizer use. The finding has already been recognised since December 2009 and the explanation has been confirmed by the experts of Pan-Hellenic Association of Professional Fertilizers Producers & Dealers. |
| Netherlands | Total $N_2O$ emissions from Agricultural soils decreased significantly since 1990. Direct emissions increased, while indirect emissions and emissions from animal manure produced in the meadow decreased, respectively. This decrease is caused by a relatively high decrease in N-input to soil (from manure and chemical fertilizer application and animal production in the meadow) partly counteracted by the increased IEF in this period that resulted from a shift from the surface spreading of manure to the incorporation of manure into soil as a result of ammonia policy driving a shift from surface spreading of manure to the incorporation of manure into the soil. The decrease in indirect $N_2O$ emissions is fully explained by the decrease in N lost by atmospheric deposition and by leaching and run-off. The decrease in $N_2O$ emissions from animal manure produced in the meadow is also entirely reflected in the decrease in N-input to soil by this source.The increase in direct $N_2O$ emissions can mainly be explained by the decrease in the direct N-input to soil by manure and chemical fertilizer application in combination with an increase of the IEF. For (direct) soil emissions by manure application to soil an increase of the IEF is caused by a ammonia policy driven shift from the surface spreading of manure to the incorporation of manure into the soil. |
| Portugal | Time series shows an abrupt decrease until 1992 and thereafter a lighter reduction: total synthetic nitrogen fertilizer use in 2003 is 22% less than in 1990. Nitrogen in fertilizers is the first source of nitrogen to soils in Portugal just above nitrogen in animal manure applied to soil. Interannual changes of emissions (2002/2003 16%, 2003/2004 6%, 2004/2005 8%, 2005/2006 11%, fluctuation from 2003) can be explained from variations of emissions from N applied as synthetic fertilizers. During this period a severe drought occured which caused reduction in the sales and use of fertilizers. |
| Sweden | Estimated standard yields for different crops are published annually by SJV/Statistics Sweden and are a function of crop yields estimated by surveys conducted over the last 15 years. By using standard yields instead of actual yields in the calculations, the time series becomes more regular. $Frac_{GASF}$: variations in $Frac_{GASF}$ are a direct consequence of the varying composition of types of mineral fertilizers (Swedish Board of Agriculture, Statistics Sweden) and the $NH_3$ emission factors from CORINAIR (1998) (see inventory report Sweden). $Frac_{GASM}$: The fraction of nitrogen supply emitted as ammonium-N is model-based and take into account many factors that influence gas emissions. The methodology, based on data collected on the use of manure from telephone interviews with farmers, was developed in the early 1990s. Later, the methodology was extended to take into account more detailed information on the use of manure and manure storage. |
| United Kingdom | Direct $N_2O$ emissions from soil are decreasing of $N_2O$ emissions in 2006 by 8%, due to a decrease in inorganic fertiliser by |

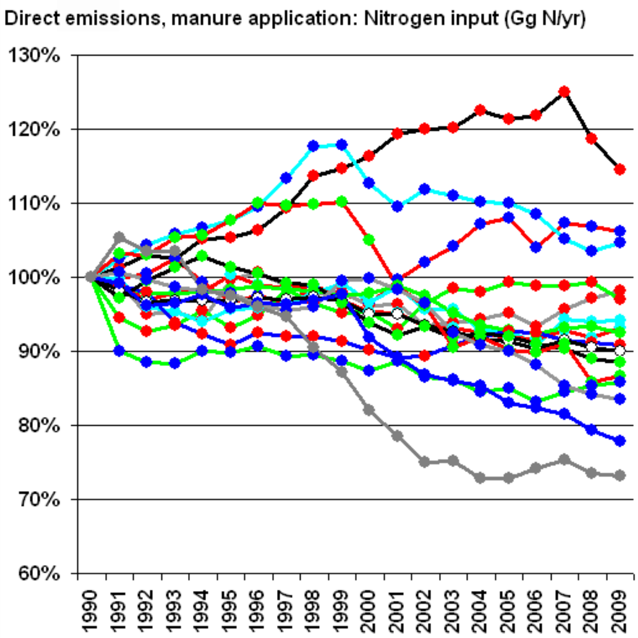
| | |
|---|---|
| | 9% |

**Figure 6.33 Trend of $N_2O$ emissions for mineral fertilizer – N-input**




| | 1990 | Trend (%) 1990-2009 | 2009 |
|---|---|---|---|
| Ireland | 373.7 | 81% | 301.4 |
| Austria | 133.3 | 79% | 106.0 |
| France | 2,409.3 | 79% | 1,910.2 |
| Spain | 1,074.2 | 71% | 762.8 |
| Luxembourg | 17.0 | 71% | 12.0 |
| Germany | 2,089.3 | 70% | 1,467.3 |
| EU-15 | 10,244.5 | 69% | 7,077.7 |
| Italy | 691.7 | 68% | 469.1 |
| United Kingdom | 1,470.6 | 66% | 966.3 |
| Belgium | 200.5 | 65% | 129.4 |
| Sweden | 222.6 | 63% | 141.1 |
| Portugal | 149.9 | 61% | 90.8 |
| Finland | 225.1 | 59% | 133.8 |
| Netherlands | 412.4 | 58% | 238.1 |
| Denmark | 393.2 | 50% | 196.4 |
| Greece | 381.6 | 40% | 153.0 |

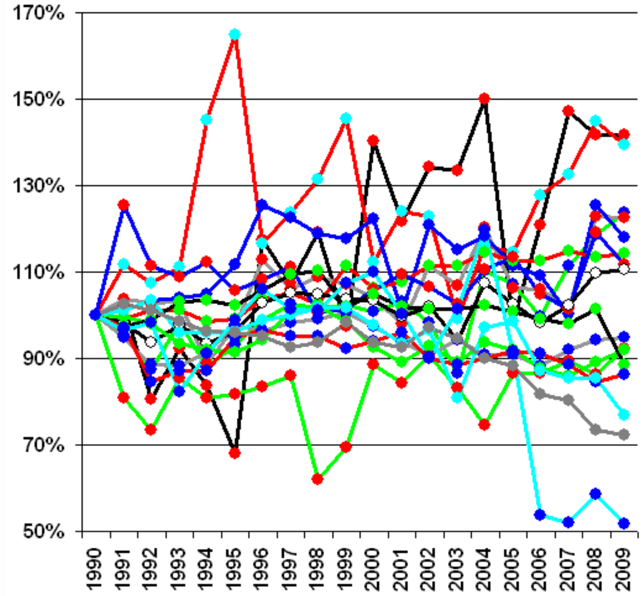
**Figure 6.34 Trend of $N_2O$ emissions for organic fertilizer – N-input**




| | 1990 | Trend (%) 1990-2009 | 2009 |
|---|---|---|---|
| Spain | 339.2 | 114% | 388.3 |
| Denmark | 180.1 | 106% | 191.1 |
| Ireland | 69.2 | 105% | 72.4 |
| Luxembourg | 5.9 | 98% | 5.8 |
| Finland | 60.3 | 97% | 58.5 |
| Italy | 473.8 | 94% | 446.4 |
| Austria | 120.4 | 93% | 112.2 |
| France | 923.9 | 92% | 854.1 |
| Greece | 42.9 | 91% | 39.0 |
| EU-15 | 4,286.6 | 90% | 3,856.8 |
| Sweden | 69.8 | 88% | 61.7 |
| Belgium | 143.1 | 87% | 124.0 |
| Germany | 921.9 | 86% | 790.7 |
| Portugal | 54.5 | 83% | 45.5 |
| United Kingdom | 471.4 | 78% | 367.0 |
| Netherlands | 410.5 | 73% | 300.3 |

**Figure 6.35 Trend of $N_2O$ emissions from crop residues – N-input**

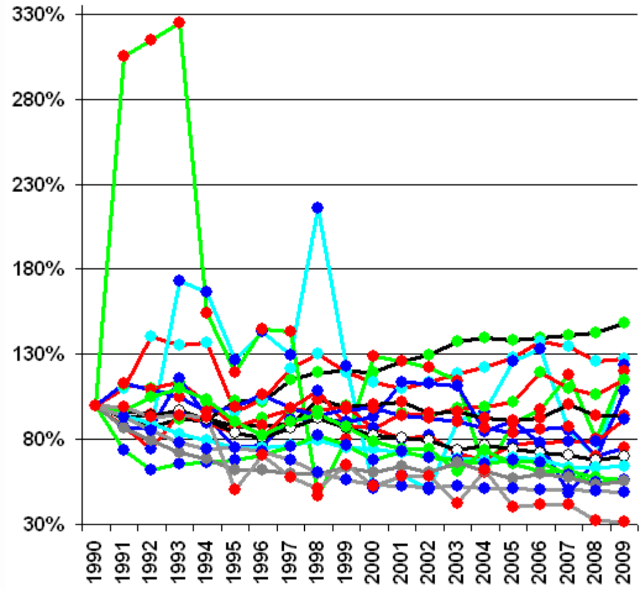
Crop residues: Nitrogen input (Gg N/yr)




| | 1990 | Trend (%) 1990-2009 | 2009 |
|---|---|---|---|
| Spain | 93.4 | 142% | 132.3 |
| Austria | 41.9 | 139% | 58.3 |
| Germany | 1,028.9 | 124% | 1,273.5 |
| Luxembourg | 3.1 | 123% | 3.8 |
| United Kingdom | 365.2 | 118% | 430.6 |
| Belgium | 63.1 | 114% | 72.1 |
| Greece | 23.6 | 112% | 26.3 |
| EU-15 | 2,524.0 | 110% | 2,788.5 |
| Portugal | 26.6 | 95% | 25.2 |
| Finland | 30.7 | 92% | 28.4 |
| France | 531.2 | 92% | 489.4 |
| Sweden | 53.4 | 89% | 47.3 |
| Denmark | 59.3 | 86% | 51.2 |
| Italy | 147.5 | 77% | 113.6 |
| Netherlands | 36.4 | 72% | 26.4 |
| Ireland | 19.7 | 52% | 10.2 |

**Figure 6.36 Trend of $N_2O$ emissions from N-fixing crops – N-input**

N-fixing crops: Nitrogen input (Gg N/yr)




| | 1990 | Trend (%) 1990-2009 | 2009 |
|---|---|---|---|
| Sweden | 23.6 | 149% | 35.1 |
| Austria | 16.8 | 127% | 21.4 |
| Ireland | 0.5 | 124% | 0.6 |
| Finland | 0.7 | 120% | 0.8 |
| Belgium | 5.6 | 115% | 6.5 |
| United Kingdom | 43.2 | 108% | 46.7 |
| Spain | 203.1 | 94% | 190.3 |
| Denmark | 44.3 | 92% | 40.7 |
| Greece | 1.1 | 75% | 0.8 |
| EU-15 | 1,262.9 | 70% | 880.9 |
| Italy | 254.7 | 64% | 163.8 |
| France | 515.7 | 56% | 288.7 |
| Germany | 140.4 | 56% | 78.5 |
| Netherlands | 7.8 | 55% | 4.3 |
| Portugal | 5.0 | 49% | 2.5 |
| Luxembourg | 0.3 | 32% | 0.1 |

**Figure 6.37** **Trend of $N_2O$ emissions from cultivated histosols – Cultivated area**

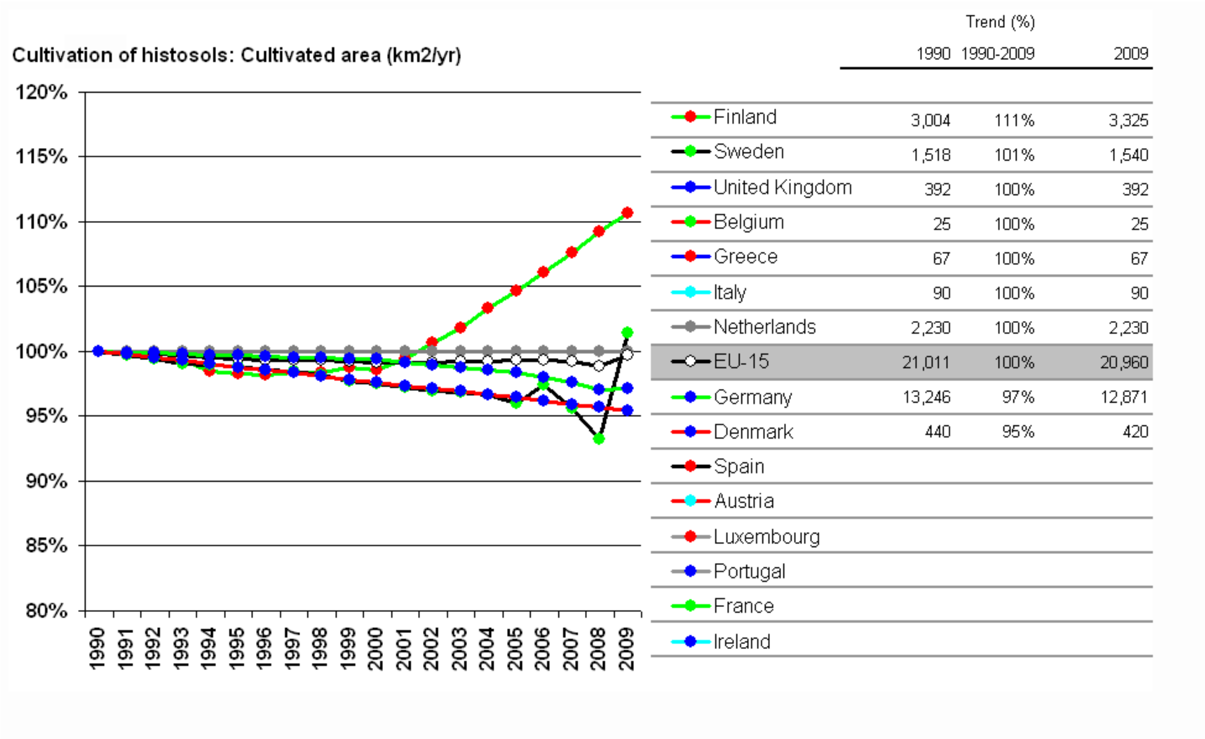



**Figure 6.38** **Trend of $N_2O$ emissions from pasture, range, and paddock – N-input**

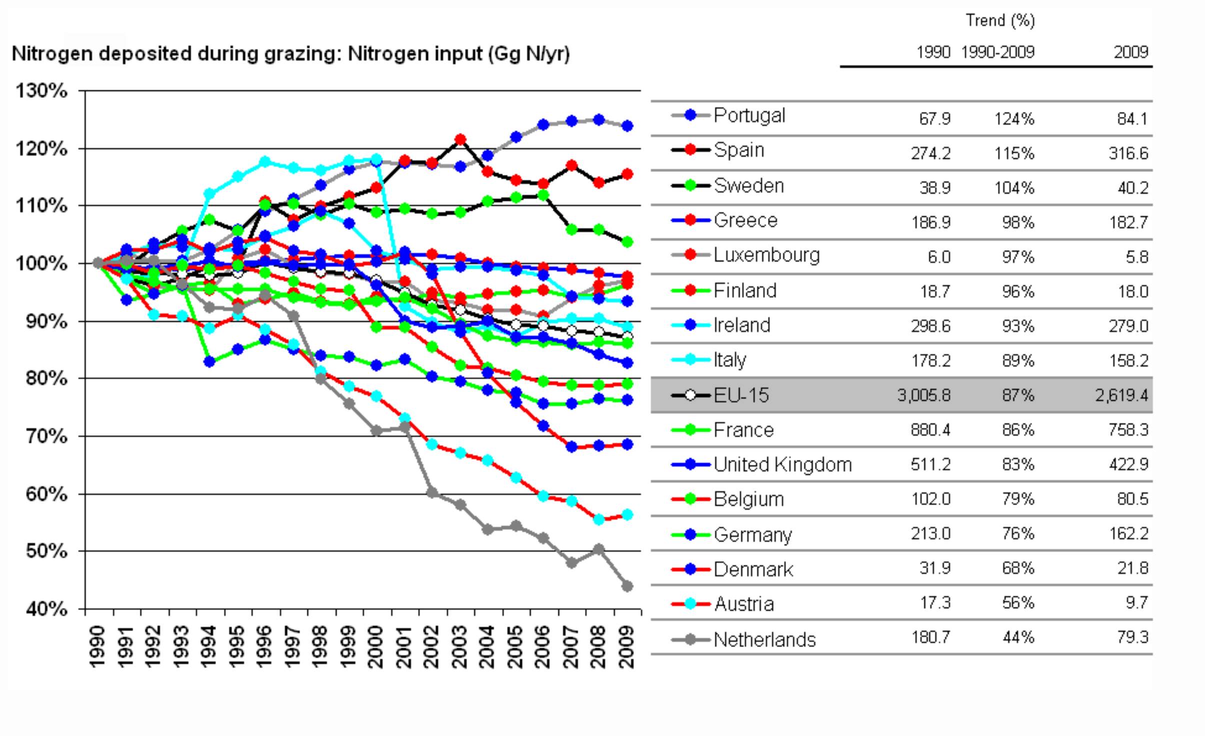
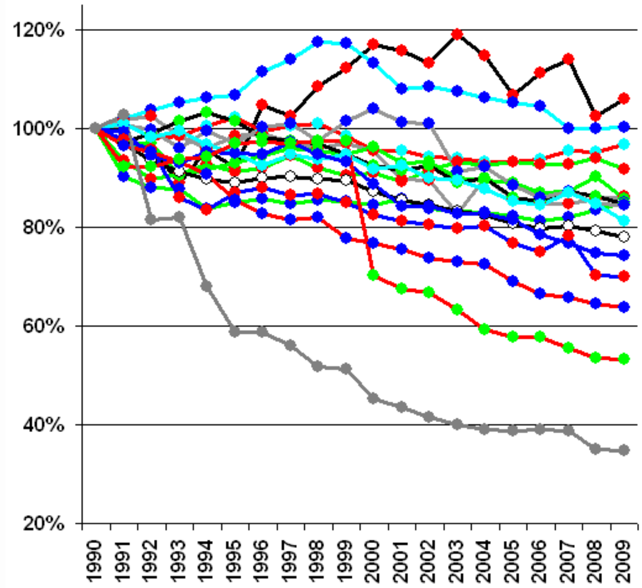


**Figure 6.39 Trend of $N_2O$ emissions for atmospheric deposition – N-input**

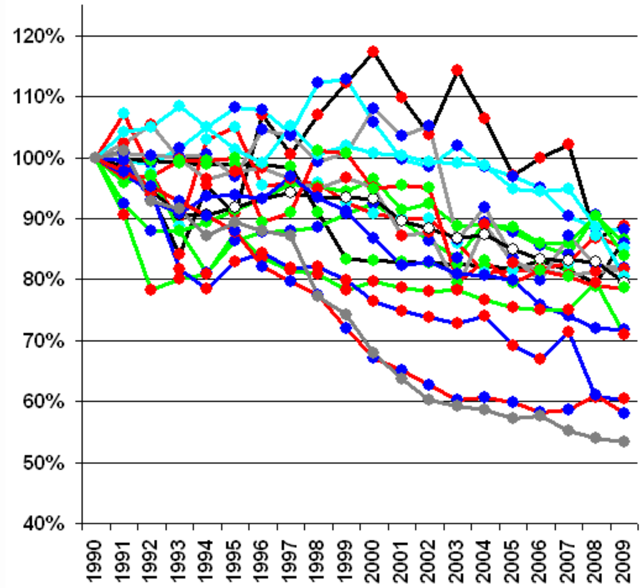
Nitrogen volatilised as NH3+NOx: Nitrogen input (Gg N/yr)




| | 1990 | Trend (%) 1990-2009 | 2009 |
|---|---|---|---|
| Spain | 170.2 | 106% | 180.3 |
| Ireland | 86.9 | 100% | 87.1 |
| Austria | 51.8 | 97% | 50.2 |
| Finland | 31.1 | 92% | 28.5 |
| Luxembourg | 4.6 | 86% | 4.0 |
| France | 676.8 | 86% | 579.5 |
| Germany | 604.0 | 85% | 512.8 |
| Sweden | 41.1 | 85% | 34.9 |
| Portugal | 43.0 | 84% | 36.3 |
| Italy | 381.0 | 81% | 309.1 |
| EU-15 | 3,081.9 | 78% | 2,406.5 |
| United Kingdom | 408.2 | 74% | 303.4 |
| Greece | 90.5 | 70% | 63.3 |
| Denmark | 95.5 | 64% | 60.8 |
| Belgium | 100.5 | 53% | 53.5 |
| Netherlands | 296.7 | 35% | 102.8 |

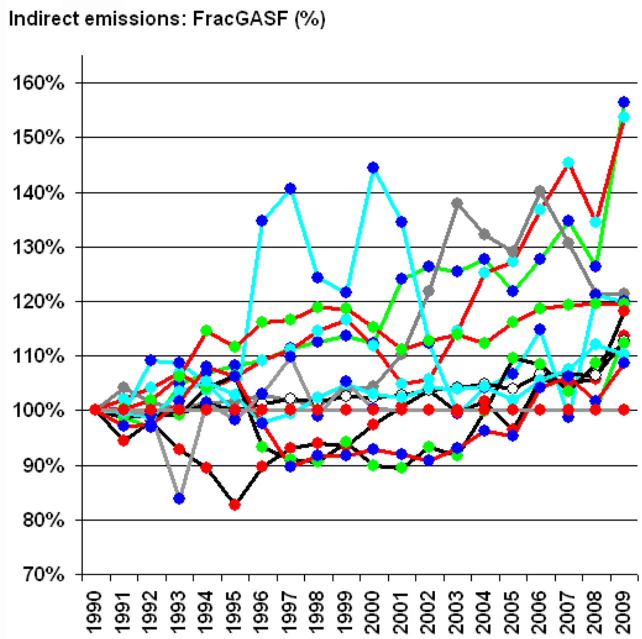
**Figure 6.40 Trend of $N_2O$ emissions for nitrogen leaching and run-off – N-input**

Nitrogen leached/run-off: Nitrogen input (Gg N/yr)



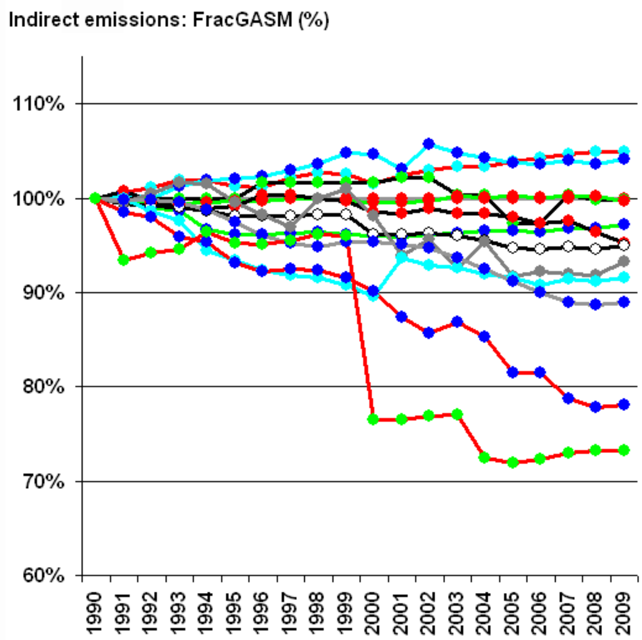

| | 1990 | Trend (%) 1990-2009 | 2009 |
|---|---|---|---|
| Spain | 511.3 | 89% | 454.2 |
| Ireland | 74.7 | 88% | 65.8 |
| Sweden | 83.8 | 86% | 72.4 |
| Germany | 1,170.5 | 86% | 1,006.1 |
| Austria | 90.3 | 85% | 76.8 |
| France | 1,419.3 | 84% | 1,190.8 |
| Portugal | 91.2 | 82% | 74.7 |
| Luxembourg | 9.8 | 82% | 8.0 |
| Italy | 516.0 | 80% | 415.3 |
| EU-15 | 5,561.1 | 80% | 4,424.6 |
| Belgium | 62.3 | 79% | 49.0 |
| United Kingdom | 857.4 | 72% | 616.1 |
| Finland | 50.7 | 71% | 36.0 |
| Greece | 199.4 | 60% | 120.4 |
| Denmark | 267.2 | 58% | 155.0 |
| Netherlands | 157.1 | 53% | 83.9 |

**Figure 6.41** **Trend of $Frac_{GASF}$**




| | 1990 | Trend (%) 1990-2009 | 2009 |
|---|---|---|---|
| Germany | 0.03 | 156% | 0.05 |
| Austria | 0.03 | 154% | 0.04 |
| Netherlands | 0.04 | 121% | 0.05 |
| Ireland | 0.01 | 120% | 0.02 |
| Belgium | 0.03 | 120% | 0.03 |
| Spain | 0.06 | 118% | 0.07 |
| Finland | 0.01 | 114% | 0.02 |
| EU-15 | 0.05 | 113% | 0.06 |
| Sweden | 0.01 | 112% | 0.01 |
| Italy | 0.09 | 110% | 0.10 |
| Denmark | 0.02 | 109% | 0.02 |
| Greece | 0.10 | 100% | 0.10 |
| Portugal | 0.06 | 100% | 0.06 |
| France | 0.10 | 100% | 0.10 |
| United Kingdom | 0.10 | 100% | 0.10 |
| Luxembourg | 0.10 | 100% | 0.10 |

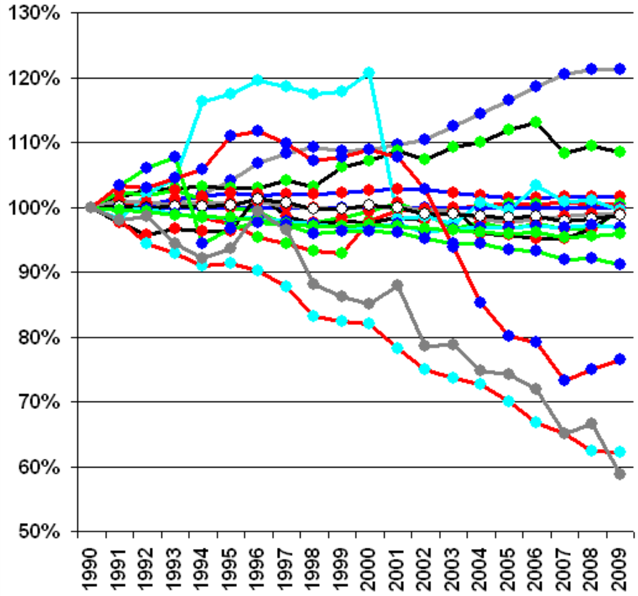
**Figure 6.42** **Trend of $Frac_{GASM}$**




| | 1990 | Trend (%) 1990-2009 | 2009 |
|---|---|---|---|
| Austria | 0.26 | 105% | 0.27 |
| Ireland | 0.19 | 104% | 0.19 |
| Greece | 0.20 | 100% | 0.20 |
| France | 0.20 | 100% | 0.20 |
| United Kingdom | 0.20 | 100% | 0.20 |
| Luxembourg | 0.20 | 100% | 0.20 |
| Sweden | 0.33 | 100% | 0.33 |
| Finland | 0.25 | 100% | 0.25 |
| Germany | 0.31 | 97% | 0.30 |
| Spain | 0.20 | 95% | 0.19 |
| EU-15 | 0.23 | 95% | 0.22 |
| Netherlands | 0.10 | 93% | 0.10 |
| Italy | 0.32 | 92% | 0.29 |
| Portugal | 0.22 | 89% | 0.19 |
| Denmark | 0.25 | 78% | 0.19 |
| Belgium | 0.29 | 73% | 0.21 |

**Figure 6.43** **Trend of Frac$_{GRAZ}$**

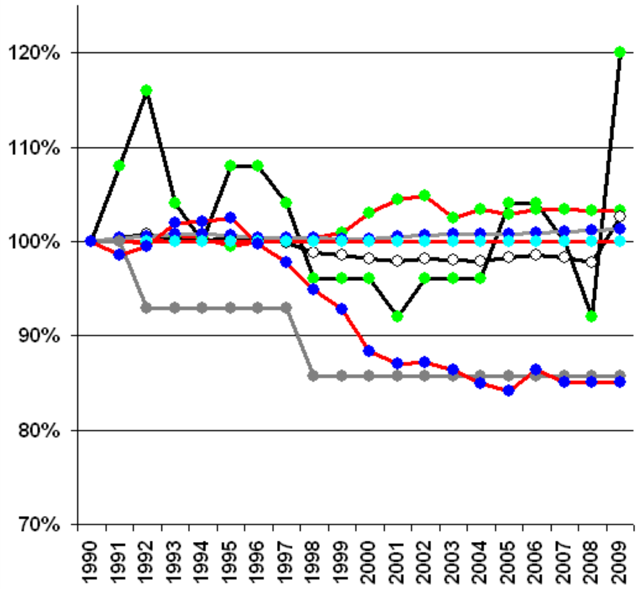
Pasture, range and paddock: FracGRAZ (%)




| | 1990 | Trend (%) 1990-2009 | 2009 |
|---|---|---|---|
| Portugal | 0.44 | 121% | 0.53 |
| Sweden | 0.30 | 108% | 0.32 |
| Greece | 0.78 | 102% | 0.79 |
| Belgium | 0.31 | 100% | 0.31 |
| United Kingdom | 0.52 | 100% | 0.52 |
| Finland | 0.18 | 100% | 0.18 |
| Spain | 0.39 | 100% | 0.39 |
| Italy | 0.19 | 100% | 0.19 |
| Luxembourg | 0.45 | 99% | 0.45 |
| EU-15 | 0.35 | 99% | 0.35 |
| Ireland | 0.68 | 97% | 0.66 |
| France | 0.43 | 96% | 0.41 |
| Germany | 0.13 | 91% | 0.12 |
| Denmark | 0.12 | 77% | 0.09 |
| Austria | 0.09 | 62% | 0.06 |
| Netherlands | 0.28 | 59% | 0.16 |

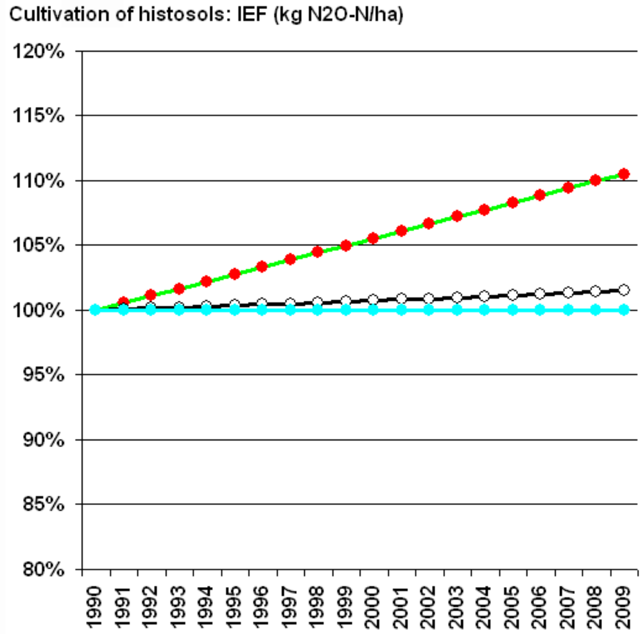
**Figure 6.44** **Trend of FracLEACH**

Indirect emissions: FracLEACH (%)



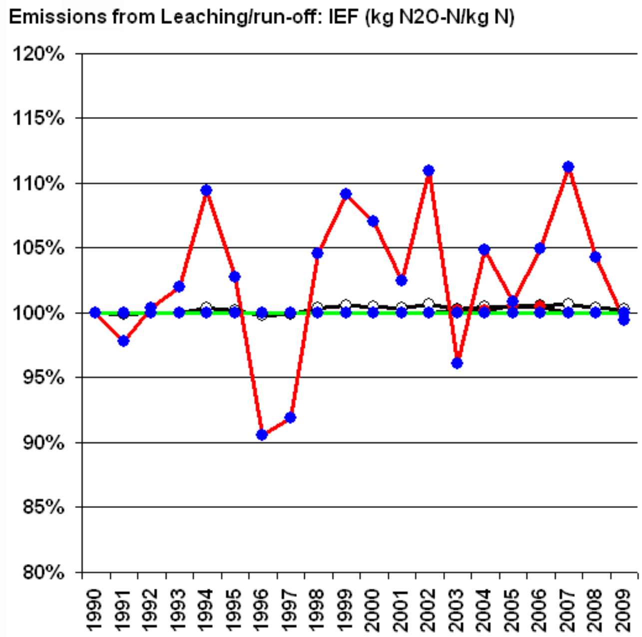

| | 1990 | Trend (%) 1990-2009 | 2009 |
|---|---|---|---|
| Sweden | 0.25 | 120% | 0.30 |
| Belgium | 0.14 | 103% | 0.14 |
| EU-15 | 0.26 | 103% | 0.27 |
| Portugal | 0.32 | 101% | 0.33 |
| Greece | 0.30 | 100% | 0.30 |
| United Kingdom | 0.30 | 100% | 0.30 |
| Finland | 0.15 | 100% | 0.15 |
| Spain | 0.30 | 100% | 0.30 |
| Italy | 0.30 | 100% | 0.30 |
| Luxembourg | 0.30 | 100% | 0.30 |
| Ireland | 0.10 | 100% | 0.10 |
| France | 0.30 | 100% | 0.30 |
| Germany | 0.30 | 100% | 0.30 |
| Austria | 0.30 | 100% | 0.30 |
| Netherlands | 0.14 | 86% | 0.12 |
| Denmark | 0.38 | 85% | 0.33 |

**Figure 6.45 Trend of direct emissions from the cultivation of histosols - IEF**




| | 1990 | Trend (%) 1990-2009 | 2009 |
|---|---|---|---|
| Finland | 7.48869 | 111% | 8.27646 |
| EU-15 | 7.57666 | 102% | 7.69275 |
| Sweden | 8.00000 | 100% | 8.00000 |
| Netherlands | 4.70000 | 100% | 4.70000 |
| Belgium | 8.00000 | 100% | 8.00000 |
| Denmark | 8.00000 | 100% | 8.00000 |
| Germany | 8.00000 | 100% | 8.00000 |
| United Kingdom | 8.00000 | 100% | 8.00000 |
| Greece | 8.00000 | 100% | 8.00000 |
| Italy | 8.00000 | 100% | 8.00000 |
| Luxembourg | | | |
| Ireland | | | |
| Portugal | | | |
| Austria | | | |
| France | | | |
| Spain | | | |

**Figure 6.46 Trend of indirect emissions from leaching/run-off - IEF**




| | 1990 | Trend (%) 1990-2009 | 2009 |
|---|---|---|---|
| EU-15 | 0.02470 | 100% | 0.02478 |
| France | 0.02500 | 100% | 0.02500 |
| Portugal | 0.02500 | 100% | 0.02500 |
| Finland | 0.02500 | 100% | 0.02500 |
| Greece | 0.02500 | 100% | 0.02500 |
| Austria | 0.02500 | 100% | 0.02500 |
| Italy | 0.02500 | 100% | 0.02500 |
| United Kingdom | 0.02500 | 100% | 0.02500 |
| Luxembourg | 0.02500 | 100% | 0.02500 |
| Ireland | 0.02500 | 100% | 0.02500 |
| Belgium | 0.02500 | 100% | 0.02500 |
| Netherlands | 0.02500 | 100% | 0.02500 |
| Spain | 0.02500 | 100% | 0.02500 |
| Sweden | 0.02500 | 100% | 0.02500 |
| Germany | 0.02500 | 100% | 0.02499 |
| Denmark | 0.01886 | 99% | 0.01875 |

### 6.3.5.3 Uncertainty and time series consistency

As described above, $N_2O$ emissions from agricultural soils belong to the most uncertain source categories of national GHG inventories. For direct $N_2O$ emissions, the highest uncertainty is attributed to the emission factor, which ranges up to 400% Greece relative uncertainty (expressed in 2•standard_deviation) and even 500% for each sub-category in Portugal. For indirect emissions, both the activity data and the emission factors are considered equally uncertain, which stems from the fact that a most uncertain parameter, the fraction of nitrogen leached, must be applied to determine the activity data. Thus, uncertainties of indirect $N_2O$ emissions are estimated as up to more than 200% (Finland, Netherland, Portugal).

This large spread of the uncertainty estimates does generally not reflect real differences in the uncertainties, but rather differences in the interpretation of the available data:

In the United Kingdom, the uncertainty assumed for agricultural soils uses a lognormal distribution since the range of possible values is so high. Here it is assumed that the 97.5 percentile is greater by a factor of 100 than the 2.5 percentile based on advice from the Land Management Improvement Division of DEFRA (per. comm.).

The estimate of Portugal is based on the Good Practice Guidance that presents a possible variation from one-fifth to 5 times the default emission factor of 1.25 per cent. From that range an uncertainty of 500 per cent was assumed in uncertainty analysis.

An overview of the uncertainty estimates for activity data and emission factors are given in Table 6.78 and Table 6.79. An overview of uncertainty estimates for agriculture at country and EU15 levels will be given in section 6.4

Table 6.80 compiles some background information on the estimates of the uncertainty of the values used as activity data and emission factors to estimate $N_2O$ emissions from agricultural soils.

**Table 6.78 Relative uncertainty estimates for activity data in category 4D**

| Member State 2009 | Total | Direct | Animal Production | Indirect |
|---|---|---|---|---|
| Austria | | 5.0 | 5.0 | 5.0 |
| Belgium | 30.0 | | | |
| Denmark | | | 25.5 | |
| Finland | | | | |
| France | | 10.0 | 20.0 | 10.0 |
| Germany | | 19.4 | 40.0 | 141.5 |
| Greece | | 20.0 | 50.0 | 20.0 |
| Ireland | | 11.2 | 11.2 | 11.2 |
| Italy | | 20.0 | 20.0 | 20.0 |
| Luxembourg | | 10.0 | 25.1 | 20.0 |
| Netherlands | | 10.0 | 10.0 | 50.0 |
| Portugal[1,2] | | 31.4 | 39.0 | 32.7 |
| Spain | | 18.0 | 16.0 | 190.0 |
| Sweden | | 26.3 | 35.0 | 35.0 |
| United Kingdom | 1.0 | | | |

1) Portugal, direct N2O emissions. Mineral fertilizer: 17%; Manure application: 107%; Crop residues: 25%; N-fixation: 25%

2) Portugal, indirect N2O emissions. Volatilization: 11%; Leaching/runoff: 39%

**Table 6.79 Relative uncertainty estimates for implied emission factors in category 4D**

| Member State 2009 | Total | Direct | Animal Production | Indirect |
|---|---|---|---|---|
| Austria | | 150.0 | 150.0 | 150.0 |
| Belgium | 250.0 | | | |
| Denmark | | | 100.0 | |
| Finland | | 71.0 | 82.0 | 248.0 |
| France | | 270.0 | 200.0 | 400.0 |
| Germany | | 52.7 | 200.0 | 322.8 |
| Greece | | 400.0 | 100.0 | 50.0 |
| Ireland | | 100.0 | 100.0 | 50.0 |
| Italy | | 100.0 | 100.0 | 100.0 |
| Luxembourg | | 150.0 | 173.2 | 150.0 |
| Netherlands | | 60.0 | 100.0 | 200.0 |
| Portugal[1,2] | | 505.0 | 500.0 | 100.0 |
| Spain | | 400.0 | 100.0 | 50.0 |
| Sweden | | 113.8 | 150.0 | 150.0 |
| United Kingdom | 424.0 | | | |

1) Portugal, Portugal, direct N2O emissions. Mineral fertilizer: 500%; Manure application: 500%; Crop residues: 510%; N-fixation: 510%

2) Portugal, Portugal, indirect N2O emissions. Volatilization: 100%; Leaching/runoff: 100%

**Table 6.80 Member State's background information for uncertainty estimates in category 4.D**

| Member State | Background information to uncertainy estimates |
|---|---|
| Austria | **Mineral Soils – EF:** Revision of the uncertainty estimate of $N_2O$ from soils. A detailed investigation revealed that the source of the 48% uncertainty presented was a statement in an IPCC report (2000) referring to a measurement uncertainty. Here we have to deal with an emission factor uncertainty, which is estimated much higher, at an order of magnitude (IPCC, 2006). This higher number is still much smaller than the two orders of magnitude recommended by IPCC (2000). The latter was considered in part systematic uncertainty, however (the random uncertainty was considered smaller than the range now used) - this is still in part true, but only reflects our lack of knowledge on soil processes. Choosing to aply a quasi-standardized value conforms to the claim of (Winiwarter, 2007) that application of similar parameters between countries allows for a smaller error in an inter-comparison, even if the difference to a "true value" might be larger.In the latest Austrian study (WINIWARTER 2008) for the emission factor of $N_2O$ from soils an uncertainty of 150% was applied. Uncertainty contributions of the activity (combined from agricultural area and average N-fertilizer input) at about 5% is almost negligible in this context. It is virtually $N_2O$ alone that determines the uncertainty. |
| Belgium | **Mineral soils - AD:** $N_2O$ emissions from soils involves the use of more AD (mineral fertilisers, atm. deposition and runoff, manure application, ...) Consequently the uncertainty on AD is estimated at 30% , which seems in line with the values applied by other parties.<br>**Mineral soils – EF:** The uncertainty of $N_2O$ from agricultural soils is crucial for the determination of the overall uncertainty. Although most countries use the IPCC default values, the uncertainty on emission factors varies widely : 2 orders of magnitude (Norway), 509 % (UK, in IPCC Good Practice Guidance), 200 % (France and the Netherlands, NIR 2003), 100 % (Ireland, NIR 2003), 75 % (Finland, overall uncertainty for AD*EF, [40]), 24 % (Austria, NIR 2003). For the time being, a more or less average value of 250 % is used for this uncertainty calculation. |
| Denmark | **Mineral soils – AD:** Both farmers and suppliers of mineral fertilisers are obliged to report to the Plant Directorate. The total sold to farmers is very close to the amount imported by the suppliers, corrected by storage. The total amount of mineral fertiliser in Denmark is, therefore, a very precise estimate for the mineral fertiliser consumed. This is also valid for N-excretion in animal manure. |
| Finland | The uncertainty estimate for $N_2O$ emissions from agricultural soils is very high due to both lack of knowledge of emissions generating process and high natural variability and was estimated at -60 to +170% (direct) and -60 to +240% (indirect). For the 2005 inventory submission, uncertainty estimates were revised based on measurements data. The range of annual average emission factors obtained from different soils reveale that uncertainty may be larger than previously estimated.<br>**Mineral soils - AD:** The most effective way to reduce uncertainty would be case D, i.e., the use of the climate-specific emission factors for $N_2O$ from agricultural soils (Monni et al., 2007). On the basis of this study, at this stage the national field data does not enable the development of a reliable national emisison factor for mineral soils. The ntioal emission factor for $N_2O$ emission from cultivated organic soils would be 7.9 kg $ha^{-1}$ a-1 with an uncertainty of -114 to +187%, which is very close to the IPCC default value... These results from the field monitoring indicated that even if large national measurement campaigns are introduced, this source will still remain very uncertain. (Monni et al., 2007)<br>**Organic soils:** The accuracy of the emission estimate for organic soils could be further improved by adopting separate emission factors for grass and cereals since emisisons from grass fields are consistently lower due to less frequent tillage of the soil and a longer period of nitrogne uptake of the grass compared to cereals (Monni et al., 2007) |
| Germany | The detailed discussion in this source indicates that the error for relevant areas is on the order of 10 % and that the error for emissions is on the order of 50%. |
| Ireland | Large uncertainties still remain in relation to the $N_2O$ emissions from the agricultural sector. These uncertainties are the main |

| | |
|---|---|
| | determinant behind uncertainty in total national emissions |
| Italy | Uncertainty for $N_2O$ emissions from agricultural soils (direct soil emissions, indirect soil emissions and animal production) has been estimated to be 102%, as combination of 20% and 100% for activity data and emission factor, respectively. |
| Luxembourg | Arable land crops, used to estimate soil emissions, are on the high end at 10%, just the "fallows" (which is the basis for calculating indirect soil emissions) is considered statistically dependent, but twice as high. Most similar analyses of uncertainties of national GHG inventories have already shown previously that $N_2O$ emissions from soils are poorly understood and are the highest priority for methodological improvement.<br>**Mineral soils – EF:** Manure application emission factor follow a 70% uncertainty for $CH_4$ and a range from 50% to 200 % (lognormal distribution) for $N_2O$. The $CH_4$ emission factor for soil emissions is considered uncertain by +/-100%, the $N_2O$ emission factor is within a factor of 10 (lognormal distribution, from 30% to 300% of the best estimate) following IPCC (2006). |
| Netherlands | The uncertainty in direct $N_2O$ emissions from Agricultural soils is estimated to be approximately 60%. The uncertainty in indirect $N_2O$ emissions from N used in agriculture is estimated to be more than a factor of 2 (Olivier et al.,2009). |
| Portugal | **Mineral soils – AD:** Comparing the values of nitrogen in synthetic fertilizers form these independent data sources between 1995 and 2000 a maximum uncertainty value of 17 per cent was obtained.<br>**Mineral soils – EF:** From that range an uncertainty of 500 per cent was assumed in uncertainty analysis for nitrogen applied as synthetic fertilizers, manure, crop residues and nitrogen fixed by n-fixing crops. Considering that in the cases of nitrogen added to soil from n-fixing crops and crop residues, an additional 100 per cent uncertainty was added to take into account errors in the determination of nitrogen content of crops and residues from production. |
| Sweden | **Mineral soils – EF:** Direct $N_2O$ emissions from agricultural fields are calculated with an error of about 80% in the emission factor. The disaggregating of direct emissions from manure and mineral fertilisers, respectively, in the Swedish inventory may reduce some of the variability but direct emissions from agricultural soils are still one of the most uncertain in the inventory. |
| United Kingdom | Emissions from agricultural soils were correlated. The uncertainty assumed for agricultural soils uses a lognormal distribution since the range of possible values is so high. Here it is assumed that the 97.5 percentile is greater by a factor of 100 than the 2.5 percentile based on advice from the Land Management Improvement Division of DEFRA (pers. comm.).<br>**Mineral soils – EF:** The overall uncertainty quoted is calculated using the first method in order that uncertainties should not be underestimated in sectors showing a skewed distribution such as agricultural soils and $N_2O$ as a whole. |

The following issue related to time-series consistency have been identified:

- **Sweden. $Frac_{GASM}$.**
  An inconsistent time series is used by Sweden, which report a higher $Frac_{GASM}$ for the years 1996-2000 due to changes in the methodology. Sweden did not yet have the possibility to carry out a revision of the older data.
- **Greece, direct $N_2O$ emissions from soils, pastures (2004/2005: decrease of 11%, 2005/2006: increase of 6%)**
  Not explained
- **$N_2O$ Emissions from indirect soil, Sweden**
  The interannual increase of indirect $N_2O$ emissions in 2008/2009 is 7%. Amount of N from 4.D.3 is estimated as area of agriculture land times a leaching factor. The estimate of this area has increased since last year. This is likely only an effect of the method used. The value for the latest year is most uncertain but was corrected over the coming years when new data are collected.

### *6.3.6 Agricultural Soils – $CH_4$*

$CH_4$ fluxes from agricultural soils is reported only by Austria. In Austria, $CH_4$ emissions from Agricultural Soils originate from sewage sludge spreading on agricultural soils. They contribute only a negligible part of Austria's total methane emissions. The average carbon content of sewage sludge amounts to 300 kg C/t (Detzel et al., 2003; Schaefer 2002); 52% of the carbon is emitted to air from which 5% as methane. Emissions of 0.42 Gg $CH_4$ $yr^{-1}$ are calculated.

In Germany, fluxes of $CH_4$ from agricultural soils are not considered for the first time in the inventory for the year 2008. $CH_4$ is taken up in aerobic soils, and N-application reduces this sink for $CH_4$. In former inventories, the estimation was based on the approach of Boeckx and Van Cleemput (2001), compiling the available observations in Europe, differentiating emissions for grassland ($EFCH_4$ = -2,5 kg $ha^{-1}$ a-1$CH_4$) and cropland ($EFCH_4$ = - 1,5 kg $ha^{-1}$ a-1 $CH_4$). In the course of the development of the IPCC(2006) guidelines, however, no consensus could be found how this $CH_4$ sink in agricultural soil could be considered (A. Freibauer, pers. comm.).

### 6.3.7 Field burning of crop residues – $CH_4$ and $N_2O$ (CRF source category 4.F)

Burning of crop residues on the field gives rise to emissions of various compounds, including aerosols and trace gases. Field burning of crop residues is forbidden in Europe. Most countries therefore do not report $CH_4$ and $N_2O$ emissions from this source category. Also at European level, this source category contributes only insignificantly to total emissions from agriculture. We therefore present only limited information, including total $CH_4$ and $N_2O$ emissions and emissions from the two most important crop groups (cereals and 'other') (Table 6.81) and methodological information as described in the national GHG inventory reports (Table 6.82). The trend of $CH_4$ and $N_2O$ emissions from field burning of crop residues is shown in Figure 6.47 and Figure 6.48. In many countries, field burning of crop residues has become illegal since 1990 so that the emissions show a significant decline by almost one order of magnitude. Only Greece and Italy report stable emissions from this source category.

**Table 6.81 $CH_4$ and $N_2O$ Emission from burning of crop residues in 2009**

| | Total Gg CO2-eq | | Cereals Gg CO2- | | Other Gg CO2-eq | |
|---|---|---|---|---|---|---|
| | CH4 | N2o | CH4 | N2o | CH4 | N2o |
| Austria | 0.9 | 0.0 | 0.5 | 0.0 | 0.4 | 0.0 |
| Belgium | | | | | | |
| Denmark | 2.6 | 0.1 | 0.2 | 0.0 | 2.4 | 0.1 |
| Finland | 0.6 | 0.0 | 0.6 | 0.0 | | |
| France | | | | | | |
| Germany | | | | | | |
| Greece | 26.9 | 0.7 | 25.9 | 0.7 | | |
| Ireland | | | | | | |
| Italy | 12.8 | 0.3 | 12.8 | 0.3 | | |
| Luxembourg | | | | | | |
| Netherlands | | | | | | |
| Portugal | 20.1 | 1.2 | 4.9 | 0.1 | 15.2 | 1.0 |
| Spain | 368.5 | 4.5 | | | 368.5 | 4.5 |
| Sweden | | | | | | |
| United Kingdom | | | | | | |
| EU-15 | **432.5** | **6.7** | **45.0** | **1.1** | **386.5** | **5.6** |

**Table 6.82 Methodologies used to calculate $CH_4$ and $N_2O$ Emission from field burning of crop residues in 2009**

| Member States | |
|---|---|
| Austria | Burning agricultural residues on open fields in Austria is legally restricted by provincial law and since 1993 additionally by federal law and is only occasionally permitted on a very small scale. According to the Presidential Conference of the Austrian Chambers of Agriculture, about 0.3% of total area under cereals is burned. |
| Finland | Default. The share of straw burned in 2007 (0.25%) is an estimate made by several experts on crop cultivation in different parts of Finland. The trend of residue burning is assumed to follow the trend of rye crop yield as rye is the most common straw burned on fields. The share of burned residue from total cereal residue on the fields for the years 1990-2006 is estimated on the basis of the annual rye yield. |
| Greece | IPCC default |
| Italy | Emissions from fixed residues,stubble (stoppie), burnt on open fields, are reported in this category (4F) while emissions from removable residues (asportabili) burnt off-site, are reported under the waste sector. The following data are used: (a) annual crop production, removable residues/product ratio, and "fixed" residue/removable residues ratio; (b) dry matter fraction; (c) fraction of the field where "fixed" residues are burned, and fraction of residues oxidized during burning; (d) fraction of carbon and nitrogen from the dry matter of residues; (e) default emissions rates for C-$CH_4$ and N-$N_2O$. |
| Portugal | In-site burning of agricultural residues is still practiced nowadays in Portugal, being however forbidden by law-decree during the Forest Fire Season from May to September. Burning of residues from vineyards and olive oil are the most significant sources. Methodology according to IPCC, except for the fact that residue biomass is not estimated from crop production but from residue production quantities by cultivated area. Quantity of residues and actually burnt fraction from expert opinion from the Agriculture Ministry (Seixas et al., 2000). Only for rice a detailed and time-series could be developed following the information received from the agriculture experts from the Portuguese Ministry of Agriculture: (i) traditionally, stubbles and straw were burnt between crops, as the use of rice straw as fodder or bedding is not significant, and is not removed from field; (ii) more recently the agricultural practices have changed. It became more common to left the straw on ground and incorporate it into soil by plowing (only procedure allowed in the area subject to the "Techniques of Integrated Production and Protection", which is about 50 per cent of rice paddies in 2004). It may be assumed that, in 1990, 100 per cent of rice paddies were burnt and no organic amendments were added to soil. Today thea area subjected to burning is between 30 and 40%. |
| United Kingdom | The estimates of the masses of residue burnt of barley, oats, wheat and linseed are based on crop production data |

| | |
|---|---|
| | (e.g. Defra, 2006a) and data on the fraction of crop residues burnt (MAFF, 1995; ADAS, 1995b). Field burning ceased being legal in 1993 in England and Wales. Burning in Scotland and Northern Ireland is considered negligible, so no estimates are reported from 1993 onwards. |

**Figure 6.47 Trend of $N_2O$ emissions from field burning of crop residues**

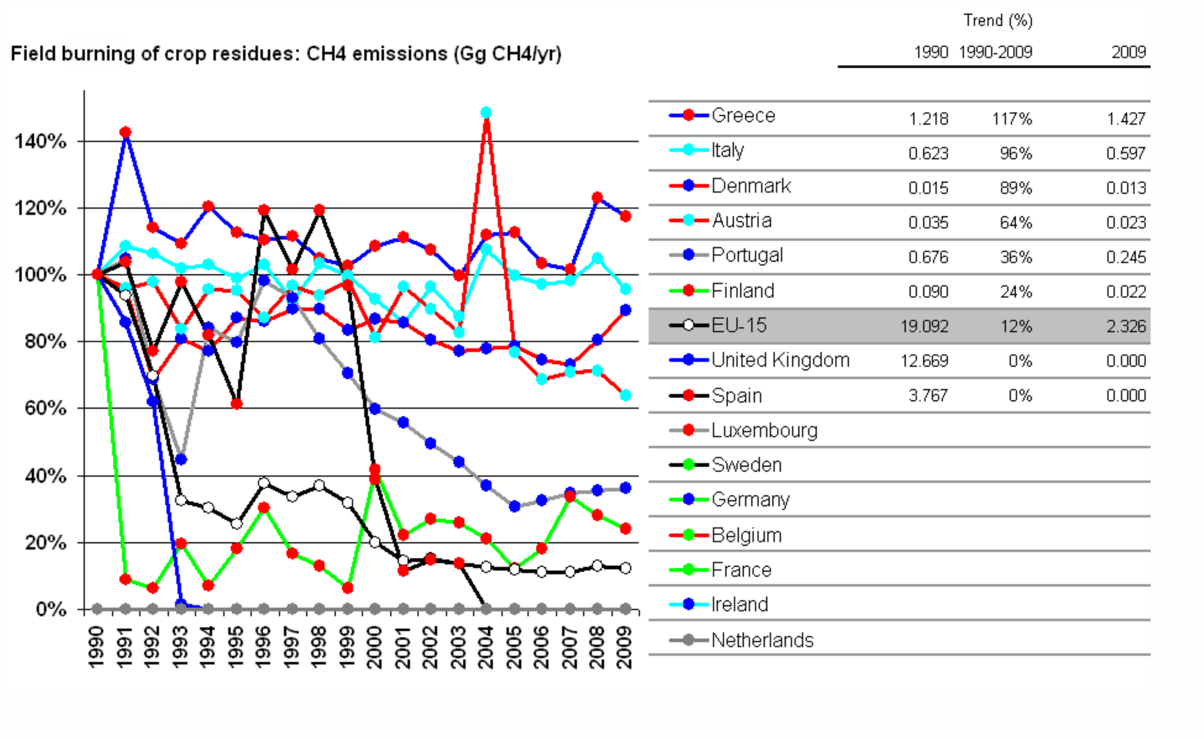
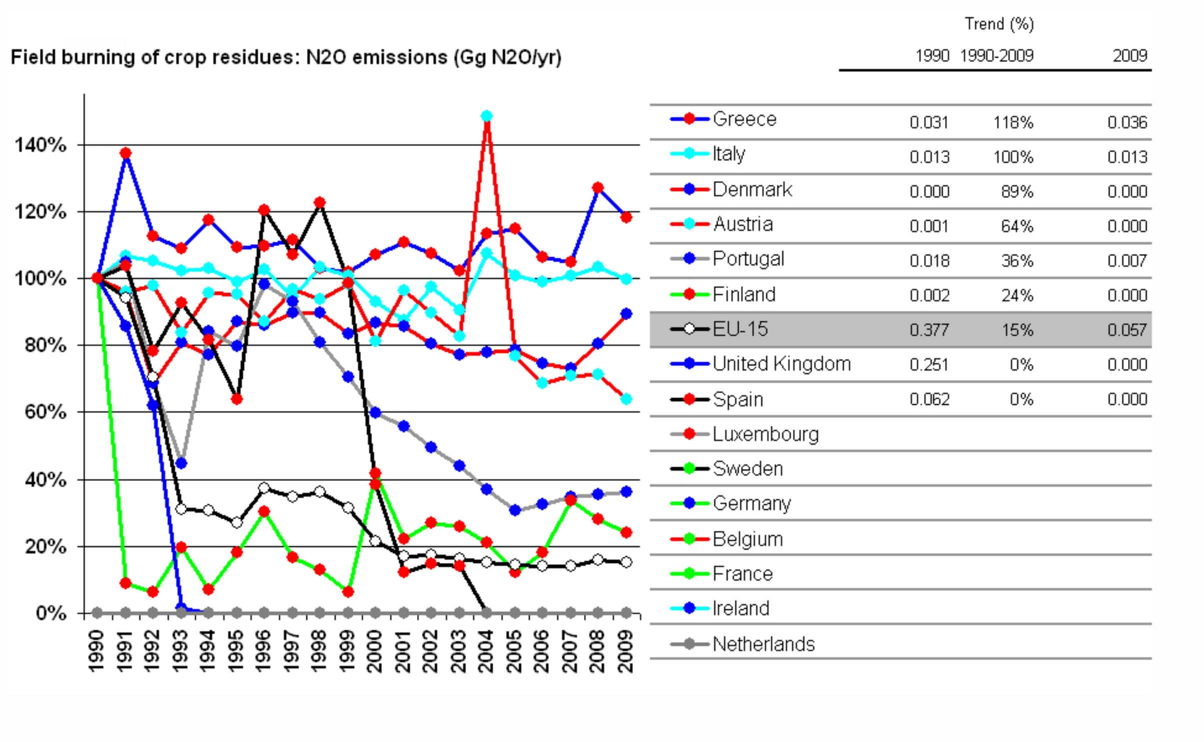



**Figure 6.48 Trend of $N_2O$ emissions from field burning of crop residues**



## 6.4 Sector-specific quality assurance and quality control

### 6.4.1 Determination of the Tier level

The IPCC methodology estimates emissions Es from a certain source category s as

$$E_s = IEF_s \cdot AD_s \tag{1}$$

where ADs are the activity data for the source category s and IEFs is the implied emission factor for this category. There are three levels for estimating the emissions, called Tier 1, Tier 2, and Tier 3, moving from the use of default values over the inclusion of national information to the application of modeling tools. In order to define an EU-wide Tier level per source category and sector, two criteria must be met:

For each source category and Member State a Tier level must be assigned.

To assess the Tier level of aggregated emissions derived at different quality, the Tier levels must be measured on an interval scale, allowing ‘intermediate’ Tier levels.

To do so, we developed standard procedures for each source category. These are based on the following principles:

However, the flow of nutrients in agriculture implies that the emission in one category can serve as activity level in another, for example, nitrogen excretion can be regarded as an emission of nitrogen in livestock production systems. According to the IPCC the amount of nitrogen excreted is an activity data for estimating $N_2O$ emissions from manure management. Thus, in contrast to the IPCC definitions, we define as activity data only this information that must be obtained using statistical surveys (e.g., population data, distribution of animal manure systems etc.) and regard everything else as parameters (emission factors and other factors).

A Tier level is assessed for each parameter by comparing the IPCC default value with the value used by the countries. If the default IPCC value is used, the Tier level is set to Tier 1 and otherwise the Tier level is set to Tier 2. Caution must be taken if country-specific data are identical to the default values.

An appropriate estimation of the basic activity data (animal numbers, mineral fertilizer consumption, allocation of manure to the manure management systems) is regarded as basic requirement for the estimation of the source strength and is not considered in the calculation of the overall Tier level. Note however, that

Tier levels are aggregated applying different aggregation rules.

The MEDIAN-rule should be applied where the Tier level of a product of different parameters Pi is to be evaluated. For example the emission factor for $CH_4$ emissions from manure management is calculated from the $CH_4$ production potential, the methane conversion factor, and the volatile solid excretion. The aggregation of the Tier level of these parameters to estimate the level of quality of the emission factor should follow the following principles. (i) If parameters with very different quality are multiplied, the higher quality should get more weight; (ii) if parameters with different uncertainty are multiplied, it should be good practice to estimate the parameter which is associated with the higher uncertainty at a higher Tier level. Thus, the aggregation rule should reward if efforts have been made to improve uncertain parameters. However, with the lack of a comprehensive set of relative uncertainty estimates for the individual parameters, in the following equation an arbitrary weighting factors $w_{p,j}$ has been introduced, based on expert judgment.

$$Q_{\prod_i P_i} = 3 - \prod_i \left[ \left(3 - Q_{P_i}\right)^{\frac{w_{p,i}}{\sum_j w_{p,j}}} \right] \tag{2}$$

with $i$ and $j$ indicating the individual parameters to be multiplied. The term (3-$Q_i$) assures that a higher weight is given to the parameter estimated with the higher Tier.

In some cases, when there is clear domination of one multiplicative parameter, the median rule simplified and the Tier level of the product is approximated with that Tier level. This simplified rule has been applied to estimate the Tier level of $CH_4$ emissions from enteric fermentation, which is in many cases based or validated with direct measurements.

The MEAN-rule if an emission estimate is calculated as the sum of two or more sub-categories. In this case, the Tier levels of the individual estimates are aggregated using an emission-weighted average. E.g., the Tier level of indirect $N_2O$ emissions from agriculture Q4D3 is calculated from the Tier levels calculated for indirect emissions through volatilization of nitrogen gases Q4D3a and leaching/run-off of nitrate Q4Db according to:

$$Q_{A+B} = \frac{Q_A \cdot E_A + Q_B \cdot E_B}{E_{A+B}} \qquad (3)$$

It must be noted, however, that a higher Tier-level does not automatically mean that also the emission estimate is more accurate. The relationship holds however, if (i) inherent links between processes are reflected in the methodology; (ii) parameters are based on statistically representative sample of measurements or carefully with experimental data validated models.

#### 6.4.1.1 $CH_4$ emissions from enteric fermentation

The Tier level for $CH_4$ emissions from enteric fermentation is determined by comparison the Implied Emission Factor with the IPCC default emission factors. The Tier level for cattle, sheep, goats, swine, and reindeer is shown in Table 6.83

**Table 6.83 Tier level of IEFs for $CH_4$ emissions from enteric fermenations**

| | Dairy Cattle | Non-dairy cattle | Sheep | Goats | Swine | Reindeer |
|---|---|---|---|---|---|---|
| Austria[1)] | Tier 2.0 | Tier 2.0 | Tier 1.0 | Tier 1.0 | Tier 1.0 | |
| Belgium | Tier 2.0 | Tier 2.0 | Tier 1.0 | Tier 1.0 | Tier 1.0 | |
| Denmark | Tier 2.0 | Tier 2.0 | Tier 2.0 | Tier 2.0 | Tier 2.0 | |
| Finland | Tier 2.0 | Tier 1.0 | Tier 1.0 | Tier 1.0 | Tier 1.0 | Tier 2.0 |
| France | Tier 2.0 | Tier 2.0 | Tier 2.0 | Tier 2.0 | Tier 2.0 | |
| Germany | Tier 2.0 | Tier 2.0 | Tier 1.0 | Tier 1.0 | Tier 2.0 | |
| Greece | Tier 2.0 | Tier 2.0 | Tier 2.0 | Tier 1.0 | Tier 1.0 | |
| Ireland | Tier 2.0 | Tier 2.0 | Tier 2.0 | Tier 1.0 | Tier 2.0 | |
| Italy | Tier 2.0 | Tier 2.0 | Tier 1.0 | Tier 1.0 | Tier 1.0 | |
| Luxembourg | Tier 2.0 | Tier 2.0 | Tier 1.0 | Tier 1.0 | Tier 1.0 | |
| Netherlands | Tier 2.0 | Tier 2.0 | Tier 1.0 | Tier 1.0 | Tier 1.0 | |
| Portugal[1)] | Tier 2.0 | Tier 2.0 | Tier 2.0 | Tier 2.0 | Tier 2.0 | |
| Spain | Tier 2.0 | Tier 2.0 | Tier 2.0 | Tier 1.0 | Tier 2.0 | |
| Sweden | Tier 2.0 | Tier 2.0 | Tier 1.0 | Tier 1.0 | Tier 1.0 | Tier 2.0 |
| United Kingdom | Tier 2.0 | Tier 2.0 | Tier 1.5 | Tier 1.0 | Tier 1.0 | |
| **EU-15** | **Tier 2.0** | **Tier 2.0** | **Tier 1.7** | **Tier 1.3** | **Tier 1.6** | |

1) Dairy-cattle for Spain and Non-dairy cattle for Austria and Portugal: IEF equals default IPCC EF, however Tier 2 has been used according to the national inventory reports.

#### 6.4.1.2 $CH_4$ emissions from manure management

The determination of the Tier level for the estimation of $CH_4$ emissions from manure management is done in four steps

1. “Default” $CH_4$ conversion factors for each manure management system are calculated on the basis of the allocation of manure to the different AWMS

The results are compared with the used MCF and a Tier 2 level assigned if the two numbers differs (see Table 6.84).

**Table 6.84 Tier level of MCF for $CH_4$ emissions from manure management**

| MCF | Dairy | Non-dairy | Sheep | Goats | Swine | Poultry |
|---|---|---|---|---|---|---|
| Austria | Tier 2.0 | Tier 2.0 | Tier 1.0 | Tier 1.0 | Tier 2.0 | Tier 1.0 |
| Belgium | Tier 2.0 | Tier 2.0 | Tier 1.0 | Tier 1.0 | Tier 2.0 | Tier 1.0 |
| Denmark | Tier 2.0 | Tier 2.0 | Tier 1.0 | Tier 1.0 | Tier 2.0 | Tier 1.0 |
| Finland | Tier 2.0 | Tier 2.0 | Tier 1.0 | Tier 1.0 | Tier 2.0 | Tier 1.0 |
| France | Tier 2.0 | Tier 2.0 | Tier 1.0 | Tier 1.0 | Tier 2.0 | Tier 1.0 |
| Germany | Tier 2.0 | Tier 2.0 | Tier 1.0 | Tier 1.0 | Tier 2.0 | Tier 1.0 |
| Greece | Tier 2.0 | Tier 2.0 | Tier 1.0 | Tier 1.0 | Tier 2.0 | Tier 1.0 |
| Ireland | Tier 1.0 | Tier 1.0 | Tier 1.0 | Tier 1.0 | Tier 2.0 | Tier 1.0 |
| Italy | Tier 2.0 | Tier 2.0 | Tier 1.0 | Tier 1.0 | Tier 2.0 | Tier 1.0 |
| Luxembourg [1)] | Tier 1.0 | Tier 1.0 | Tier 1.0 | Tier 1.0 | Tier 1.0 | Tier 1.0 |
| Netherlands [2)] | Tier 2.0 | Tier 2.0 | Tier 1.0 | Tier 1.0 | Tier 2.0 | Tier 1.0 |
| Portugal | Tier 2.0 | Tier 1.0 | Tier 1.0 | Tier 1.0 | Tier 2.0 | Tier 1.0 |
| Spain | Tier 1.0 | Tier 1.0 | Tier 1.0 | Tier 1.0 | Tier 1.0 | Tier 1.0 |
| Sweden | Tier 2.0 | Tier 2.0 | Tier 1.0 | Tier 1.0 | Tier 2.0 | Tier 1.0 |
| United Kingdom | Tier 1.0 | Tier 1.0 | Tier 1.0 | Tier 1.0 | Tier 1.0 | Tier 1.0 |
| **EU-15** | **Tier 1.8** | **Tier 1.8** | **Tier 1.0** | **Tier 1.0** | **Tier 1.7** | **Tier 1.0** |

Sheep and goats get Tier 1 for MCF!

The data used for $B_0$ and VS are compared with IPCC default values.

**Table 6.85 Tier level of $B_0$ for $CH_4$ emissions from manure management**

| B0 | Dairy Cattle | Non-dairy cattle | Sheep | Goats | Swine | Poultry |
|---|---|---|---|---|---|---|
| Austria | Tier 1.0 | Tier 1.0 | Tier 1.0 | Tier 1.0 | Tier 1.0 | Tier 1.0 |
| Belgium | Tier 1.0 | Tier 1.0 | Tier 1.0 | Tier 1.0 | Tier 1.0 | Tier 1.0 |
| Denmark | Tier 1.0 | Tier 1.0 | Tier 1.0 | Tier 1.0 | Tier 1.0 | Tier 1.0 |
| Finland | Tier 1.0 | Tier 1.0 | Tier 1.0 | Tier 1.0 | Tier 1.0 | Tier 1.0 |
| France | Tier 1.0 | Tier 1.0 | Tier 1.0 | Tier 1.0 | Tier 1.0 | Tier 1.0 |
| Germany | Tier 1.0 | Tier 2.0 | Tier 1.0 | Tier 2.0 | Tier 1.0 | Tier 2.0 |
| Greece | Tier 1.0 | Tier 1.0 | Tier 1.0 | Tier 1.0 | Tier 1.0 | Tier 1.0 |
| Ireland | Tier 1.0 | Tier 1.0 | Tier 1.0 | Tier 1.0 | Tier 1.0 | Tier 1.0 |
| Italy | Tier 2.0 | Tier 2.0 | Tier 1.0 | Tier 1.0 | Tier 2.0 | Tier 1.0 |
| Luxembourg | Tier 1.0 | Tier 1.0 | Tier 1.0 | Tier 1.0 | Tier 1.0 | Tier 1.0 |
| Netherlands [2)] | Tier 1.0 | Tier 1.0 | Tier 1.0 | Tier 1.0 | Tier 1.0 | Tier 1.0 |
| Portugal | Tier 1.0 | Tier 1.0 | Tier 1.0 | Tier 1.0 | Tier 1.0 | Tier 1.0 |
| Spain | Tier 1.0 | Tier 1.0 | Tier 1.0 | Tier 1.0 | Tier 1.0 | Tier 1.0 |
| Sweden | Tier 1.0 | Tier 1.0 | Tier 2.0 | Tier 2.0 | Tier 1.0 | Tier 2.0 |
| United Kingdom | Tier 1.0 | Tier 2.0 | Tier 1.0 | Tier 1.0 | Tier 1.0 | Tier 1.0 |
| **EU-15** | **Tier 1.1** | **Tier 1.2** | **Tier 1.0** | **Tier 1.0** | **Tier 1.1** | **Tier 1.1** |

**Table 6.86** **Tier level of VS for $CH_4$ emissions from manure management**

| VS | Dairy Cattle | Non-dairy cattle | Sheep | Goats | Sw ine | Poultry |
|---|---|---|---|---|---|---|
| Austria | Tier 2.0 | Tier 2.0 | Tier 1.0 | Tier 1.0 | Tier 2.0 | Tier 1.0 |
| Belgium | Tier 2.0 | Tier 2.0 | Tier 2.0 | Tier 2.0 | Tier 2.0 | Tier 2.0 |
| Denmark | Tier 2.0 | Tier 2.0 | Tier 2.0 | Tier 2.0 | Tier 2.0 | Tier 2.0 |
| Finland | Tier 2.0 | Tier 2.0 | Tier 1.0 | Tier 1.0 | Tier 1.0 | Tier 2.0 |
| France | Tier 1.0 | Tier 1.0 | Tier 1.0 | Tier 1.0 | Tier 1.0 | Tier 1.0 |
| Germany | Tier 2.0 | Tier 2.0 | Tier 1.0 | Tier 2.0 | Tier 2.0 | Tier 2.0 |
| Greece | Tier 2.0 | Tier 2.0 | Tier 2.0 | Tier 1.0 | Tier 1.0 | Tier 1.0 |
| Ireland | Tier 2.0 | Tier 2.0 | Tier 2.0 | Tier 2.0 | Tier 1.0 | Tier 1.0 |
| Italy | Tier 2.0 | Tier 2.0 | Tier 1.0 | Tier 1.0 | Tier 2.0 | Tier 1.0 |
| Luxembourg | Tier 2.0 | Tier 2.0 | Tier 2.0 | Tier 2.0 | Tier 2.0 | Tier 1.0 |
| Netherlands [2)] | Tier 1.0 | Tier 1.0 | Tier 1.0 | Tier 1.0 | Tier 1.0 | Tier 1.0 |
| Portugal | Tier 2.0 | Tier 2.0 | Tier 2.0 | Tier 2.0 | Tier 2.0 | Tier 2.0 |
| Spain | Tier 2.0 | Tier 2.0 | Tier 1.0 | Tier 1.0 | Tier 2.0 | Tier 2.0 |
| Sw eden | Tier 2.0 | Tier 2.0 | Tier 1.0 | Tier 2.0 | Tier 2.0 | Tier 2.0 |
| United Kingdom | Tier 2.0 | Tier 2.0 | Tier 1.0 | Tier 1.0 | Tier 1.0 | Tier 1.0 |
| **EU-15** | **Tier 1.7** | **Tier 1.4** | **Tier 1.4** | **Tier 1.3** | **Tier 1.6** | **Tier 1.1** |

The final Tier level is obtained using the MEDIAN rule from the Tier levels of MCF, $B_0$, and VS, using the following weigths: $w_{MCF}$=0.13; $wB_0$=0.13; $w_{VS}$=0.75. The highest weight is given to the Volatile solid excretion factor because it can and should be based on the detailed characterization of the animal performance.

**Table 6.87** **Tier level of the IEFs for $CH_4$ emissions from manure management**

| | Dairy Cattle | Non-dairy cattle | Sheep | Goats | Sw ine | Poultry |
|---|---|---|---|---|---|---|
| Austria | Tier 1.9 | Tier 1.9 | Tier 1.0 | Tier 1.0 | Tier 1.9 | Tier 1.0 |
| Belgium | Tier 1.9 | Tier 1.9 | Tier 1.8 | Tier 1.8 | Tier 1.9 | Tier 1.8 |
| Denmark | Tier 1.9 | Tier 1.9 | Tier 1.8 | Tier 1.8 | Tier 1.9 | Tier 1.8 |
| Finland | Tier 1.9 | Tier 1.9 | Tier 1.0 | Tier 1.0 | Tier 1.2 | Tier 1.8 |
| France | Tier 1.2 | Tier 1.2 | Tier 1.0 | Tier 1.0 | Tier 1.2 | Tier 1.0 |
| Germany | Tier 1.9 | Tier 2.0 | Tier 1.0 | Tier 1.9 | Tier 1.9 | Tier 1.9 |
| Greece | Tier 1.9 | Tier 1.9 | Tier 1.8 | Tier 1.0 | Tier 1.2 | Tier 1.0 |
| Ireland | Tier 1.8 | Tier 1.8 | Tier 1.8 | Tier 1.8 | Tier 1.2 | Tier 1.0 |
| Italy | Tier 2.0 | Tier 2.0 | Tier 1.0 | Tier 1.0 | Tier 2.0 | Tier 1.0 |
| Luxembourg | Tier 1.8 | Tier 1.8 | Tier 1.8 | Tier 1.8 | Tier 1.8 | Tier 1.0 |
| Netherlands [1)] | Tier 2.0 | Tier 2.0 | Tier 2.0 | Tier 2.0 | Tier 2.0 | Tier 2.0 |
| Portugal | Tier 1.9 | Tier 1.8 | Tier 1.8 | Tier 1.8 | Tier 1.9 | Tier 1.8 |
| Spain | Tier 1.8 | Tier 1.8 | Tier 1.0 | Tier 1.0 | Tier 1.8 | Tier 1.8 |
| Sw eden | Tier 1.9 | Tier 1.9 | Tier 1.2 | Tier 1.9 | Tier 1.9 | Tier 1.9 |
| United Kingdom | Tier 1.8 | Tier 1.9 | Tier 1.0 | Tier 1.0 | Tier 1.0 | Tier 1.0 |
| **EU-15** | **Tier 1.8** | **Tier 1.5** | **Tier 1.3** | **Tier 1.3** | **Tier 1.7** | **Tier 1.1** |

[1)] Netherlands does not give background data in Table 4B(a), how ever according to the national inventory report a Tier 2 methodology is used.

### 6.4.1.3 $N_2O$ emissions from manure management

The determination of the Tier level of the estimate of $N_2O$ emissions from manure management is done in four steps

1. The comparison of the N-excretion rates used with the IPCC default valuees (see Table 6.88)

The determination of the Tier level of manure allocated to the manure management systems based on the Tier level of the N-excretion rate by animal type and the allocation of manure-nitrogen to the manure management systems reported in Table 4B(b) (see Table 6.89)

The comparison of the $N_2O$ emission factor used with the IPCC default values (see Table 6.90)

The calculation of the overall Tier level on the basis of the MEDIAN rule by using the Tier level of the IEF (with a weight of 0.33) and the Tier level of the allocated manure nitrogen to the manure management systems (with a weight of 0.67).

**Table 6.88 Tier level of the N-excretion rates for $N_2O$ emissions from manure management**

| | Dairy | Non-Dairy | Sheep | Swine | Poultry | Buffalo | Goats | Horses | Mules and Asses |
|---|---|---|---|---|---|---|---|---|---|
| Austria | Tier 2.0 | Tier 2.0 | Tier 2.0 | Tier 2.0 | Tier 2.0 | | Tier 2.0 | Tier 2.0 | |
| Belgium | Tier 2.0 | Tier 2.0 | Tier 2.0 | Tier 2.0 | Tier 2.0 | | Tier 2.0 | Tier 2.0 | Tier 2.0 |
| Denmark | Tier 2.0 | Tier 2.0 | Tier 2.0 | Tier 2.0 | Tier 2.0 | | Tier 2.0 | Tier 2.0 | |
| Finland | Tier 2.0 | Tier 2.0 | Tier 2.0 | | Tier 2.0 | | Tier 2.0 | Tier 2.0 | |
| France | Tier 1.0 | Tier 2.0 | Tier 2.0 | Tier 2.0 | Tier 1.0 | | Tier 1.0 | Tier 1.0 | Tier 1.0 |
| Germany | Tier 2.0 | Tier 2.0 | Tier 2.0 | Tier 2.0 | Tier 2.0 | Tier 2.0 | Tier 2.0 | Tier 2.0 | Tier 2.0 |
| Greece | Tier 1.0 | Tier 2.0 | Tier 2.0 | Tier 2.0 | Tier 1.0 | Tier 2.0 | Tier 2.0 | Tier 1.0 | Tier 1.0 |
| Ireland | Tier 2.0 | Tier 2.0 | Tier 2.0 | Tier 2.0 | Tier 2.0 | | Tier 2.0 | Tier 2.0 | Tier 2.0 |
| Italy | Tier 2.0 | Tier 2.0 | Tier 2.0 | Tier 2.0 | Tier 2.0 | Tier 2.0 | Tier 2.0 | Tier 2.0 | Tier 2.0 |
| Luxembourg | Tier 2.0 | Tier 2.0 | Tier 2.0 | Tier 2.0 | Tier 2.0 | | Tier 2.0 | Tier 2.0 | Tier 2.0 |
| Netherlands [1)] | Tier 2.0 | Tier 2.0 | Tier 2.0 | Tier 2.0 | Tier 2.0 | Tier 2.0 | Tier 2.0 | Tier 2.0 | Tier 2.0 |
| Portugal | Tier 2.0 | Tier 2.0 | Tier 2.0 | Tier 2.0 | Tier 2.0 | | Tier 2.0 | Tier 2.0 | Tier 2.0 |
| Spain | Tier 2.0 | Tier 2.0 | Tier 2.0 | Tier 2.0 | Tier 2.0 | | Tier 2.0 | Tier 1.0 | Tier 1.0 |
| Sweden | Tier 2.0 | Tier 2.0 | Tier 2.0 | Tier 2.0 | Tier 2.0 | | Tier 2.0 | Tier 2.0 | |
| United Kingdom | Tier 2.0 | Tier 2.0 | Tier 2.0 | Tier 2.0 | Tier 2.0 | | Tier 2.0 | Tier 2.0 | |
| EU-15 | **Tier 1.7** | **Tier 1.8** | **Tier 1.6** | **Tier 2.0** | **Tier 1.6** | **Tier 2.0** | **Tier 1.8** | **Tier 2.0** | **Tier 2.0** |

[1)] Netherlands does not give N-excretion data in Table 4B(b), however according to the national inventory report a Tier 2 methodology is used.

**Table 6.89 Tier level of the allocation of manure-nitrogen to the manure management systems for $N_2O$ emissions from manure management**

| Member State | Liquid system[1)] | Daily Spread | Solid storage and dry lot | Pasture range paddock | Other |
|---|---|---|---|---|---|
| Austria | Tier 2.0 | | Tier 2.0 | Tier 1.9 | Tier 2.0 |
| Belgium | Tier 2.0 | Tier 2.0 | Tier 2.0 | Tier 2.0 | Tier 2.0 |
| Denmark | Tier 1.9 | | Tier 2.0 | Tier 2.0 | Tier 2.0 |
| Finland | Tier 0.9 | | Tier 0.7 | Tier 1.2 | Tier 1.2 |
| France | Tier 1.7 | | Tier 1.6 | Tier 1.8 | |
| Germany | Tier 2.0 | | Tier 2.0 | Tier 2.0 | |
| Greece | Tier 2.0 | Tier 1.7 | Tier 1.5 | Tier 1.9 | Tier 1.1 |
| Ireland | Tier 2.0 | | Tier 2.0 | Tier 2.0 | |
| Italy | Tier 2.0 | | Tier 1.9 | Tier 2.0 | Tier 2.0 |
| Luxembourg | Tier 2.0 | | Tier 2.0 | Tier 2.0 | Tier 2.0 |
| Netherlands | Tier 2.0 | | Tier 2.0 | Tier 2.0 | |
| Portugal | Tier 2.0 | | Tier 1.9 | Tier 2.0 | |
| Spain | Tier 1.8 | Tier 1.8 | Tier 1.8 | Tier 2.0 | Tier 2.0 |
| Sweden | Tier 2.0 | | Tier 2.0 | Tier 1.9 | Tier 2.0 |
| United Kingdom | Tier 2.0 | Tier 2.0 | Tier 2.0 | Tier 2.0 | Tier 2.0 |
| EU15 | **Tier 1.8** | **Tier 1.8** | **Tier 1.7** | Tier 1.7 | **Tier 1.8** |

[1)] including anaerobic lagoon

**Table 6.90 Tier level of the IEFs for $N_2O$ emissions from manure management**

| | Liquid system[1)] | Solid storage and dry lot | Other |
|---|---|---|---|
| Austria | Tier 1 | Tier 1 | Tier 2 |
| Belgium | Tier 1 | Tier 1 | Tier 1 |
| Denmark | Tier 2 | Tier 1 | Tier 2 |
| Finland | Tier 1 | Tier 2 | Tier 1 |
| France | Tier 1 | Tier 1 | NA |
| Germany | Tier 2 | Tier 2 | NO |
| Greece | Tier 1 | Tier 1 | Tier 1 |
| Ireland | Tier 1 | Tier 1 | NO |
| Italy | Tier 1 | Tier 1 | Tier 1 |
| Luxembourg | | | Tier 1 |
| Netherlands | Tier 1 | Tier 2 | NO |
| Portugal | Tier 1 | Tier 1 | NO |
| Spain | Tier 1 | Tier 1 | Tier 2 |
| Sweden | Tier 1 | Tier 1 | Tier 1 |
| United Kingdom | Tier 2 | Tier 2 | Tier 1 |
| EU15 | **Tier 1.1** | **Tier 1.7** | **Tier 1.6** |

**Table 6.91 Tier level of the estimation of $N_2O$ emissions from manure management**

| | Liquid system[1)] | Solid storage and dry lot | Other | Total |
|---|---|---|---|---|
| Austria | Tier 1.7 | Tier 1.7 | Tier 2.0 | Tier 1.8 |
| Belgium | Tier 1.7 | Tier 1.7 | Tier 1.7 | Tier 1.7 |
| Denmark | Tier 1.9 | Tier 1.7 | Tier 2.0 | Tier 1.9 |
| Finland | Tier 1.1 | Tier 1.6 | Tier 1.2 | Tier 1.1 |
| France | Tier 1.5 | Tier 1.4 | NA | Tier 1.5 |
| Germany | Tier 2.0 | Tier 2.0 | NO | Tier 2.0 |
| Greece | Tier 1.7 | Tier 1.4 | Tier 1.1 | Tier 1.7 |
| Ireland | Tier 1.7 | Tier 1.7 | NO | Tier 1.7 |
| Italy | Tier 1.7 | Tier 1.6 | Tier 1.7 | Tier 1.7 |
| Luxembourg | Tier 2.0 | Tier 2.0 | Tier 1.7 | Tier 2.0 |
| Netherlands | Tier 1.7 | Tier 2.0 | NO | Tier 1.8 |
| Portugal | Tier 1.7 | Tier 1.6 | NO | Tier 1.7 |
| Spain | Tier 1.6 | Tier 1.6 | Tier 2.0 | Tier 1.8 |
| Sw eden | Tier 1.7 | Tier 1.7 | Tier 1.7 | Tier 1.7 |
| United Kingdom | Tier 2.0 | Tier 2.0 | Tier 1.7 | Tier 1.9 |
| EU15 | **Tier 1.9** | **Tier 1.6** | **Tier 1.9** | **Tier 1.7** |

[1)] including anaerobic lagoon

### 6.4.1.4 $CH_4$ emissions from rice cultivation

No combination of information is required.

### 6.4.1.5 $N_2O$ emissions from agricultural soils

The determination of the Tier level of $N_2O$ emissions from agricultural soils is done in four steps:

1. The comparison of the used emission factors (for direct $N_2O$ emissions induced by the application of synthetic fertilizer, animal wastes, nitrogen from crop residues and N-fixing crops and by the cultivation of histosols; for $N_2O$ emissions from manure deposited by grazing animals; for indirect $N_2O$ emissions induced by volatilization of $NH_3$+$NO_x$ from synthetic fertilizer and from applied manure, and induced by leaching/run-off of nitrogen from the fields) with the respective IPCC default values.
2. With the exception of direct $N_2O$ emissions induced by the application of mineral fertilizer, a Tier level has been considered for the nitrogen input data.
    a. For the application of animal waste the Tier levels of N allocation to liquid systems (incl. anaerobic lagoons), solid storage and dry lot, and other systems has been combined using the MEAN rule.
    b. For N-fixing crop, crop residues and cultivated area of histosols, the Tier level has been estimated from the information reported in the national inventory reports
    c. For nitrogen deposited by grazing animals, the Tier level calculated under category 4B(b) for pasture, range, and paddock is used.
3. The Tier level of the $N_2O$ emission estimate is calculated on the basis of the above-obtained information:
4. Application of synthetic fertilizer the Tier level of the emission factor is used
    a. Direct emissions from other nitrogen sources using the MEDIAN rule with equal weights for the Tier level of the nitrogen input and the emission factor
    b. $N_2O$ emissions from grazing animals using the MEDIAN rule for N-input, $Frac_{GRAZ}$, and the emission factor using equal weights. The Tier level for $Frac_{Graz}$ has been determined on the basis of the information given in the national inventory reports
    c. $N_2O$ emissions from volalised nitrogen using the MEDIAN rule for the amount of volatilised nitrogen, which is calculated from the Tier levels for volatilised synthetic fertilizer and manure nitrogen using the MEAN rule, and the emission factor using equal

weights. The Tier level for volatilised synthetic fertilizer is obtained by comparing $Frac_{GASF}$ with the IPCC default value. The Tier level for volatilised manure nitrogen is obtained using the MEDIAN rule on the basis of $Frac_{GASM}$ (comparing with the IPCC default value) and the Tier level of applied nitrogen manure using equal weights.

d. $N_2O$ emissions from leached/run-off nitrogen using the MEDIAN rule for N-input, FracLEACH and the emission factor giving higher weight to FracLEACH and the emission factor (0.43 each) than to the N-input (0.14)

**Table 6.92 Tier level of the estimation of direct $N_2O$ emissions from agricultural soils**

| Member States | Synthetic fertilizer | Animal Wastes appl. | | | N-fixing crops | | | Crop Residues | | | Cultivation of Histosols | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | N2O emis. | N input | EF | N2O emissions | N input | EF | N2O emissions | N input | EF | N2O emissions | N input | EF | N2O emissions |
| Austria | Tier 1.0 | Tier 1.8 | Tier 1.0 | Tier 1.5 | Tier 2.0 | Tier 1.0 | Tier 1.6 | Tier 2.0 | Tier 1.0 | Tier 1.6 | Tier 1.0 | NO | NO |
| Belgium | Tier 1.0 | Tier 1.7 | Tier 1.0 | Tier 1.4 | Tier 1.0 | Tier 1.0 | Tier 1.0 | Tier 1.0 | Tier 1.0 | Tier 1.0 | Tier 1.0 | Tier 2.0 | Tier 1.6 |
| Denmark | Tier 1.0 | Tier 1.9 | Tier 1.0 | Tier 1.5 | Tier 2.0 | Tier 1.0 | Tier 1.6 | Tier 2.0 | Tier 1.0 | Tier 1.6 | Tier 2.0 | Tier 2.0 | Tier 2.0 |
| Finland | Tier 1.0 | Tier 1.1 | Tier 1.0 | Tier 1.1 | Tier 2.0 | Tier 1.0 | Tier 1.6 | Tier 2.0 | Tier 1.0 | Tier 1.6 | Tier 2.0 | Tier 2.0 | Tier 2.0 |
| France | Tier 1.0 | Tier 1.5 | Tier 1.0 | Tier 1.3 | Tier 1.0 | Tier 1.0 | Tier 1.0 | Tier 1.0 | Tier 1.0 | Tier 1.0 | Tier 1.0 | NO | NO |
| Germany | Tier 1.0 | Tier 2.0 | Tier 1.0 | Tier 1.6 | Tier 2.0 | Tier 1.0 | Tier 1.6 | Tier 2.0 | Tier 1.0 | Tier 1.6 | Tier 2.0 | Tier 2.0 | Tier 2.0 |
| Greece | Tier 1.0 | Tier 1.7 | Tier 1.0 | Tier 1.4 | Tier 1.0 | Tier 1.0 | Tier 1.0 | Tier 1.0 | Tier 1.0 | Tier 1.0 | Tier 1.0 | Tier 2.0 | Tier 1.6 |
| Ireland | Tier 1.0 | Tier 1.7 | Tier 1.0 | Tier 1.4 | Tier 1.0 | Tier 1.0 | Tier 1.0 | Tier 1.0 | Tier 1.0 | Tier 1.0 | Tier 1.0 | NO | NO |
| Italy | Tier 1.0 | Tier 1.7 | Tier 1.0 | Tier 1.4 | Tier 2.0 | Tier 1.0 | Tier 1.6 | Tier 2.0 | Tier 1.0 | Tier 1.6 | Tier 1.0 | Tier 2.0 | Tier 1.6 |
| Luxembourg | Tier 1.0 | Tier 2.0 | Tier 1.0 | Tier 1.6 | Tier 1.0 | Tier 1.0 | Tier 1.0 | Tier 1.0 | Tier 1.0 | Tier 1.0 | Tier 1.0 | NO | NO |
| Netherlands | Tier 2.0 | Tier 1.8 | Tier 2.0 | Tier 1.9 | Tier 2.0 | Tier 2.0 | Tier 2.0 | Tier 2.0 | Tier 2.0 | Tier 2.0 | Tier 1.0 | Tier 2.0 | Tier 1.6 |
| Portugal | Tier 1.0 | Tier 1.7 | Tier 1.0 | Tier 1.4 | Tier 1.0 | Tier 1.0 | Tier 1.0 | Tier 1.0 | Tier 1.0 | Tier 1.0 | Tier 1.0 | NO | NO |
| Spain | Tier 2.0 | Tier 1.8 | Tier 2.0 | Tier 1.9 | Tier 2.0 | Tier 1.0 | Tier 1.6 | Tier 1.0 | Tier 1.0 | Tier 1.0 | Tier 1.0 | NO | NO |
| Sweden | Tier 2.0 | Tier 1.7 | Tier 2.0 | Tier 1.9 | Tier 2.0 | Tier 1.0 | Tier 1.6 | Tier 2.0 | Tier 1.0 | Tier 1.6 | Tier 1.0 | Tier 2.0 | Tier 1.6 |
| United Kingdom | Tier 1.0 | Tier 1.9 | Tier 1.0 | Tier 1.5 | Tier 1.0 | Tier 1.0 | Tier 1.0 | Tier 1.0 | Tier 1.0 | Tier 1.0 | Tier 1.0 | Tier 2.0 | Tier 1.6 |
| EU-15 | **Tier 1.1** | | | **Tier 1.5** | | | **Tier 1.4** | | | **Tier 1.3** | | | **Tier 1.9** |

**Table 6.93 Tier level of the estimation of $N_2O$ emissions from pasture, range and paddock**

| Member States | Animal Production | | | |
|---|---|---|---|---|
| | N-input | FracGRAZ | EF | N2O emissions |
| Austria | Tier 1.9 | Tier 1.0 | Tier 1.0 | Tier 1.4 |
| Belgium | Tier 2.0 | Tier 1.0 | Tier 1.0 | Tier 1.4 |
| Denmark | Tier 2.0 | Tier 1.0 | Tier 1.0 | Tier 1.4 |
| Finland | Tier 1.2 | Tier 1.0 | Tier 1.0 | Tier 1.1 |
| France | Tier 1.8 | Tier 1.0 | Tier 2.0 | Tier 1.6 |
| Germany | Tier 2.0 | Tier 2.0 | Tier 1.0 | Tier 1.7 |
| Greece | Tier 1.9 | Tier 1.0 | Tier 1.0 | Tier 1.4 |
| Ireland | Tier 2.0 | Tier 1.0 | Tier 1.0 | Tier 1.4 |
| Italy | Tier 2.0 | Tier 1.0 | Tier 1.0 | Tier 1.4 |
| Luxembourg | Tier 2.0 | Tier 1.0 | Tier 1.0 | Tier 1.4 |
| Netherlands | Tier 2.0 | Tier 1.0 | Tier 2.0 | Tier 1.7 |
| Portugal | Tier 2.0 | Tier 1.0 | Tier 1.0 | Tier 1.4 |
| Spain | Tier 2.0 | Tier 1.0 | Tier 2.0 | Tier 1.7 |
| Sweden | Tier 1.9 | Tier 2.0 | Tier 1.0 | Tier 1.7 |
| United Kingdom | Tier 2.0 | Tier 1.0 | Tier 1.0 | Tier 1.4 |
| EU-15 | | | | **Tier 1.5** |

**Table 6.94 Tier level of the estimation of indirect $N_2O$ emissions from nitrogen volatilised from agricultural soils**

| Member States | $Frac_{GASF}$ | Manure application | $Frac_{GASM}$ | Volatilized Manure | Volatili-zation | Emission Factor | N2O emissions from volatilised nitrogen |
|---|---|---|---|---|---|---|---|
| Austria | Tier 2.0 | Tier 1.8 | Tier 2.0 | Tier 1.9 | Tier 2.0 | Tier 1.0 | Tier 1.6 |
| Belgium | Tier 2.0 | Tier 1.7 | Tier 2.0 | Tier 1.9 | Tier 2.0 | Tier 1.0 | Tier 1.6 |
| Denmark | Tier 2.0 | Tier 1.9 | Tier 2.0 | Tier 2.0 | Tier 2.0 | Tier 1.0 | Tier 1.6 |
| Finland | Tier 2.0 | Tier 1.1 | Tier 2.0 | Tier 1.6 | Tier 2.0 | Tier 1.0 | Tier 1.6 |
| France | Tier 1.0 | Tier 1.5 | Tier 1.0 | Tier 1.3 | Tier 1.0 | Tier 1.0 | Tier 1.0 |
| Germany | Tier 2.0 | Tier 2.0 | Tier 2.0 | Tier 2.0 | Tier 2.0 | Tier 1.0 | Tier 1.6 |
| Greece | Tier 1.0 | Tier 1.7 | Tier 1.0 | Tier 1.4 | Tier 1.0 | Tier 1.0 | Tier 1.0 |
| Ireland | Tier 2.0 | Tier 1.7 | Tier 2.0 | Tier 1.9 | Tier 2.0 | Tier 1.0 | Tier 1.6 |
| Italy | Tier 1.0 | Tier 1.7 | Tier 2.0 | Tier 1.9 | Tier 1.6 | Tier 1.0 | Tier 1.3 |
| Luxembourg | Tier 1.0 | Tier 2.0 | Tier 1.0 | Tier 1.6 | Tier 1.0 | Tier 1.0 | Tier 1.0 |
| Netherlands | Tier 2.0 | Tier 1.8 | Tier 2.0 | Tier 1.9 | Tier 2.0 | Tier 1.0 | Tier 1.6 |
| Portugal | Tier 2.0 | Tier 1.7 | Tier 2.0 | Tier 1.9 | Tier 2.0 | Tier 1.0 | Tier 1.6 |
| Spain | Tier 2.0 | Tier 1.8 | Tier 2.0 | Tier 1.9 | Tier 2.0 | Tier 1.0 | Tier 1.6 |
| Sweden | Tier 2.0 | Tier 1.7 | Tier 2.0 | Tier 1.9 | Tier 2.0 | Tier 2.0 | Tier 2.0 |
| United Kingdom | Tier 1.0 | Tier 1.9 | Tier 1.0 | Tier 1.5 | Tier 1.0 | Tier 1.0 | Tier 1.0 |
| EU-15 | | | | | | | **Tier 1.3** |

**Table 6.95 Tier level of the estimation of indirect $N_2O$ emissions from nitrogen leached/run-off from agricultural soils**

| Member States | N input | $Frac_{LEACH}$ | Emission factor |
|---|---|---|---|
| Austria | Tier 1.8 | Tier 1.0 | Tier 1.0 |
| Belgium | Tier 1.7 | Tier 2.0 | Tier 1.0 |
| Denmark | Tier 1.9 | Tier 2.0 | Tier 2.0 |
| Finland | Tier 1.1 | Tier 2.0 | Tier 1.0 |
| France | Tier 1.5 | Tier 1.0 | Tier 1.0 |
| Germany | Tier 2.0 | Tier 1.0 | Tier 2.0 |
| Greece | Tier 1.7 | Tier 1.0 | Tier 1.0 |
| Ireland | Tier 1.7 | Tier 2.0 | Tier 1.0 |
| Italy | Tier 1.7 | Tier 1.0 | Tier 1.0 |
| Luxembourg | Tier 2.0 | Tier 1.0 | Tier 1.0 |
| Netherlands | Tier 1.8 | Tier 2.0 | Tier 1.0 |
| Portugal | Tier 1.7 | Tier 2.0 | Tier 1.0 |
| Spain | Tier 1.8 | Tier 1.0 | Tier 1.0 |
| Sweden | Tier 1.7 | Tier 1.0 | Tier 1.0 |
| United Kingdom | Tier 1.9 | Tier 1.0 | Tier 1.0 |
| EU-15 | | | |

### 6.4.2 Uncertainty

Quantitative estimates of the contribution of agriculture to the overall uncertainty of the national GHG inventories are reported in Table 6.101. These data are calculated from the information on the uncertainty of activity data and implied emission factors (see sections above and Table 6.97 through Table 6.99 summarizing all categories in agriculture) and the emissions data. For several countries, $N_2O$ emissions from agricultural soils are by far dominating the uncertainty of national inventory. The uncertainty estimate for this source category ranges from 13.5% of total national GHG emissions (excl. LULUCF, Denmark) to 228.4% of total national GHG emissions (United Kingdom). Overall, the estimate for the uncertainty range is relatively stable since the last years.

**Table 6.96 Range of contribution of category 4D to overall GHG uncertainty. Minimum and maximum values since 2005 submission**

| | Minimum uncertainty | Maximum uncertainty |
|---|---|---|
| 2005 | 0.7% (Austria) | 20.9% (France) |
| 2006 | 1.5% (Austria) | 17.6% (France) |
| 2007 | 1.9% (Denmark) | 19.9% (France) |
| 2008 | 1.7% (Denmark) | 20.1% (France) |
| 2009 | 2.0% (Denmark) | 17.9% (France) |
| 2011 | 2.4% (Netherlands) | 18.7% (United Kingdom) |

The contribution of the whole agricultural sector to the overall uncertainty is very similar to the contribution of agricultural soils (21.8% to 236.6%), highlighting again the dominance of this category.

Some countries allocate the biggest contribution to the direct emissions and others to the indirect emissions of $N_2O$. For example, the uncertainty of direct $N_2O$ emissions is estimated in the Greece inventory of being ±400% (61.2% of the national total) versus ±54% (10.7% of the national total) of the indirect emissions. On the other hands, the Netherlands estimate an uncertainty of ±61% and ±206% for direct and indirect $N_2O$ emissions agricultural soils, respectively (corresponding to 12.8% and 18.8% of the national total uncertainty, respectively).

$CH_4$ emissions from enteric fermentation are less uncertain (3.4% to 12.4% of total national GHG emissions) and manure management contributes with less than 12.5% uncertainty.

An overview of the estimated total GHG inventory uncertainty carried out with the Tier 1 methodology and the contribution of the agricultural sector to the overall uncertainty (calculated from reported relative uncertainties for activity data and emission factors, and the reported emissions) is given in Table 6.101. The corresponding uncertainties for activity data and emission factors are given in Table 6.97 and Table 6.98, and the combined uncertainty (Tier 1 approach) is given in Table 6.99. The data for the combined uncertainty are “gap-filled” at the category-level, if required, to allow a meaningful comparison of the uncertainty estimates at EU-level, using information reported at the level below the categories.

A table summarizing background information on the uncertainty estimates is given in Table 6.100.

It is interesting to note that combined relative uncertainty of agriculture in some cases is higher than the overall uncertainty of the greenhouse gas inventory (for example in Austria and Spain). This is due to the fact that the combined uncertainty is calculated neglecting any other contribution to the uncertainty. As uncertainties are assumed to be uncorrelated between the different sectors, the consideration of more sectors can thus lead to the partial compensation of the individual uncertainties.

Some countries have carried out also a Monte Carlo uncertainty assessment. In most cases, both the input data and also the results do not deviate much from the Tier 1 analysis. Main differences between both methods are (i) the possibility to assess emission sources where the distribution of the uncertainty is non-normal and (ii) the consideration of correlation between source categories, which tends to reduce the compensation effect.

**Table 6.97 Member States's uncertainty estimates for Activity Data used in the agriculture sector**

| Member State | Enteric ferment. (4A) | Manure Managem. (4B) | | Agricultural soils (4D) | | | |
|---|---|---|---|---|---|---|---|
| | | | | total | direct | animal prod. | indirect |
| | $CH_4$ | $CH_4$ | $N_2O$ | $N_2O$ | $N_2O$ | $N_2O$ | $N_2O$ |
| Austria | *(1) | *(6) | 10 | | 5 | 5 | 5 |
| Belgium | 5 | 10 | 10 | 30 | | | |
| Denmark | 2 | 5 | 22 | 0 | | 25 | |
| Finland | 0 | 0 | 0 | 0 | | | |
| France | 5 | 5 | 5 | 0 | 10 | 20 | 10 |
| Germany | *(2) | *(7) | 5 | 0 | 19 | 40 | 141 |
| Greece | 5 | 5 | 50 | | 20 | 50 | 20 |
| Ireland | *(3) | *(8) | 11 | 0 | 11 | 11 | 11 |
| Italy | 20 | 20 | 20 | | 20 | 20 | 20 |
| Luxembourg | | | | | 10 | 25 | |
| Netherlands | *(4) | *(9) | 10 | | 10 | 10 | 50 |
| Portugal | *(5) | *(10) | 39 | *(11),(12) | 31 | 39 | 33 |
| Spain | 3 | 3 | 16 | | 18 | 16 | 190 |
| Sweden | 5 | 20 | 20 | 0 | 26 | 35 | 35 |
| United Kingdom | 0 | 0 | 1 | 1 | | | |

*(1)- Cattle: 10%
*(2)- Dairy cattle 6% and non-dairy cattle 4%. Buffalo 8%
*(3)- Dairy and non-dairy cattle and other animals: 1%
*(4)- Dairy and non-dairy cattle, swine and other animals: 5%
*(5)- Dairy and non-dairy cattle: 6%; Sheep: 19%; goats: 19%; horses: 71%; mules and asses: 272%; poultry: 11%; other animals: 771%
*(6)- Cattle and swine: 10%
*(7)- Dairy cattle 6% and non-dairy cattle 4%. Buffalo 8% and swine 8%
*(8)- Dairy and non-dairy cattle and other animals: 1%
*(9)- Cattle, swine, poultry and other animals: 10%
*(10)- Dairy and non-dairy cattle: 6%; Sheep: 19%; goats: 19%; horses: 71%; mules and asses: 272%; swine: 11%; poultry: 41%; rabbits: 771%
*(11)- Portugal, direct N2O emissions. Mineral fertilizer: 17%; Manure application: 107%; Crop residues: 25%; N-fixation: 25%
*(12)- Portugal, indirect N2O emissions. Volatilization: 11%; Leaching/runoff: 39%

**Table 6.98 Member States's uncertainty estimates for Emission Factors used in the agriculture sector**

| Member State | Enteric ferment. (4A) | Manure Managem. (4B) | | Agricultural soils (4D) | | | |
|---|---|---|---|---|---|---|---|
| | | | | total | direct | animal prod. | indirect |
| | $CH_4$ | $CH_4$ | $N_2O$ | $N_2O$ | $N_2O$ | $N_2O$ | $N_2O$ |
| Austria | *(1) | *(6) | 100 | | 150 | 150 | 150 |
| Belgium | 20 | 40 | 90 | 250 | | | |
| Denmark | 20 | 20 | 50 | | | 100 | |
| Finland | 32 | 16 | 82 | | 71 | 82 | 248 |
| France | 40 | 50 | 50 | | 270 | 200 | 400 |
| Germany | *(2) | *(7) | 40 | | 53 | 200 | 323 |
| Greece | 30 | 50 | 100 | | 400 | 100 | 50 |
| Ireland | *(3) | *(8) | 86 | | 100 | 100 | 50 |
| Italy | 20 | 100 | 100 | | 100 | 100 | 100 |
| Luxembourg | | | | | 150 | 173 | |
| Netherlands | *(4) | *(9) | 100 | | 60 | 100 | 200 |
| Portugal | *(5) | *(10) | 97 | *(11),(12) | 505 | 500 | 100 |
| Spain | 10 | 10 | 100 | | 400 | 100 | 50 |
| Sweden | 25 | 50 | 50 | | 114 | 150 | 150 |
| United Kingdom | 20 | 30 | 414 | 424 | | | |

*(1)- Cattle: 20%

*(2)- Dairy cattle 40% and non-dairy cattle 25%. Buffalo 26%

*(3)- Dairy and non-dairy cattle 15, other animals: 30%

*(4)- Dairy cattle 15%, non-dairy cattle 20%, swine 50% and other animals: 30%

*(5)- Dairy and non-dairy cattle: 20%; Sheep: 20%; goats: 20%; horses: 50%; mules and asses: 50%; poultry: 20%; other animals: 20%

*(6)- Cattle and swine: 50%

*(7)- Dairy cattle 40% and non-dairy cattle 27%. Buffalo 18% and swine 30.3824246173491%

*(8)- Dairy and non-dairy cattle and other animals: 15%

*(9)- Cattle, swine, poultry and other animals: 100%

*(10)- Dairy and non-dairy cattle: 61%; Sheep: 59%; goats: 58%; horses: 61%; mules and asses: 61%; swine: 91%; poultry: 66%; rabbits: 66%

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**Table 6.99 Member States's uncertainty estimates for agriculture (combined uncertainty calculated from the given uncertainty of AD and EF)**

| Member State | Enteric ferment. (4A) | Manure Managem. (4B) | | Agricultural soils (4D) | | | |
|---|---|---|---|---|---|---|---|
| | | | | total | direct | animal prod. | indirect |
| | $CH_4$ | $CH_4$ | $N_2O$ | $N_2O$ | $N_2O$ | $N_2O$ | $N_2O$ |
| Austria | 22 | 40 | 100 | 105 | 150 | 150 | 150 |
| Belgium | 21 | 41 | 91 | 252 | | | |
| Denmark | 20 | 21 | 55 | 103 | | 103 | |
| Finland | 32 | 16 | 82 | 69 | 71 | 82 | 248 |
| France | 40 | 50 | 50 | 198 | 270 | 201 | 400 |
| Germany | 25 | 25 | 41 | 125 | 56 | 204 | 352 |
| Greece | 30 | 50 | 112 | 120 | 400 | 112 | 54 |
| Ireland | 11 | 11 | 87 | 58 | 101 | 101 | 51 |
| Italy | 28 | 102 | 102 | 66 | 102 | 102 | 102 |
| Luxembourg | 30 | 0 | 0 | 93 | 150 | 175 | 151 |
| Netherlands | 12 | 71 | 100 | 63 | 61 | 100 | 206 |
| Portugal | 14 | 77 | 105 | 228 | 506 | 502 | 105 |
| Spain | 10 | 10 | 101 | 208 | 400 | 101 | 196 |
| Sweden | 25 | 54 | 54 | 86 | 117 | 154 | 154 |
| United Kingdom | 20 | 30 | 414 | 424 | | | |

**Table 6.100 Member State's background information on the uncertainty estimates in the sector of agriculture**

| Member State | Uncertainties |
|---|---|
| Austria | Separate uncertainty calculations, albeit with the same (as much as possible) input information was performed using a spreadsheet prepared specifically according to the Tier 1 approach (IPCC 2000), and with a Monte Carlo approach fully considering statistical dependence of detailed input data (Tier 2). Since the first detailed uncertainty analysis (Winiwarter and Rypdal, 2001) the Austrian inventory compilers have spent considerable effort to also obtain uncertainties from individual contributors to the inventory. Studies on methane emissions reported also uncertainty in emission factors (Amon et al. 2002, Gebetsroither et al. 2002). |
| Belgium | In Flanders, a complete study of the uncertainty was conducted in 2004 by an independent consultant, Det Norske Veritas, both on Tier 1 and Tier 2 level. The uncertainties were determined for the emission level 2001 and for the 1990-2001 trend in emissions for all source categories comprising emissions of $CO_2$, $CH_4$ and $N_2O$. These results are available in the technical report 'Quantification of Uncertainties – Emission Inventory of Greenhouse Gases of the Flemish Region of June 2004'. |
| Denmark | The uncertainty estimates are based on the Tier 1 methodology in the IPCC Good Practice Guidance (GPG) (IPCC, 2000). Uncertainty estimates for the all sectors are included in the current year. The estimated uncertainties for some of the emission sources, based on expert judgement (Olesen et al. 2001, Gyldenkærne, pers. comm., 2005). The uncertainties for the number of animals and the number of hectares with different crops under cultivation are very small. |
| Finland | Uncertainty is quantified with a Tier 2 approach (KASPER model, developed by VTT Technical Research Centre of Finland). A simulation model was constructed for uncertainty analysis using Monte Carlo simulation and sensitivity analysis using an extended version of Fourier Amplitude Sensitivity Test (FAST, Saltelli et al. 2005). In agriculture, an uncertainty estimate was given for each calculation parameter of the calculation model at a detailed level. A detailed description of the uncertainty analysis has been presented in Monni & Syri (2003), Monni (2004) and Monni et al. (2007). |
| France | Uncertainty calculation according to Tier 1 methodology. Strongest impact on total uncertainty arises from the category of $N_2O$ emissions from agricultural soils. |
| Ireland | Tier 1 method. In some of the most important emissions sources in Agriculture (such as enteric fermentation and agricultural soils) and Waste (solid waste disposal, for example) the activity data or emission factors ultimately used are determined by several specific component inputs, which are all subject to varying degrees of uncertainty. The uncertainty estimates used for both activity data and emission factor for these sources have been derived by assigning uncertainties to the key component parameters and combining them at the level of activity data or emission factors, as appropriate, for each activity for input to the Tier 1 uncertainty assessment. |
| Italy | Tier 1 approach. In addition, a Tier 2 approach, corresponding to the application of Monte Carlo analysis, has been applied to specific categories of the inventory but the results show that, with the information available at present, applying methods higher than the Tier 1 does not make a significant difference in figures. For $N_2O$ emissions from agricultural soils, a Montecarlo analysis was applied assuming a normal distribution for activity data and two tests one with a lognormal and the other with a normal for emission factors; the results with the normal distribution calculated an uncertainty figure equal to 32.44, lower than the uncertainty by the Tier 1 approach which was 102; in the case of the lognormal distribution there were problems caused by the formula specified in the IPCC guidelines which is affected by the unit and needs further study before a throughout application. |
| Luxembourg | In December 2007, the Environment Agency contracted Austrian Research Centers GmbH - ARC28 for performing a detailed uncertainty analysis of Luxembourg's GHG inventory. Monte-Carlo approach were used to calculate overall uncertainty. Within this project, we use the software "@RISK" from Palisade Co. (www.palisade.com). |
| Netherlands | Tier 1 method for base year and last reported year – for both the annual emissions and the emission trend for the Netherlands. All uncertainty figures should be interpreted as corresponding to a confidence interval of 2 standard deviations (2?), or 95%. In cases where asymmetric uncertainty ranges were assumed, the largest percentage was used in the calculation. Furthermore, a Tier 2 uncertainty assessment was carried out in 2006 (Ramirez, 2006). The study used the same uncertainty assumption as the Tier 1 study but accounted for correlations and non-Gaussian distributions. Results are at the same order of magnitude for the level assessment, although a higher uncertainty is found for the trend analysis. As part of the above mentioned study, the expert judgments and assumptions made for uncertainty ranges in emission factors and activity data for the Netherlands have been compared to the uncertainty assumptions (and their underpinnings) used in Tier 2 studies carried out by other European countries. |
| Sweden | During 2005, a SMED study was carried out to improve tranparency and quality in the uncertainty estimates of the Swedish National Greenhouse gas inventory (Gustafsson, 2005). Although much activity data in the agricultural sector is estimated from extensive surveys, with high quality estimates at national level, the sector contributes to a large part of the total estimated uncertainty. |
| United Kingdom | Both the Tier 1 and Tier 2 uncertainty estimates. The Tier 2 approach provides estimates according to GHG (1990, base year and latest reporting year) and has now been extended to provide emissions by IPCC sector and is based on a background paper (Eggleston et al., 1998). An internal review was completed of the Monte Carlo analysis was completed in 2006 (Abbott et al., 2006). The uncertainty of the majority of the sectors was assumed to be normally distributed; for certain sectors where data are highly correlated or the distributions non-normal, custum corrleations or fuctions have been used (landfill, sewage sludge distributions calculated from a known data series; agricultural soils lognormal distribution with the 97.5%il being 100 times the 2.5%il). Calculations are carried out using the @RISK software. |

The uncertainties estimates are combined to the EU-15 level for source categories in the agriculture sector and for the sector as a whole are combined with a Tier 1 approach considering an assumed degree of dependence between each pair of countries. The quantitative assessment of the quality-levels outlined above helps to derive a reasonable estimate for the correlation coefficient $\rho_{XY}$ between two countries X and Y. To this purpose, the Tier levels $Q_X$ and $Q_Y$ are transformed with the following equation:

$$\rho_{X,Y} = \sqrt{(2 \cdot Q_X) \cdot (2 \cdot Q_Y)} \qquad (4)$$

Equation (4) leads to the situation of no correlation $(\rho_{X,Y} = 0)$ for two countries with a Tier 2 approach and full correlation $(\rho_{X,Y} = 1)$ if both countries used a Tier 1 approach. A correlation coefficient can be calculated for any intermediate situation. This information is further processed within the standard IPCC Tier 1 method for both level and trend uncertainty.

**Table 6.101 Member States's uncertainty estimates for agriculture expressed in percent of total GHG emissions. The table shows three "scenarios" for the uncertainty at EU-15 level, i.e., (i) with the correlation between MS uncertainty estimates as quantified with equation (4); (ii) under the assumption of no correlation and (iii) under the assumption of full correlation between the uncertainty estimates of MS. Scenario (i) is considered to be the most realistic case, and scenarios (ii) and (iii) are giving the range of uncertainty at EU-15 level.**

| Member State | Total agriculture | Enteric ferment. (4A) | Manure Managem. (4B) | | Agricultural soils (4D) | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | total | direct | animal prod. | indirect |
| | | $CH_4$ | $CH_4$ | $N_2O$ | $N_2O$ | $N_2O$ | $N_2O$ | $N_2O$ |
| | uncertainties expressed as % of total GHG emissions | | | | | | | |
| Austria | 45.6 | 9.6 | 1.7 | 12.2 | 42.8 | 35.9 | 1.9 | 23.3 |
| Belgium | 97.0 | 7.6 | 6.9 | 7.3 | 96.2 | | | |
| Denmark | 55.1 | 6.0 | 2.6 | 2.4 | 54.7 | | 2.3 | |
| Finland | 43.1 | 8.8 | 0.8 | 5.8 | 41.8 | 33.4 | 2.5 | 25.0 |
| France | 97.2 | 12.4 | 7.2 | 3.1 | 96.0 | 61.2 | 15.5 | 72.4 |
| Germany | 75.0 | 7.3 | 2.1 | 1.2 | 74.6 | 21.0 | 4.4 | 71.5 |
| Greece | 67.1 | 11.1 | 1.8 | 3.8 | 66.1 | 61.2 | 22.4 | 10.7 |
| Ireland | 21.8 | 5.7 | 1.4 | 1.8 | 21.0 | 13.5 | 15.6 | 3.6 |
| Italy | 33.9 | 8.8 | 8.5 | 11.1 | 29.5 | 21.8 | 4.6 | 19.4 |
| Luxembourg | 84.6 | 11.0 | | | 42.5 | 29.9 | 14.8 | 26.3 |
| Netherlands | 28.0 | 4.8 | 12.2 | 6.0 | 24.0 | 12.8 | 7.8 | 18.8 |
| Portugal | 86.4 | 5.0 | 12.5 | 4.3 | 85.2 | 65.1 | 52.9 | 14.7 |
| Spain | 95.6 | 3.4 | 1.5 | 6.6 | 94.7 | 88.5 | 6.8 | 32.9 |
| Sweden | 48.9 | 8.4 | 3.1 | 2.9 | 48.0 | 34.4 | 7.4 | 19.8 |
| United Kingdom | 236.6 | 6.7 | 1.9 | 18.4 | 235.7 | | | |
| **EU15** | **6.4** | **0.4** | **0.3** | **0.3** | **7.3** | | | |
| **EU15 no corr** | **3.9** | **0.3** | **0.2** | **0.3** | **3.9** | | | |
| **EU15 full corr** | **8.7** | **0.8** | **0.4** | **0.6** | **8.6** | | | |

Uncertainties calculated from information contained in NIR on uncertainty of activity data and emission factors, and emission data, using the Tier 1 approach.

### *6.4.3 Improvements since last submission*

A major revision of the present chapter on methodological issues and uncertainty in the sector agriculture has been done for the submission in 2006. The chapter gives now a complete overview of all relevant parameters required for the estimation of GHG emissions in this sector. This has been done in parallel to the calculation of all background parameter in the CRF tables for agriculture.

The changes are partly due to a "natural evolution" of the inventory generation over the years and partly motivated by recommendations made by the UNFCCC review team on the occasion of the in-country review in 2005. The main issues raised by the Expert Review Team in 2005 and the major changes include (i) more transparent overview tables on methodological issues; (ii) better presentation of trend development; (iii) streamlining information contained in CRF and NIR; (iv) continuous working with Member States in order to improve the inventory and allowing the quantification of all background data; (v) including a summary of workshops.

For the submission in 2007, few improvements have been added, mainly regarding the calculation of the quality of the EC estimate. Several errors that were identified in the background tables of the Member States could be eliminated, such as the inconsistent use of units or implied emission factors. These corrections did not have an impact on the calculated emissions, but made the aggregation of background information difficult and the comparison impossible.

For the submission in 2008, based on recommendations by the Expert Rview Team of the in-country review in 2007, several improvements were implemented, including higher transparency in describing the aggregation of animal numbers presented under Option B into Option A (which is used at EU level), time series consistencies and trends (including epidemic diseases and issues raised by the ERT, such as the buffalo population in Germany and the goat population in Luxembourg, manure managed in 'other' systems in Italy, or $Frac_{GASM}$ used in Sweden), and outliers. A discussion on the main policies driving the level of GHG emissions in Europe was introduced.

Further a novel approach to calculate uncertainties at the EU level including the assessment of the quality of the emission estimates at MS and EU level has been implemented and described in the NIR. This method was presented during the in-country-review in 2007 and its implementation in the EC-IR was suggested by the ERT. This is complemented by a series of tables giving background information for the estimates of the uncertainty levels for activity data and emission factors.

Emission sources reported by a few MS only (such as $CH_4$ emissions from enteric fermentation of poultry, reported by Austria and Luxembourg only) will still lead to a discrepancy between the IEF for EU-15 reported in the CRF-tables and the NIR. This is because our principle to not change the category MS report emissions (with the above-mentioned exception of the shift from Option B to Option A for cattle). In the annex to the NIR a weighted average of the IEF for poultry is calculated instead giving the IEF of those animals for which emissions have been quantified and included into the EU total. This is documented also in the CRF tables in a transparent way.

For the submissions in 2008 trough 2011, background information was further developed, in particular with regard to the general development and policy drivers in the countries. A new section was introduced giving most important information on the source category 'Field Burning of Agricultural Residues' and information on the methodology and trends of emissions in this category has been added. For the submission in 2011, a new section was added summarizing the findings of the GGELS project (Evaluation of the livestock sector's contribution to the EU greenhouse gas emissions (GGELS); http://afoludata.jrc.ec.europa.eu/index.php/dataset/detail/236).

Continuous work with MS helps to identify and correct errors; and justifications for un-documented national emission factors have been requested (for example, for the use of IPC2006 default values) and are now also included in national inventory reports (Germany). Even though **the number of errors could be significantly reduced with regard to previous submissions** a few errors remain and have been requested to be corrected by the MS, such as for example a few (remaining) mistakes in the units reported.

The MS CRF tables are carefully checked on these errors and corrected before calculating the background data for the European Union.

### 6.4.4 Activities to improve the quality of the inventory in agriculture

As a first activity to assure the quality of the inventory by Member States, a workshop on “Inventories and Projections of Greenhouse Gas Emissions from Agriculture” was held at the European Environment Agency in February 2003. The workshop focused on the emissions of methane ($CH_4$) and nitrous oxide ($N_2O$) induced by activities in the agricultural sector, not considering changes of carbon stocks in agricultural soils, but including emissions of ammonia ($NH_3$). The consideration of ammonia emissions allows the validation of the $N_2O$ emission sources and it further strengthens the link between greenhouse gas and air pollutant emission inventories reported under the UNFCCC, the EC Climate Change Committee, the UNECE Long-Range Transboundary Air Pollution Convention, and the EU national emission ceiling directive. Objectives of the workshop were to compare the Member States’ methodologies and to identify and explain the main differences. The longer term objective is to further improve the methods used for inventories and projections in the different Member States and to identify how national and common agricultural policies could be integrated in EU-wide emission scenarios.

Information on the workshop and the recommendations can be downloaded at the following website:

http://ccupeople.jrc.ec.europa.eu/leip/expmeetcat4d_2004/recommendations.htm

### 6.4.5 Comparison of national inventories with EU-wide calculations with the CAPRI model

The GGELS-project on the "Evaluation of the livestock sector's contribution to the EU greenhouse gas emissions" was commissioned by the Directorate-General for Agriculture and Rural Development to the Joint Research Centre and run from 09/2008-12/2010. The study included the implementation of an LCA (life-cycle assessment) approach into the CAPRI model including update of GHG-calculation modules, as well as an ex-ante according to the latest CAPRI projections for the year 2020 and an explorative assessment of technological and policy mitigation options. Ancillary assessments were made on a description of livestock systems in Europe, the GHG emissions related to imported meat product and livestock's impact on biodiversity.

For the LCA-approach, activity-based emissions according to the emissions source categories in the IPCC (2006) guidelines are converted to product-based emission intensities, using well-defined allocation rules. Additional emissions that are generated during the life-cycle of a product are estimated as well and included in the estimated emission intensities. The GGELS report include also a detailed comparison of activity-based emissions estimates calculated with the CAPRI model with those reported in the greenhouse gas inventory report of the European Comminuties in 2010 for the year 2004, which is the base year for the version of the CAPRI model used.

The report, executive summary and the data tables are available at:

http://afoludata.jrc.ec.europa.eu/index.php/dataset/files/236

A detailed description of the methodology used in the study is given in section 4.2. (Activity-based GHG emissions from the European livestock system considered in the sector ‘agriculture’ of the IPCC guidelines) of the report with additional data tables provided in the Annex to Chapter 4 (Quantification of greenhouse gas and ammonia emissions from the livestock sector in the EU – Methodology). Section 5 (Comparison of EU livestock GHG emissions derived by CAPRI with official GHG inventories) provides a detailed comparison between the emissions estimates.

In the following, a summary of this comparison is provided as given in the executive summary of the report:

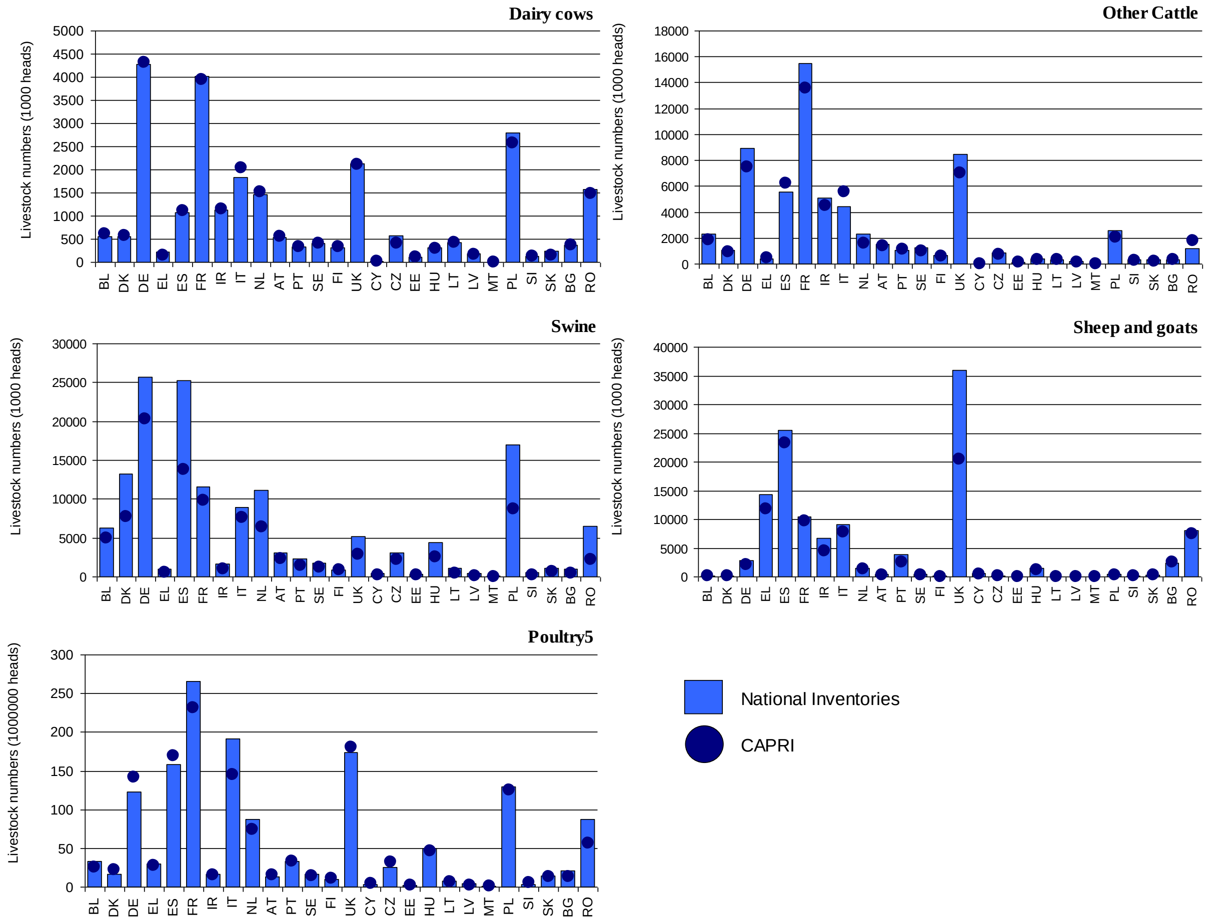
The objective of the GGELS project was to provide an estimate of the net emissions of GHGs and ammonia ($NH_3$) from livestock sector in the EU-27 according to animal species, animal products and livestock systems following a food chain approach.

For the comparison of activity-based GHG emissions calculated in the GGELS project (taking into account only emissions directly created during the agricultural production process) with official national GHG emissions submitted to the UNFCCC, we selected the latest inventory submission of the year 2010 (EEA, 2010), using the data reported for the year 2004, the base year selected also for the CAPRI calculations.

Differences in basic input parameters, such as animal numbers and mineral fertilizer application rates are limited, since both are based on the official numbers of livestock statistics. However, on the one hand EUROSTAT data are not always in line with national statistical sources used by national inventories, and on the other hand CAPRI changes input data if they are not consistent with each other. Moreover, for some animal activities CAPRI does not use livestock numbers but numbers of the slaughtering statistics. Therefore, some differences exist, especially in case of swine, sheep and goats, where CAPRI generally uses lower numbers than the national inventories. This has to be kept in mind when looking at the results in later sections.

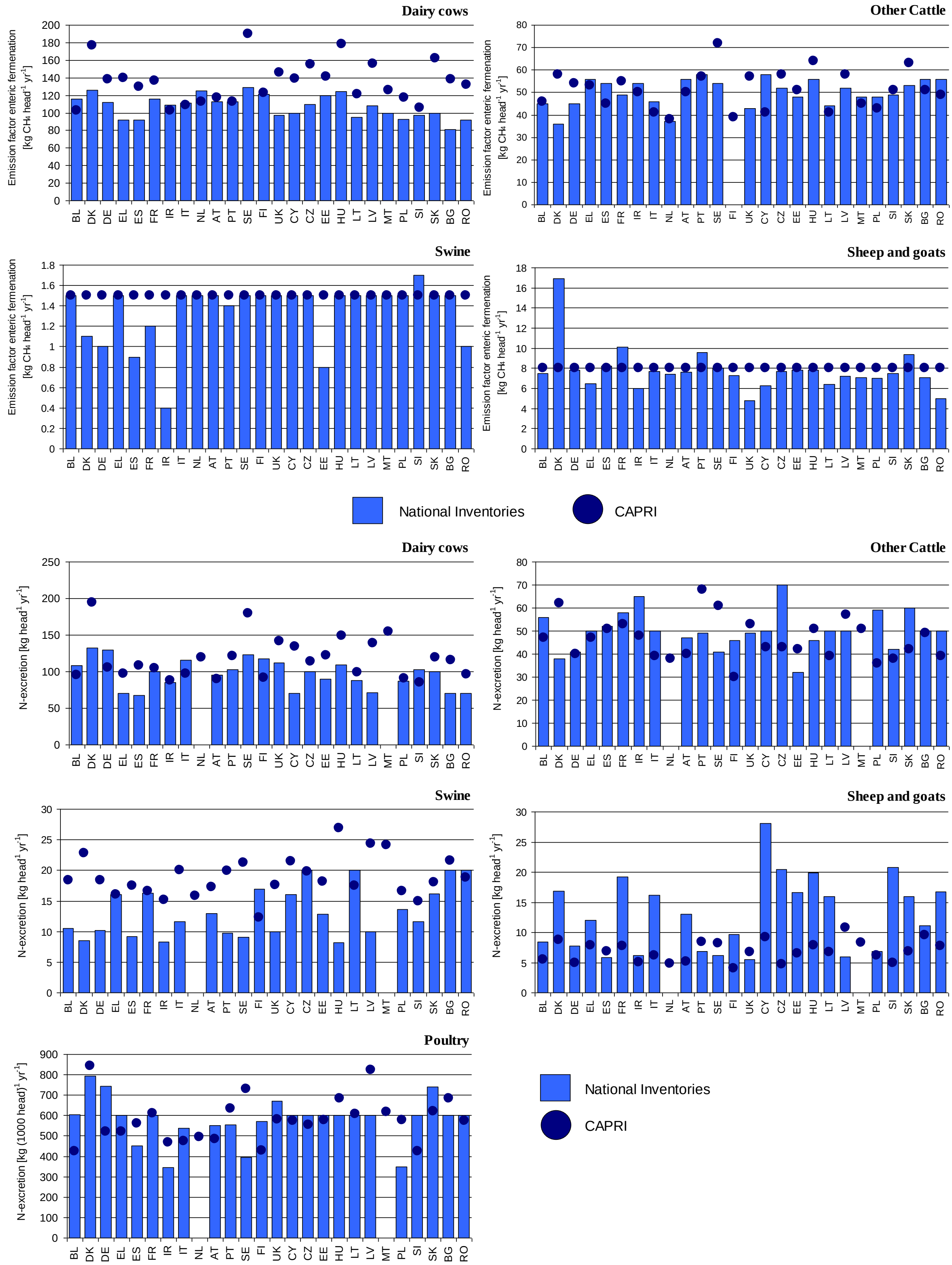
In some cases results differ substantially between CAPRI and the inventory submissions, which can be related to three different reasons: First, the approach of CAPRI and the national inventories is not always the same. Especially, the MITERRA approach, which is applied for the calculation of nitrogen emissions in the CAPRI model, differs substantially from the IPCC approach usually applied in the inventories. In CAPRI the excretion is not an exogenous parameter but is calculated as the difference between nitrogen intake and nitrogen retention of animals. For cattle and poultry deviations are generally low, while for swine, sheep and goats the differences are larger (see Figure 6.49). In case of swine the usually higher CAPRI values partly compensate the lower livestock numbers.

**Figure 6.49** **Comparison of livestock numbers used in National Inventories to the UNFCCC for the year 2004 (EEA, 2010) and livestock numbers used in CAPRI**



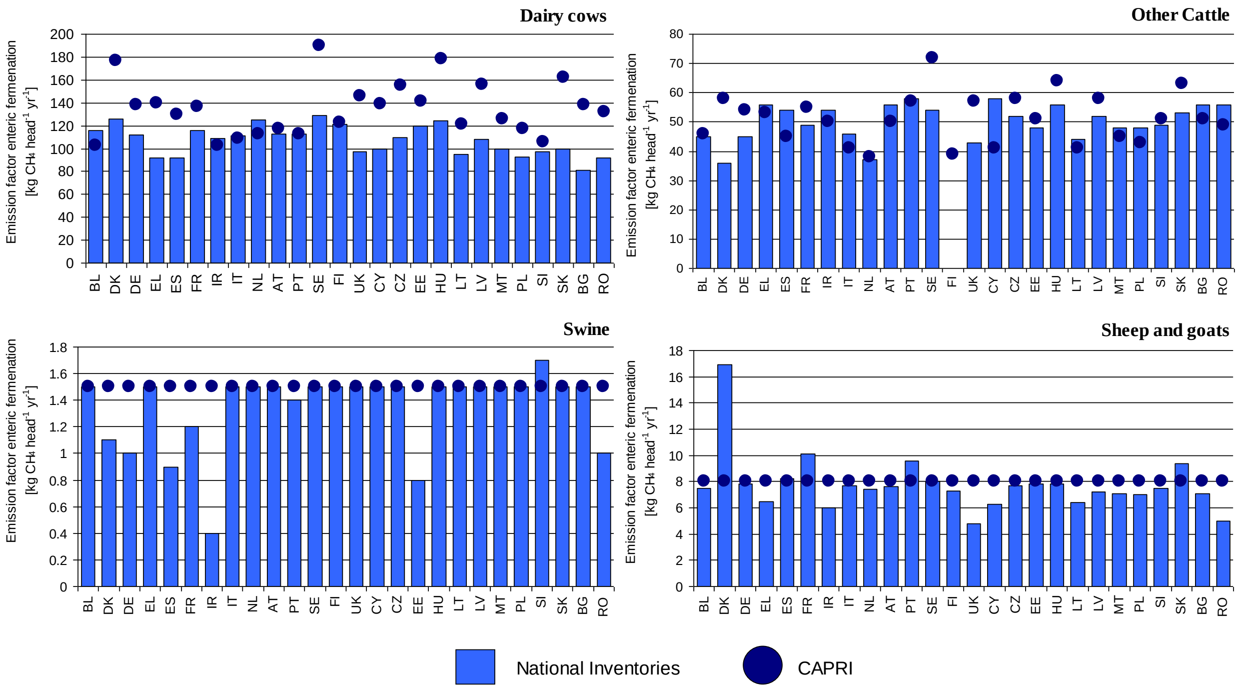

Second, most countries base their inventory calculations on the IPCC guidelines 1996, while CAPRI uses parameters of the most recent guidelines of the year 2006. In some cases emission factors and other parameters suggested by the IPCC changed considerably between 1996 and 2006, leading to corresponding changes in the estimation of emissions. Finally, apart from different approaches and different parameters due to changes in the IPCC guidelines, also other input data can impact on the results. This could be i.e. differences in livestock numbers, the distribution of manure management systems or time spent on pastures, average temperatures, or more technical data like fertilizer use, milk yields, live weight, nutrient contents, nitrogen excretion etc., which are partly assumed and partly already an output of calculation procedures in the CAPRI model. Since the national inventories use other input data some differences in the results are not surprising. For example, differences in estimated $CH_4$ emissions from enteric fermentation are mainly due to different emission factors for dairy and non-dairy cattle, since other animal categories play a less important role with respect to total emissions from enteric fermentation. The following factors can be identified as potential reasons for the deviations. First, for cattle (Tier 2 approach) CAPRI calculates the digestible energy endogenously, while most inventory reports use default values. Secondly, in the inventories most countries apply a methane conversion factor of 6% (default value according to IPCC 1997, see IPCC 1996), while CAPRI uses 6.5% (default value of IPCC 2006, see IPCC, 2006), leading to higher emission factors in CAPRI of around 8%. Thirdly, animal live weight impacts directly on net energy requirement, but can only be compared for dairy cows. CAPRI generally assumes a live weight of 600 kg, while national inventories use different values ranging from 500 to 700 kg. However, a simple regression suggests that live weight is not a key factor for the generally higher CAPRI values. Finally, there are differences in the weight gain and milk yields. While assumptions on the weight gain are not available in the inventory submissions and, therefore, cannot be compared, milk yields are usually higher in CAPRI than in the national submissions, favouring higher emission factors in case of dairy cows.

**Figure 6.50** **Comparison of N-excretion data used in National Inventories to the UNFCCC for the year 2004 (EEA, 2010) and N-excretion data calculated with CAPRI**



For EU-27, CAPRI calculates total agricultural sector emissions of 378 Mio tons of $CO_{2\text{-eq}}$, which is 79% of the value reported by the member states (477 Mio tons, biomass burning of crop residues and $CH_4$ emissions from rice production not included). On member state level this ranges between 54% in Cyprus and 127% in Denmark. Therefore, Denmark is the only member state for which CAPRI estimates total emissions higher than the NIs. With respect to the different emission sources, the relation of CAPRI emissions to NIs are: 103% for $CH_4$ emissions from enteric fermentation, 54% for $CH_4$ and 93% for $N_2O$ emissions from manure management, 92% for $N_2O$ emissions from grazing animals, 81% for $N_2O$ emissions from manure application to managed soils, 89% for $N_2O$ emissions from mineral fertilizer application, 87% for $N_2O$ emissions from crop residues, 89% for indirect $N_2O$ emissions following volatilization of $NH_3$ and $NO_X$, 11% of $N_2O$ emissions following Runoff and Leaching of nitrate, and 97% of emissions from the cultivation of organic soils.

**Figure 6.51 Comparison of emission factors for enteric fermentation in dairy and non-dairy cattle, swine, and sheep and goats used in National Inventories to the UNFCCC for the year 2004 (EEA, 2010) and the emission factors calculated (in case of dairy and non-dairy cattle) or used (in case of swine and sheep and goats) in CAPRI**




## 6.5 Sector-specific recalculations

### 6.5.1 Enteric Fermentation (CRF source category 4.A)

Information on recalculations of emission estimates in category 4A contained in the NIR of some countries are summarized below:

**Table 1.102 Member State's background information for recalculations of emissions in category 4.A**

| Member State | Recalculations |
|---|---|
| Austria | |
| Belgium | The fat% in the milk has slightly changed for the entire timeseries in the Flemish region. |
| Denmark | The emissions of $CH_4$ from enteric fermentation have been recalculated due to an error in the calculation of the emission from sows. This error was reason for a doublet counting of the emission from sows, therefore gives the recalculation a decrease in the emission from enteric fermentation. In the emission of $CH_4$ from enteric fermentation are furthermore from this year included emissions from poultry. The emissions are very low and contribute by less than 1 % of the total emission from enteric fermentation. Data of $CH_4$ from enteric fermentation from fur farming have been collected but these show that the emission is approximately zero. |
| Finland | |

| Member State | Recalculations |
|---|---|
| France | |
| Germany | |
| Greece | $CH_4$ emissions from enteric fermentation have been recalculated for dairy cattle, for other cattle and for sheep for the whole of 1990-2008 period. $CH_4$ emissions from enteric fermentation of dairy cattle and for other cattle were recalculated due to applying of Tier 2 methodology. $CH_4$ emissions from enteric fermentation of sheep were recalculated following the recommendations of 2010 centralized ERT review in order for estimations to be consistent with the IPCC good practice guidance:<br>• Estimation of energy for growth for all growing sheep considering that in mature age (1 year old) sheep obtain their mature weight (70 kg for males and 53 kg for females).<br>• Estimation of energy for wool for all mature sheep.<br>• Reconsidering of the number of milking ewes and births type considering that except of single births, double births occur based on the number of sheep born.<br>$CH_4$ emissions from enteric fermentation of poultry were recalculated for using country specific emission factors the first time. Emissions for 2007 and 2008 of othen animall where not recalculated, although provisional data had been used in the previous submission due to lack of updated data. According to ELSTAT, updated data for both 2007 and 2008 will be provided for the estimations of the next submission. |
| Ireland | |
| Italy | |
| Luxembourg | |
| Portugal | |

### 6.5.2 Manure Management (CRF source category 4.B(a))

Information on recalculations of emission estimates in category 4B(b) contained in the NIR of some countries are summarized below:

**Table 1.103 Member State's background information for recalculations of emissions in category 4.B**

| Member State | Recalculations |
|---|---|
| Austria | Within the revision of submission 2010 for dairy cattle the share of liquid systems has been increased significantly. For non-dairy cattle and swine the share of solid systems has been reduced, mainly due to the considerable share of deep litter in solid storage (reported under 'other systems'). For sheep, goats, horses and other animals the revised data show an increased share of solid storage systems and a decreased share of pasture. The new AWMS data reflect the situation in Austria much better than the IPCC default AWMS distribution and the distribution from the study by (KONRAD 1995) used before.<br>As a result of the comprehensive survey on animal husbandry (AMON et al. 2007) in submission 2010 deep litter systems were introduced to the Austrian AWMS distribution. Bearing the new study results of Austrian measurements on liquid systems in mind (see above), it is unlikely that the IPCC default MCF of 39% for deep litter systems would be applicable to Austrian conditions. Austrian measurements showed that $CH_4$ emissions from farmyard manure were always lower than $CH_4$ emissions from liquid manure. It would contradict latest scientific results to apply a higher MCF to deep litter systems than to liquid manure systems. In the IPCC guidelines the default MCF for deep litter systems equals the default MCF for liquid systems. Hence, for Austria the chosen MCF of 17% (IPCC 2006) is a conservative estimate. |
| Belgium | Small correction of the storage type in the Walloon region (% of solid storage and liquid systems ), on the whole time series. |
| Denmark | MCF factor for animal housed in deep litter systems was changed to 10 % in accordance with the IPCC guidelines. This affects emissions from cattle, sheep and goats. MCF for poultry has been changed to 1.5 % in accordance with the IPCC guidelines. During the recalculation process an error in MCF used for grazing animals was discovered. By an erroneous configuration in IDA, the Danish calculation model, the MCF for grazing animals followed the manure type. This is now corrected to a MCF of 1% for all livestock categories. |
| Finland | |
| France | |
| Germany | |
| Greece | $CH_4$ and $N_2O$ emissions from manure management have been recalculated because of the updated emissions factors use on the estimation of emissions from manure management of dairy cattle, other cattle, buffalo and sheep. Tier 2 approach was used for the estimation of methane emissions of dairy cattle, other cattle and sheep. |
| Ireland | |
| Italy | |
| Luxembourg | |
| Netherlands | |
| Portugal | |
| Spain | |
| Sweden | |
| United Kingdom | |

### 6.5.3 Manure Management (CRF source category 4.B(b))

Information on recalculations of emission estimates in category 4B(b) contained in the NIR of some countries are summarized below:

**Table 1.104 Member State's background information for recalculations of emissions in category 4.B-$N_2O$**

| Member State | Recalculations |
|---|---|
| Austria | |
| Belgium | Small correction of the storage type in the Walloon region (% of solid storage and liquid systems ), on the whole time series |
| Denmark | N-excretion from swine has been adjusted because of an error in Nexcretion from sows. This correction gives rise to an increased Nexcretion for all years 1990 – 2008.<br>New data for the housing type distribution for 2008 have been included and this give some changes in the allocation of the N-excretion on the different management systems and thereby a change in $N_2O$ emission. |
| Finland | |
| France | |
| Germany | N-excretion on pastures have been reduced due to a re-calculation of energy content in rough feed. Daily weight increase has been updated for non-dairy cattle. An error in the calculation of the energy requirement for swine has been corrected. A change in housing systems for laying hens leads to a change in the final weight and N-excretion rates. |
| Greece | $CH_4$ and $N_2O$ emissions from manure management have been recalculated because of the updated emissions factors use on the estimation of emissions from manure management of dairy cattle, other cattle, buffalo and sheep. Tier 2 approach was used for the estimation of methane emissions of dairy cattle, other cattle and sheep. Moreover, Western Europe values for the Nex of dairy cattle, other cattle and buffalo were used following the recommendations of ERT of 2010 review, while adjustment factors for young animals (other cattle, sheep) were applied as it is proposed by IPCC guidelines (Table 4.14, IPCC 1997). |
| Ireland | |
| Italy | |
| Luxemburg | |
| Netherlands | This year N-flows from animal production have been assessed by the National Emission Model for Ammonia (NEMA) for the first time. Results include emissions of ammonia ($NH_3$), nitric oxide (NO), laughing gas ($N_2O$) and nitrogen gas (N2) from stable and storage. Emission factors used for these initially represented IPCC 2006 defaults, since it was believed these would be more applicable for the Netherlands. However during review of the preliminary figures it was noted insufficient data was available to justify country specific values here. Therefore, calculations were done again using IPCC 1996 and GPG 2001 defaults, which led to 510 kton $CO_2$ eq higher emissions from category 4B manure management in the final submission of the year 2009. |
| Portugal | |
| Spain | |
| Sweden | |
| United Kingdom | |

### 6.5.4 Agricultural Soils – $CH_4$ (Source category 4.D)

Information on recalculations of emission estimates in category 4D contained in the NIR of some countries are summarized below:

**Table 1.105 Member State's background information for recalculations of emissions in category 4.D**

| Member State | Recalculations |
|---|---|
| | No recalculations |

### 6.5.5 Agricultural Soils - $N_2O$ (Source category 4.D)

Information on recalculations of emission estimates in category 4D contained in the NIR of some countries are summarized below:

**Table 1.106 Member State's background information for recalculations of emissions in category 4.D**

| Member State | Recalculations |
|---|---|
| Austria | 4.D.1 Crop Residue: Following a recommendation of the ERT during the Centralized Review 2010, emissions from field burning have been calculated on a crop by crop basis. The improved calculations of FracBURN resulted in slightly lower $N_2O$ emissions from crop residues (-0.08 Mg $N_2O$ in 2008).<br>4.D.1 Other direct emissions: The amount of sewage sludge applied to soils for the years 2006- 2008 has been updated (+0.04 Mg $N_2O$ in 2008) |
| Belgium | In the Flemish region there has been a recalculation of the $NH_3$-emissions for the period 2000-2008. This results in an in- |

| Member State | Recalculations |
|---|---|
| | crease of the $N_2O$ direct and indirect emission of ± 1.5% (sector 4D). Also in the Flemish region, the net amount exported and processed manure has been updated from 2000 on (source VLM). This results in either an increase or decrease of the $N_2O$ emission from sector 4D depending of the year (± 1%). Small corrections in the calculation sheet in the Walloon region (time series). |
| Denmark | The emission factor for histosols have been changed to the IPCC default, 8 kg $N_2O$-N per ha. The calculation of $N_2O$ emission from leaching has been changed due to available data, which make it possible to divide the calculation of the emission in three separately parts; groundwater, rivers and estuaries. In IPCC guidelines is recommended a specific emission factor for each of these three different environmental areas, which is used in the Danish emission inventory. The recalculation gives a decrease of the emission from 4.D by 7 - 16 % in 1990 - 2008. |
| Finland | The time series of cultivated organic soils was updated for the years 1990-2008 as new area data was available from the Finnish Forest Research Institute. As a result, $N_2O$ emissions from cultivated organic soils were recalculated for the years 1990-2008. |
| France | |
| Germany | Default emissions factors from the Revised 1996 IPCC Guidelines are used for all $N_2O$ emission sources. Changes in the quantity of N-excretion lead to changes in $N_2O$ emissions from applied manure and manure deposited on pastures. Data for the calculation of $N_2O$ from crop residues have been corrected. For the calculation of $N_2O$ emissions following nitrogen leaching and run-off, losses of gaseous emissions are subtracted before applying the leaching fraction. |
| Greece | $N_2O$ emissions from agricultural soils have been recalculated for the period 1990-2008 because of the updating of nitrogen excretion (Nex) for dairy cattle, other cattle, buffalo and sheep. Small recalculations due to estimation of $N_2O$ from the sewage sludge use in agriculture. |
| Ireland | |
| Italy | New estimation for sewage sludge applied to soils |
| Luxemburg | |
| Netherlands | Slightly higher emissions due to changes in category 4B(b) |
| Portugal | |
| Spain | |
| Sweden | |
| United Kingdom | |

### 6.5.6 Field burning of agricultural residues - $N_2O$ (Source category 4.F)

Information on recalculations of emission estimates in category 4F contained in the NIR of some countries are summarized below:

**Table 1.107 Member State's background information for recalculations of emissions in category 4.F**

| Member State | Recalculations |
|---|---|
| Austria | In response to questions raised during the UNFCCC centralized review 2010, the estimate has been improved by providing a breakdown of the emissions on a crop by crop basis. The more detailed calculations using crop specific parameters caused slightly decreased emissions. |

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# 7 LULUCF (CRF SECTOR 5)

Complying with relevant provisions, Sector 5 LULUCF (Land Use, Land Use Change and Forestry) of the European Union (EU) GHG Inventory is a compilation of the reports submitted by the EU's Member States (MS). MS' NIRs of 2011 are used as the primary source of data and information, unless otherwise specified and referenced.

This chapter provides the general trends of emissions and removals from LULUCF at the EU-15 level, compares the methods used by different countries and describes the efforts carried out to harmonize and improve the complete and consistent reporting of GHG inventory at EU-15 level. More detailed information can be found in the NIRs of individual MS.

In particular, for the EU-15, this chapter includes: an overview on LULUCF sector including overall trends, the contribution of land use changes, the completeness of reporting, the key categories and some general methodological information; the trends of net emissions, activity data and emissions factors for each category; some specific methodological information for the relevant categories; and an overview of cross-cutting issues including uncertainties, QA/QC, time series consistency and recalculations.

Meanwhile, the Chapter 22 (LULUCF for EU-27) provides some basic information for the new 12 MS of the European Union.

## 7.1 Overview of the sector (EU-15)

With almost all lands under more or less intensive management, Europe is a fine-grained mosaic of different land uses, resulting in a highly fragmented landscape. According to Eurostat (2008), forests and other woodland in EU-27 represent around 161 Million ha, or 42% of total land. The utilized arable area accounts for 27 % of total land, whereas permanent grasslands and built-in area represent around 15% and 8%, respectively. Although no major differences exist between EU-15 and the new 12 MS, the relative share of different land uses vary widely across individual MS, according to the prevailing ecological and socio-economic conditions.

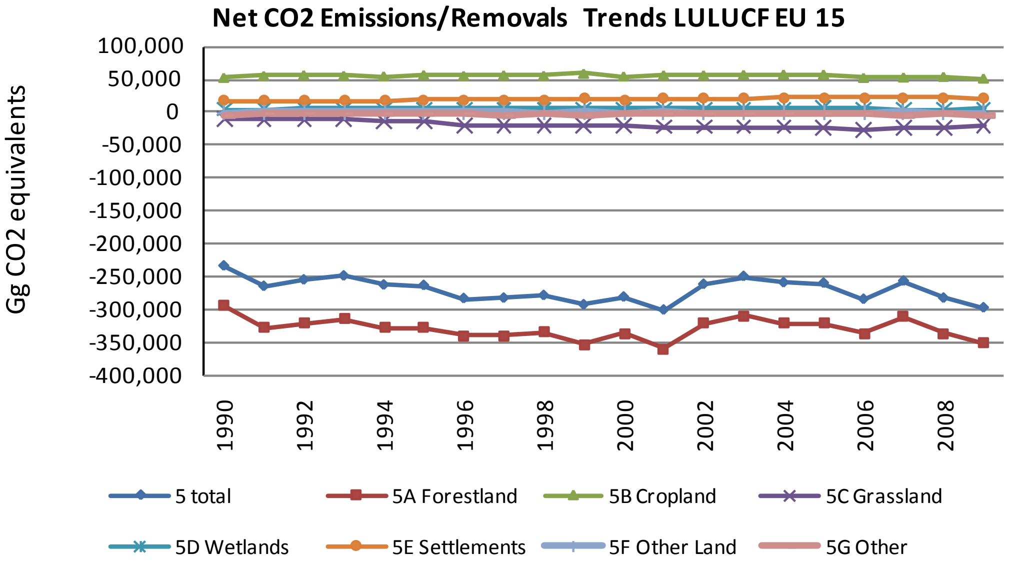
The EU agricultural and environmental policies have been the major driver of land use and land use change in Europe since 1990. In particular, the Common Agricultural Policy and rural development programs have stimulated less intense agricultural practices and a general decrease of area of the utilized arable land, compensated by the increase in forest and urban areas. Furthermore, the EU environmental policy (e.g. Natura 2000 network) has stimulated a significant increase of forest and woodlands area under conservation regime with the purpose of preserving biodiversity and landscapes. Currently, at EU-27 level, around 25% of total forest and woodland areas are excluded from harvesting, and felling accounts for only 60% of the net annual wood increment (Eurostat 2008[31]), which explains the significant build-up of biomass (i.e. carbon removal) in the forests.

### *7.1.1 Trends by land use categories*

The Sector 5 LULUCF of the EU-15 is a net carbon sink, resulting from higher removals by sinks than emissions from sources. Overall, forests are a significant net carbon sink, croplands are a source and grasslands are a small sink (Figure 7.1). In 2009, the net $CO_2$ in LULUCF sink in the EU-15 was -298 203 Gg$CO_2$-eq. which represents an increase of about 27% compared to annual sink in 1990 (Figure 7.1). The contribution of $CH_4$ and $N_2O$ is less than 1% of net annual sink.

[31] EEA Report No 3/2008, European forests - ecosystem conditions and sustainable use

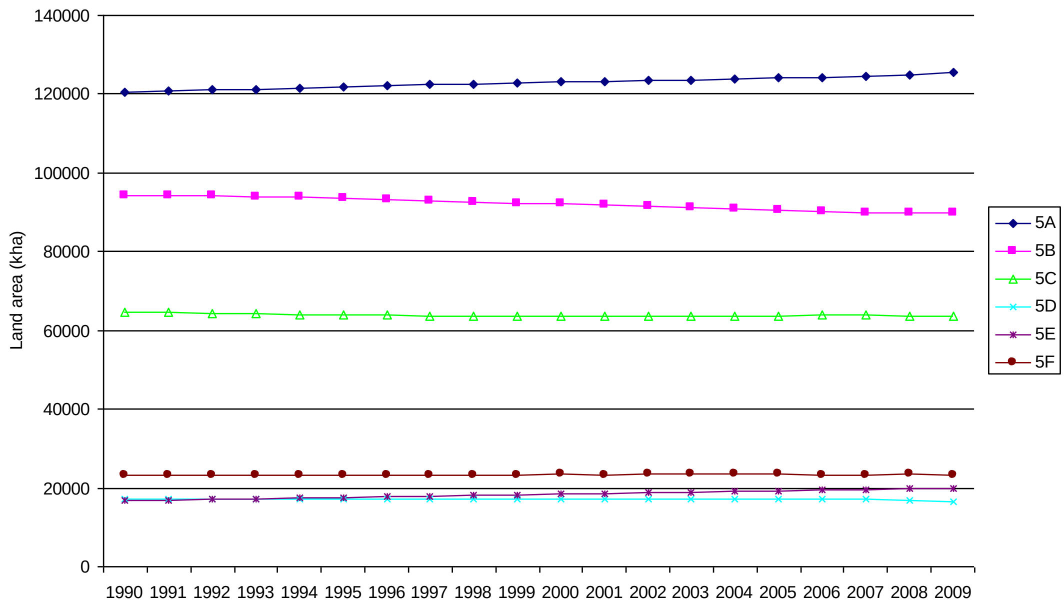
**Figure 7.1** **Sector 5 LULUCF: EU-15 GHG emissions (+) and removals (-) for 1990–2009, in $CO_2$ eq. (Gg), for all land use categories**




The significant increase of the EU-15 annual sink was related to the increase by all MS during the '90s. It was followed by a decline largely attributable to Germany, whose forest sink decreased of about 50000 Gg $CO_2$ in 2002 to 26 % of previous reported area (caused by inconsistent data between old and new forest inventories). The other year-to-year variations of the forest sink are mainly related to major wind storms (e.g. 2000 in central-western Europe) and wild fires (e.g. forest fires in 1990, 2003 and 2007 in Mediterranean countries).

Increase of the removal trend is supported by modification of the land area. The reported land area of the different categories (Figure 7.2) confirms the trends known from other statistics (e.g. Eurostat), although the absolute numbers may slightly differ due to different definitions under different reporting requirements. For EU-15, the main changes in area from 1990 and 2009 regarded Forests land (+4.2%), Cropland (7%) and Settlements (+20%). The total reported land area is higher than that reported in NIR 2010 (by some 2% in 1990) and increased from 336 602 kha in 1990 to 338 620 kha in 2009 (+1%). This small inconsistency of total land area reported in time is caused by the fact that reporting complete and consistent information on activity data represents a challenging task for the MS (see Ch. 7.2 and followings for more details, and 7.8.4 for QA/QC and planned improvements).

**Figure 7.2** EU-15 total land area in the various LULUCF categories (kha), as reported in the MS' CRFs




Although MS showed net sinks in LULUCF sector in 2009, it should be noted that the MS are practically split in two groups: some with very small sinks (e.g. Belgium, Denmark and Ireland) other with high sinks (e.g. Italy, France, Spain, Finland and Sweden). Also, there are few countries that estimate LULUCF as a source: Germany since 2002 (because of very high emissions in 5B) and The Netherlands since 1990 (because of the emissions in 5C). LULUCF sector in Denmark was also a small source before 2007.

**Table 7.1** Sector 5 LULUCF: MS' contributions to net $CO_2$ emissions in 2009

| Member State | Net $CO_2$ emissions (Gg) | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | |
|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$) | (%) | (Gg $CO_2$) | (%) |
| Austria | -13,780 | -17,635 | -17,574 | 5.9% | 61 | 0% | -3,794 | 28% |
| Belgium | -1,557 | -1,556 | -1,600 | 0.5% | -44 | 3% | -44 | 3% |
| Denmark | 3,136 | -2,128 | -1,131 | 0.4% | 997 | -47% | -4,266 | -136% |
| Finland | -15,161 | -27,172 | -40,704 | 13.6% | -13,531 | 50% | -25,542 | 168% |
| France | -42,554 | -72,077 | -67,126 | 22.5% | 4,951 | -7% | -24,572 | 58% |
| Germany | -31,949 | 14,443 | 17,155 | -5.8% | 2,712 | 19% | 49,105 | -154% |
| Greece | -2,524 | -3,100 | -3,043 | 1.0% | 57 | -2% | -520 | 21% |
| Ireland | -580 | -2,400 | -2,216 | 0.7% | 185 | -8% | -1,635 | 282% |
| Italy | -62,077 | -92,879 | -94,731 | 31.8% | -1,853 | 2% | -32,654 | 53% |
| Luxembourg | 345 | -275 | -299 | 0.1% | -24 | 9% | -644 | -187% |
| Netherlands | 2,692 | 2,668 | 2,475 | -0.8% | -193 | -7% | -217 | -8% |
| Portugal | -9,412 | -13,512 | -14,155 | 4.7% | -643 | 5% | -4,743 | 50% |
| Spain | -19,249 | -29,142 | -28,696 | 9.6% | 446 | -2% | -9,448 | 49% |
| Sweden | -44,804 | -34,019 | -41,769 | 14.0% | -7,750 | 23% | 3,035 | -7% |
| United Kingdom | 3,057 | -4,691 | -4,789 | 1.6% | -99 | 2% | -7,846 | -257% |
| **EU-15** | **-234,417** | **-283,475** | **-298,203** | **100.0%** | **-14,728** | **5%** | **-63,786** | **27%** |

Overall, for the EU-15, LULUCF sector in 2009 offsets 7.9% of the total EU-15 emissions (without LULUCF), with values ranging from 1.9 % (as source, in Germany) to -69.4 % (as sink, in Sweden)) (Table 7.2, column a). The most important LULUCF category, Forest Land, in 2009 was a net sink for all MS (Table 7.2), which offset ranged from 1.4 % (Netherlands) to 76.5 % (Sweden), while the overall offset for the EU-15 was -9.4% (Table 7.2, column b). T The most significant contributors to EU-15's 5A inventory are France and Italy (Table 7.2, column c).

**Table 7.2** **Sector 5 LULUCF: Contribution of Sector 5 (column a) and Category 5A (column b) to total emissions (without LULUCF) and MS contribution to EU-15 Category 5A (column c)**

| Member State | Sector 5 over total emission excluding LULUCF | Category 5.A over total emissions | Member States contribution to EU-15 total for Category 5A |
|---|---|---|---|
| | (a) (%) | (b) (%) | (c) (%) |
| Austria | -21.9% | -24.0% | 5.5% |
| Belgium | -1.3% | -2.7% | 1.0% |
| Denmark | -1.8% | -4.5% | 0.8% |
| Finland | -61.1% | -71.1% | 13.5% |
| France | -12.4% | -15.4% | 22.7% |
| Germany | 1.9% | -2.8% | 7.2% |
| Greece | -2.5% | -1.9% | 0.7% |
| Ireland | -3.5% | -4.3% | 0.8% |
| Italy | -19.3% | -13.5% | 18.9% |
| Luxembourg | -2.5% | -4.0% | 0.1% |
| Netherlands | 1.2% | -1.4% | 0.8% |
| Portugal | -18.9% | -19.9% | 4.2% |
| Spain | -7.8% | -6.8% | 7.2% |
| Sweden | -69.4% | -76.5% | 13.1% |
| United Kingdom | -0.7% | -2.2% | 3.6% |
| **EU-15** | **-7.9%** | **-9.4%** | **100.0%** |

*Source: MS' submissions 2011, CRF table 5, 5A and Summary 2.*

### *7.1.2 Contribution of land use changes*

Entire land use change area only represents 9 % of the total reported land area in EU-15 (Table 7.3, column b), which is less than reported last year especially under recalculations of 5A2 (mainly under France data improvement on afforestation/reforestation and conversions to forestland, which also generated changes in the entire land matrix, most notable the decrease of "conversions to grassland" by 3 percentage points). Significant improvement in the activity data for GHG inventories over last years is reflected by better allocation of land from "other land" to another category (absolute value area is half that reported last year).

The sink on conversions to forestland and grassland is almost balanced by emissions from conversions to cropland and settlements at EU-15 level. Overall, 2009 estimates are 22 % smaller than those reported for 2008 under the effect of recalculations (the biggest fall was in "conversions to forestland", and the increase in "conversions to grassland"), and also likely because of land leaving their transition period. Despite small share of total land, the emissions and removals associated with land conversions represent, in absolute terms, 26% of the net emissions from LULUCF (Table 7.3, column d).

**Table 7.3** **Contribution of land use changes in 2009 for EU-15, in terms of area (columns a-b) and GHG emissions (columns c-d).**

| Land conversions | a) land area | b) % of area of the corresponding category[1] | c) emissions (+) and removals (-) (Gg $CO_2$ equivalents) | d) % of net emissions of the corresponding category[1,2] |
|---|---|---|---|---|
| 5A2. Land converted to Forest Land | 5017 | 4% | -31593 | 9% |
| 5B2. Land converted to Cropland | 9735 | 11% | 32546 | 63% |
| 5C2. Land converted to Grassland | 10177 | 16% | -30315 | 154% |
| 5D2. Land converted to Wetlands | 588 | 4% | 2346 | 45% |
| 5E2. Land converted to Settlements | 4001 | 20% | 19150 | 89% |
| 5F2. Land converted to Other Land | 1019 | 4% | -280 | 100% |
| ***Total land use changes*** | ***30536*** | ***9%*** | ***116231*** | ***26%*** |

*[1] the corresponding category is 5A (Forest land) for 5A2, 5B (Cropland) for 5B2 and so on.*
*[2] The contribution of emissions from land use changes to the total of each category was obtained by considering separately the absolute values of each subcategory, i.e. (abs 5A2)/(abs 5A1+ abs 5A2) x 100.*

Land use area under conversion is 20 % higher in 2009 than in 1990 (Table 7.4). Overall, land use changes associate with emissions in 1990 and turned into removal in 2009.

**Table 7.4** **EU-15 land use change matrix for the years 1990 and 2009, in terms of area and net emissions (in italics).**

| Year 1990 | | Land area conversions from… (kHa) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | forestland | cropland | grassland | wetlands | settlements | otherland | *Total "to"* |
| Conversions to | forestland | | 956 | 1903 | 205 | 160 | 231 | ***3456*** |
| | cropland | 347 | | 7854 | 29 | 262 | 27 | ***8519*** |
| | grassland | 778 | 7617 | | 34 | 357 | 81 | ***8867*** |
| | wetlands | 41 | 62 | 78 | | 23 | 89 | ***293*** |
| | settlements | 381 | 938 | 1433 | 18 | | 28 | ***2798*** |
| | otherland | 149 | 100 | 125 | 36 | 16 | | ***426*** |
| *Total "from"* | | ***1695*** | ***9673*** | ***11392*** | ***323*** | ***819*** | ***456*** | ***24359*** |

| Year 1990 | | Net emissions in conversion from ...(GgCO2) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | forestland | cropland | grassland | wetlands | settlements | otherland | *Total "to"* |
| Net emissions in conversions to … | forestland | | -3025 | -10207 | -745 | -1587 | -1138 | ***-16701*** |
| | cropland | 4052 | | 33123 | 52 | 329 | 205 | ***37761*** |
| | grassland | 3715 | -23462 | | -482 | -1213 | -399 | ***-21842*** |
| | wetlands | 1088 | 150 | -108 | | 34 | 917 | ***2081*** |
| | settlements | 5627 | 1581 | 7979 | -5 | | 176 | ***15359*** |
| | otherland | 1070 | -1242 | -133 | -80 | -105 | | ***-491*** |
| *Total "from"* | | ***15552*** | ***-25998*** | ***30654*** | ***-1260*** | ***-2543*** | ***-239*** | ***16166*** |

| Year 2009 | | Land area conversions from… (kHa) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | forestland | cropland | grassland | wetlands | settlements | otherland | *Total "to"* |
| Conversions to | forestland | | 1416 | 2080 | 673 | 278 | 570 | ***5017*** |
| | cropland | 341 | | 9036 | 38 | 298 | 21 | ***9735*** |
| | grassland | 810 | 8582 | | 60 | 596 | 130 | ***10177*** |
| | wetlands | 167 | 54 | 164 | | 37 | 166 | ***588*** |
| | settlements | 671 | 1167 | 2041 | 46 | | 77 | ***4001*** |
| | otherland | 266 | 303 | 297 | 130 | 23 | | ***1019*** |
| *Total "from"* | | ***2254*** | ***11522*** | ***13618*** | ***947*** | ***1232*** | ***964*** | ***30537*** |

| Year 2009 | | Net emissions in conversion from ...(GgCO2) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | forestland | cropland | grassland | wetlands | settlements | otherland | *Total "to"* |
| Net emissions in conversions to … | forestland | | -10217 | -14416 | -1676 | -2479 | -2805 | ***-31593*** |
| | cropland | 4545 | | 27271 | 392 | 163 | 175 | ***32546*** |
| | grassland | 3694 | -32400 | | -18 | -1422 | -168 | ***-30315*** |
| | wetlands | 839 | 94 | 272 | | 39 | 1103 | ***2346*** |
| | settlements | 8241 | 4938 | 5286 | 104 | | 581 | ***19150*** |
| | otherland | 743 | -631 | -317 | -25 | -51 | | ***-280*** |
| *Total "from"* | | 18063 | -38217 | 18095 | -1224 | -3750 | -1114 | ***-8147*** |

The most important land use changes in EU-15, in terms land area involved, are the conversions from grassland to cropland (and vice versa), the conversions from grassland to forestland, and the conversion of forestland to settlements. Share of emissions becomes important for conversions from grassland to cropland, while conversion to forestland have increasing contribution.

On average, since 1990, out of the lands "under conversion" 35% are conversions to forest land, 28% are conversions to settlements and an equal 15 % for conversions to grasslands and cropland. When interpreting the data of Table 7.4 it is important to note that some differences may occur among MS in terms of both land use definitions and the reported time series (e.g. some countries start only in 1990, and not all countries use the 20-yrs default transition period, some MS assume linear transition in time).

### 7.1.3 Completeness

Table 7.5 illustrates the current coverage of reporting for the various land sub-categories in the year 2009. The three main land uses have practically complete coverage (France and Netherlands assume there is no emissions from CL; Greece and Italy assume there is no conversion to CL, several countries assume GL is neutral and Greece assumes there is no conversion to GL).

**Table 7.5 Sector 5 LULUCF: Coverage of $CO_2$ emissions and removals in the various land sub-categories for the year 2009, as derived from 2011 submission**

| Member State | Reporting category | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Forest land | | Cropland | | Grassland | | Wetland | | Settlements | | Other land | |
| | 5A1 F-F | 5A2 L-F | 5B1 C-C | 5B2 L-C | 5C1 G-G | 5C2 L-G | 5D1 W-W | 5D2 L-W | 5E1 S-S | 5E2 L-S | 5F1 O-O | 5F2 L-O |
| Austria | R | R | R | E | R | E | | E | | E | | E |
| Belgium | R | R | E | E | E | E | | R | | E | | E |
| Denmark | E | E | E | R | E | E | E | R | | E | | |
| Finland | R | E | E | E | E | R | | E | | | | |
| France | R | R | | R | | R | | E | | E | | E |
| Germany | R | R | E | R | E | R | E | E | E | E | | E |
| Greece | R | R | R | | | | | E | | E | | E |
| Ireland | R | E | R | E | E | R | E | E | | E | | |
| Italy | R | R | R | | R | R | | | | E | | |
| Luxemb. | R | R | E | E | | E | | E | | E | | E |
| Netherl. | R | R | | E | E | E | | E | | E | | E |
| Portugal | R | R | R | E | | R | | E | E | E | | E |
| Spain | R | R | R | | | R | | | | E | | |
| Sweden | R | R | E | E | R | R | E | | R | E | | |
| UK | R | R | E | E | | R | | | | E | | |

*R = the pool acts as net Removal; E = the pool acts as net Emission*
*Empty cells = the pool was not reported, included elsewhere or reported as zero.*

For other land use sub-categories emissions are mainly reported as not occurring for land remaining in the same category. Meanwhile there is a quite complete reporting on the conversions, with relevant IPCC guidelines implemented for pools (i.e. SOC – soil organic carbon change is not estimated for conversions from forest to 5E).

Despite heterogeneous definitions of land categories implemented by the MS, comparability of LULUCF sectors in the national GHG inventories is ensured as long as $CO_2$ removal and GHG emissions are estimated under complete national inventories. On the other hand, the quantitative effect of definitional differences are likely negligible.

Table 7.6 shows the completeness of reporting of C stock changes by pools for the three most important land sub-categories in 2009. Compared to the previous submissions, several MS have increased the number of pools estimated and reported. This is also the case of empty cells in Table 7.7 where such pools are not reported as sink or source, but demonstrated in the NIR to be very small sinks, then reported in the CRF by notation keys (and further making the link with Kyoto Protocol reporting), while the effort to provide estimates is ongoing.

Pools also have different definitions amongst MS, in which case the comparability of inputs into EU GHG inventory for LULUCF sector is ensured as it operates with changes in the C stocks or emissions, which are fully additive among various pools or sources. On the other hand, the quantitative effect of definitional differences are likely negligible.

### *7.1.4 Key categories*

The following subcategories of the LULUCF sector of the EU-15 GHG inventory were found to be key categories for the trend and the level assessment in 2009:

- 5A1 Forest Land remaining Forest Land: $CO_2$
- 5A2 Land converted to Forest Land: $CO_2$
- 5B1 Cropland remaining Cropland: $CO_2$
- 5B2 Land converted to Cropland: $CO_2$
- 5C1 Grassland remaining Grassland: $CO_2$
- 5C2 Land converted to Grassland: $CO_2$
- 5E2 Land converted to Settlements: $CO_2$

**Table 7.6** **Sector 5 LULUCF: Reporting of carbon pools for the most important land sub-categories for the year 2009 (from Tables 5A, 5B and 5C of MS's CRF 2011)**

| MS | Forest land | | | | | | | | Cropland | | | | | | | | Grassland | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | FL-FL | | | | L-FL | | | | CL-CL | | | | L-CL | | | | GL-GL | | | | L-GL | | | |
| | Bi-om | DOM | SOC Min | SOC Org | Bi-om | DOM | SOC Min | SOC Org | Bi-om | DOM | SOC Min | SOC Org | Bi-om | DOM | SOC Min | SOC Org | Biom | DOM | SOC Min | SOC Org | Biom | DOM | SOC Min | SOC Org |
| **AT** | R | R | | | R | R | R | | E | | R | | R | E | E | | | | R | ie | E | E | E | |
| **BE** | R | R | R | | R | | R | | | | E | | E | | E | | | | E | | E | | E | |
| **DK** | R | E | | E | E | R | E | E | E | | R | E | R | E | R | ie | E | | E | E | E | E | R | E |
| **FI** | R | ie | R | E | R | ie | E | E | R | | R | E | R | R | E | E | | | R | E | R | R | R | E |
| **FR** | R | R | | | R | R | R | | | | | | R | R | R | | | | | | E | E | R | |
| **DE** | R | R | | E | R | R | R | E | R | ie | R | E | R | R | R | E | R | ie | | E | R | ie | R | E |
| **GR** | R | | | | R | | | | R | | R | E | ie | | | | | | | | | | | |
| **IE** | R | R | | R | E | R | E | R | | | R | | | | E | | | | | E | R | | R | E |
| **IT** | R | R | R | | R | R | R | | R | R | R | E | | | | | R | R | R | | E | | R | |
| **LU** | R | | | | R | | R | | E | | | | E | E | E | | | | | | E | E | R | |
| **NL** | R | R | | | R | | | | | | | ie | E | E | | | | | | E | E | E | | |
| **PT** | R | E | R | | R | E | R | | R | E | E | | E | E | E | | | | | | E | E | R | |
| **ES** | R | | | | R | | R | | R | | R | | | | | | | | | | | | R | |

| | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **SE** | R | R | R | E | R | R | R | E | R | E | E | E | E | E | E | E | R | R | R | E | R | E | R | E |
| **UK** | R | R | R | R | R | R | R | R | R | | ie | E | E | ie | E | ie | | | | | E | ie | R | ie |

*Pools: DOM – dead organic matter, Biom –biomas, SOCmin – mineral soils organic carbon, SOCorg – organic soils organic carbon*

*R: net Removal; E: net Emission*

*Empty cells = the pool was not reported or reported as zero (either "not estimated" (reported in CRF as "NE" alone or in combination with other keys), assumed as "no C stock change" (following IPCC tier 1), or assumed as "not occurring" (notation keys used "NO" and/or "NA")*

*ie means that the pools change is estimated but included elsewhere*

### *7.1.5 General methodological information*

This chapter provides general information on methods, activity data, carbon stock change factors and emissions factors on sink and sources for the main land sub-categories (5A: Forest Land, 5B: Cropland and 5C: Grassland). Detailed information can be found in Ch. 7.3, Methodological issues.

Given the heterogeneity of the countries in terms of ecological and socio-economic conditions, there are no unique definitions of different land uses across MS. Data on the area of land use categories, the land affected by disturbances and the amount of harvest used to estimate GHG emissions and removals mainly come from national statistics, national forest inventories and forest management plans (Table 7.7). Thematic maps are sometimes used (national maps, Corine Land Cover).

**Table 7.7 Data sources for activity data as NIR 2011. NFI: national forest inventory; NS: national statistics (agricultural and forest statistics, management plans, cadastral data); NM: national maps; CLC: Corine Land Cover, EO: Earth Observation. Empty cells: no information reported/ no reported pool/Tier 1**

| Member State | Reporting categories | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 5A | | | | 5B | | 5C | | Other LU categories |
| | 5.A.1 | 5.A.2 | Harvest | Disturbance | 5.B.1 | 5.B.2 | 5.C.1 | 5.C.2 | |
| Austria | NFI | NFI | NFI, NS | NFI | NS | NS | NS | NS | NS |
| Belgium | NFI | | NS | | CLC, NS | | CLC, NS | | NS |
| Denmark | NS, NFI | NS,NFI | NS,NFI | | NS, NM | | NS,NM | | NS |
| Finland | NFI | | NS | | NS | | NFI, NS | | NFI, NS |
| France | NFI, NM | NFI, NM | NS | NS | NS, NM | NS, NM | NS, NM | NS, NM | NS, NM |
| Germany | NFI | NFI | | NS | NS, NM, CLC | NS, NM, CLC | NS, NM, CLC | NS, NM, CLC | NS, NM, CLC |
| Greece | NFI, NS | NS | NS | NS | NS | | NS | | |
| Ireland | NFI, NS | NS, NM, CLC | NS | NS | NS | NM | NS | NM, CLC | NS, CLC |
| Italy | NFI, NS | NS | NS | NS | NS | NS | NS | NS | NS, CLC |
| Luxembourg | EO | EO | EO | EO | EO | EO | EO | EO | EO |
| The Netherlands | NFI, NM | NFI, NM | NS | | NM | NM | NM | NM | NM |
| Portugal | NFI, CLC | CLC, NS | NS | NS | CLC | CLC | CLC | CLC | CLC |
| Spain | NFI, CLC, NM | NS | | NS | CLC, NS | CLC | CLC | CLC | CLC |
| Sweden | NFI | NFI | NFI | NFI | NFI | NFI | NFI | NFI | NFI |
| United Kingdom | | NS | NS | NS | NS | NS | NS | NS | NS |

The methods used by the MS to estimate emissions and removals from the LULUCF sector vary among countries and land use categories, especially function of data availability. Table 7-8 is a summary of relevant information in the GHG inventory 2011 for the LULUCF sector.

Because of different underlying methods of each country, when comparing the absolute levels or trends of the implied emission/carbon stock change factors across MS, much caution should be used. Indeed, in some cases, large differences may only be attributable to the different estimating or reporting methodology and they do not truly reflect the different intensity of emissions and removals. For example, some implied emission factors may be significantly affected by new areas entering a given category or time series for land conversions starts in 1990. Furthermore, the fact that not all countries use the 20-year default transition period for land use change categories means that the corresponding emission factors are not fully comparable across all MS.

**Table 7-8** **Summary of methods and C stock change factors used by countries to calculate emission and removals of different pools in the LULUCF sector.**

| | Forest land | | | | | | | | Cropland | | | | | | | | Grassland | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | FL-FL | | | | L-FL | | | | CL-CL | | | | L-CL | | | | GL-GL | | | | L-GL | | | |
| MS | BM | DOM (1) | SOC Min | SOC Org (2) | BM | DOM | SOC Min | SOC Org (2) | BM (3) | DOM | SOC Min (4) | SOC Org (2) | BM (5) | DOM | SOC Min | SOC Org (2) | BM | DOM | SOC Min (4) | SOC Org (2) | BM | DOM | SOC Min | SOC Org (2) |
| **AT** | CS | CS,D | D | NO | CS | CS | CS | NO | D | D | CS,CS | NO | CS,CS | CS | CS | NO | D | D | CS,CS | CS | CS | CS | CS | NO |
| **BE** | CS | CS,D | CS | NO | CS | D | CS | NO | NE | D | CS | NO | CS,NO | NE | CS | NO | D | D | CS | NO | CS | NE | CS | NO |
| **DK** | CS | CS,D | D | CS | CS | CS | CS | CS | CS | D | CS | CS | CS,CS | CS | CS | CS | CS | D | CS | CS | CS | CS | CS | CS |
| **FI** | CS | CS | CS | CS | CS | CS | CS | CS | CS | D | CS,D | CS | CS,NE | CS | CS | CS | D | D | CS,D | CS | CS | CS | CS | CS |
| **FR** | CS | CS,D | D | NO | CS | CS | CS | NO | CS | D | NE | NO | CS,NE | CS | CS | NO | D | D | NE | NO | CS | CS | CS | NO |
| **DE** | CS | CS,D | D | CS | CS | CS | CS | CS | D | D | CS | CS | CS,CS | CS | CS | CS | CS | CS | NE | CS | CS | CS | CS | CS |
| **GR** | CS | D | D | NO | CS | D | D | NO | CS | D | D,D | CS | CS,NE | NE | NE | NO | D | D | NO | NO | NE | NE | NE | NO |
| **IE** | CS | CS,D | D | CS | CS | CS | CS | CS | NO | D | CS,D | NO | NO,NE | NO | CS | NO | D | D | NE | CS,D | CS | NE | CS | CS |
| **IT** | CS | D,CS | CS | NO | CS | CS | CS | NO | CS | CS | CS | CS | NO,NO | NO | NO | NO | CS | CS | CS,D | NO | CS | NE | CS | NO |
| **LU** | CS | D | D | NO | CS | D | CS | NO | CS | D | NE | NO | CS | CS | CS | NO | D | D | NE | NO | CS | CS | CS | NO |
| **NL** | CS | CS | D | NE | CS | D | NE | NE | NE | D | NE | CS | CS,NE | CS | NE | NE | D | D | NE | CS | CS | CS | NE | NE |
| **PT** | CS | CS | CS | NO | CS | CS | CS | NO | CS | CS | CS | NO | CS,CS | CS | CS | NO | D | D | NE | NO | CS | CS | CS | NO |
| **ES** | CS | D | D | NO | CS | D | CS | NO | CS | D | CS | NO | NO,NO | NO | NO | NO | D | D | NE | NO | NE | NE | CS | NO |
| **SE** | CS | CS | CS | CS | CS | CS | CS | CS | CS | CS | CS | CS | CS,CS | CS | CS | CS | CS | CS | CS | CS | CS | CS | CS | CS |

| | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **UK** | CS | CS | CS | CS | CS | CS | CS | CS | CS | D | CS | CS | CS,CS | CS | CS | CS | D | D | NE | NO | CS | CS | CS | CS |

*(D: default; CS: country specific; NA: not applicable; NE – not estimated; NO- not occurring)*
*Source: CRFs 2011*
*"CS" country specific data, associated either with IPCC method (tier 2) or country-specific method (tier 3, if data are highly disaggregated). Note that sometimes not all parameters involved in the estimation are truly "CS" (e.g. root/shoot ratio and BEF are often taken by IPCC). However it is expected that if "CS" is reported, the most important parameters are truly "CS*
*"D" means that the default IPCC emission factors are used in the estimation. D is typically associated with IPCC default method (tier 1). If the heading is in grey, D means that NO change in C stock is assumed (following IPCC tier 1).*
*"NE" means either country assumes the emission/removal is negligible or not enough data is available for estimation*
*"NO" means emissions or removals "not occurring" in a country (it includes also "NA" - not applicable)*
*(1) for DOM under "FL r FL" the 2 notations separated by a comma mean: first one refers to DW (dead wood), second to LT (litter)*
*(2) for ORGANIC SOIL any notation key reported for a country showing some activity data of org soil for any land (sub)category is assumed as NE. D refers to the use of IPCC default emissions factors*
*(3) BIOMASS C stock change in CL-CL is assumed only for perennial woody crops. Biomass of annual crops is always assumed zero C stock change by definition.*
*(4) for SOC MIN on CL and GL the 2 notation keys separated by comma mean that the country uses IPCC default method (which is tier 1 if associated with D data or tier 2 if associated with CS data); in this case, the first notation key refers to "reference C stock", and second to "C stock change factor" (see IPCC-GPG for details). A cell with a single "CS" indicate a country-specific method and data (i.e. tier 3 if data are highly disaggregated)*
*(5) for BIOMASS under L - CL, "conversion to cropland", the 2 notation keys used mean: first one refers to FL-CL and second to GL-CL*
*Grey heading means that for these pools IPCC TIER 1 allows to assume no change in C stock (note that if the category is a key category, in theory higher tiers should be used)*

## 7.2 Forest land (CRF 5A)

### 7.2.1 Overview of the Forest land category

Forests land is the dominant category in the LULUCF sector. According to the data provided by the MS in their 2011 submissions, total forest area in EU-15 increased from 120531 kha in 1990 to 125638 kha in 2009, which is some 4.2% more. This trend, reflected in official statistics of the MS and EU, is due to the decreasing grazing pressure and decreasing agricultural activities on marginal lands, which promoted natural forest expansion, and also to the promotion of national afforestation programs (including grant-aid).

The largest forest area is in Sweden (28200 kha, or 65% of total country land area), Finland (22100 kha ha or 65% of total area); France (22300 kha, including overseas territories), while the lowest share is found in Malta (1%), the Netherlands (10%) and the United Kingdom (9%).

European Union's forests present a large variety of ecological and socio-economic conditions. While forests are recognized as one of Europe's most important renewable resources providing multiple benefits to the society and the economy, they represent the main repository of biological diversity, ranging from the Mediterranean to the Arctic Circle, from sea shores to alpine zones. Largely because of this ecological and socio-economic diversity, the definition of "forest" differs among MS (see following subchapters).

Deforestation does not appear to be a major issue in Europe; although it may be relevant for specific countries (see Chapter 11 on KP LULUCF for more data on deforestation). In any case, the deforestation area is more than compensated by that of new planting and forest expansion.

Currently, European forests show a considerable sink, documented by both forestry administrative institutions and the scientific community. Also, national GHG inventories submissions report increasing IEFs (i.e. C stock change factor for biomass) over time series since 1990 for 5A1 Forest remaining forest, by almost all MS. For many centuries, European forests have been intensively exploited and consequently depleted of carbon. Since the middle of the 20$^{th}$ century, in most EU countries growth rates started to increase, as globalized trading and technological development diminished direct anthropogenic pressure on forests. This reversal was first noted during the extensive surveys carried out in the '80s, when there was concern that Europe's forests were dying due to acid rains. Although it was found evidence of patches of damaged forests, it appeared progressively evident that most of European forests were growing much faster than previously thought from yield table estimates (Karjalainen 1999[32]). Overall, in the last 50 years, forests of Europe have increased by 75% their standing stock (Ciais et al. 2008[33]). Among the likely causes of this increased forest growth the scientific community has suggested: 1) harvesting less than the increment, especially in central and southern Europe, 2) young age structure, i.e. most forests are still recovering from past overexploitation and are still an exponential growth phase, 3) increased fertility of forest soils due to improved silvicultural practices, and 4) fertilizing effects of increased nitrogen deposition and possibly effects of the climate change (enhanced atmospheric $CO_2$ concentration and increased length of growing season, although considerable uncertainties still exist).

In addition to the above general causes, differences among countries in the absolute level and trend of the carbon sink may be also due to other factors, including:

- Different biological and ecological potential under the range of climatic zones;
- Past and current intensity of forest management: in Nordic countries like Finland and Sweden, where the forest sector is very important for economy, almost all the growth is harvested and

[32] Karjalainen, T., Spiecker, H. and Laroussinie, O. (Eds.). Causes and Consequences of Accelerating Tree Growth in Europe Eds. EFI Proceedings No. 27. European Forest Institute, Joensuu, Finland

[33] Ciais P, Schelhaas MJ, Zaehle S, Piao SL, Cescatti A, Liski J, Luyssaert S, Le-Maire G, Schulze E-D, Bouriaud O, Freibauer A, Valentini R, Nabuurs GJ (2008). Carbon accumulation in European forests. Nature Geoscience 1: 425-429

little biomass accumulates. By contrast, in countries like France and Italy, the current wood harvest is considerably less than the increment.

- The intensity and frequency of natural events, which is somewhat regionalized (e.g. forest fires are typically more frequent in the Mediterranean countries, windbreaks damages occur especially in coniferous plantations)

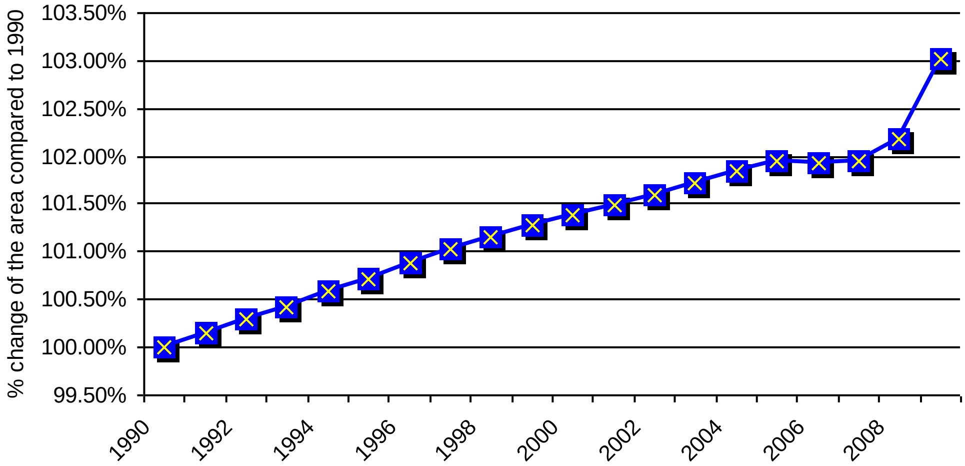
Forests and forestry are under competence of the MS. At European Union level there is only a general framework mainly aimed at coordinating the national forest policies and supporting the sustainable management of forests (i.e. Forest Strategy, Forest Action Plan).

## *7.2.2 Forest land remaining forest land (CRF 5A1)*

### 7.2.2.1 Overview of Forest land remaining forest land

The area of “Forest remaining forestland” slightly increased by 3 % at EU-15 level since 1990 (Figure 7.3), with large differences among MS (e.g., +39% in Ireland, +20% in Italy and -11 % in the Netherlands).

**Figure 7.3 The relative trend of 5A1 – forest land remaining forest land – area in EU-15, 1990-2009**




In absolute terms, most of the increase of “Forest remaining forest” area was reported by Italy (1460 kha ha), Sweden (900 kha) and UK (500 kha). The increase of area over recent years is mainly due to Sweden (Table 7.9).

**Table 7.9 The trend of activity data in the “forest land remaining forest land” subcategory 5A1 in EU-15’s MS (kha, 1990-2009)**

| Member State | 1990 | 1995 | 2000 | 2005 | 2009 | Difference 2009 to 1990 |
|---|---|---|---|---|---|---|
| Austria | 3,505 | 3,558 | 3,684 | 3,746 | 3,779 | 8% |
| Belgium | 711 | 705 | 700 | 695 | 692 | -3% |
| Denmark | 539 | 537 | 535 | 533 | 533 | -1% |
| Finland | 21,925 | 21,912 | 21,899 | 21,869 | 21,849 | 0% |
| France | 21,918 | 21,994 | 22,093 | 22,207 | 22,272 | 2% |

| | | | | | | |
|---|---|---|---|---|---|---|
| Germany | 10,999 | 10,964 | 10,929 | 10,894 | 10,866 | -1% |
| Greece | 3,359 | 3,358 | 3,357 | 3,357 | 3,356 | 0% |
| Ireland | 322 | 363 | 390 | 412 | 447 | 39% |
| Italy | 7,450 | 7,835 | 8,220 | 8,605 | 8,916 | 20% |
| Luxembourg | 79 | 81 | 82 | 84 | 86 | 8% |
| The Netherlands | 381 | 369 | 358 | 346 | 337 | -11% |
| Portugal | 3,563 | 3,615 | 3,666 | 3,717 | 3,758 | 5% |
| Spain | 12,587 | 12,584 | 12,582 | 12,579 | 12,577 | 0% |
| Sweden | 27,737 | 27,843 | 27,866 | 27,881 | 28,639 | 3% |
| United Kingdom | 2,002 | 2,205 | 2,346 | 2,426 | 2,513 | 26% |
| **EU-15** | 117,076 | 117,924 | 118,708 | 119,354 | 120,621 | 3% |

At EU-15 level, 5A1 is a sink of about 310,000 $GgCO_2$ in 2009, 15 % more than 1990 and 6% more than in 2008 (Table 7.10). The strong increase of the sink in 2009 compared to 2008 is largely due to Finland and Sweden (under various harvesting share which was variable in time).

**Table 7.10 5A1 Forest Land remaining Forest Land: MS' contributions to net $CO_2$ removal/emissions**

| Member State | Net $CO_2$ emissions (Gg) | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$) | (%) | (Gg $CO_2$) | (%) | | |
| Austria | -11,401 | -16,744 | -16,756 | 5.4% | -13 | 0% | -5,355 | 47% | T3 (biomass, dead wood), T1 (soil) | CS (biomass, dead wood), D (soil) |
| Belgium | -3,248 | -3,088 | -3,128 | 1.0% | -40 | 1% | 120 | -4% | CS,T2 | CS |
| Denmark | -725 | -4,829 | -2,591 | 0.8% | 2,238 | -46% | -1,866 | 257% | T3 | CS,D |
| Finland | -21,800 | -35,100 | -47,408 | 15.3% | -12,308 | 35% | -25,608 | 117% | T2,T3 | CS,D |
| France | -46,540 | -78,443 | -72,866 | 23.4% | 5,577 | -7% | -26,326 | 57% | CR,CS,T2 | CS |
| Germany | -70,988 | -20,657 | -20,642 | 6.6% | 14 | 0% | 50,345 | -71% | CS,T1,T2 | CS,D |
| Greece | -1,327 | -1,956 | -1,956 | 0.6% | 0 | 0% | -628 | 47% | T2 | CS,D |
| Ireland | -1,165 | -2,740 | -2,989 | 1.0% | -249 | 9% | -1,823 | 157% | D,T1 | CS,D |
| Italy | -40,919 | -61,680 | -65,040 | 20.9% | -3,360 | 5% | -24,121 | 59% | T1,T2 | D,CS |
| Luxembourg | 239 | -362 | -393 | 0.1% | -31 | 8% | -632 | -264% | T2 | CS |
| Netherlands | -2,434 | -2,004 | -2,144 | 0.7% | -140 | 7% | 290 | -12% | CS | CS |
| Portugal | -4,442 | -11,375 | -12,131 | 3.9% | -756 | 7% | -7,689 | 173% | D | D,CS |
| Spain | -18,665 | -18,631 | -18,629 | 6.0% | 2 | 0% | 36 | 0% | T2 | D,CS |
| Sweden | -47,590 | -34,993 | -44,056 | 14.2% | -9,063 | 26% | 3,534 | -7% | T1,T2,T3 | CS |
| United Kingdom | -6,313 | -9,859 | -9,319 | - | - | - | - | - | D,CS,T3 | CS |
| **EU-15** | **-271,005** | **-292,601** | **-310,729** | **100.0%** | **-18,128** | **6%** | **-39,724** | **15%** | | |

In 2009, the largest removals were reported by France, Italy and Finland. The largest changes of the MS sinks are when compare to 1990, either increases (e.g Denmark, Finland, Portugal) or decreases (e.g Germany, Sweden). Portugal recalculated 1990 to a sink, previously it was a source caused by the forest fires. France includes into annual removal estimates the $CH_4$ sink represented by undisturbed forest soils (which is reported as $CO_2$eq and included into 5A1 sink estimate). In most cases, $CO_2$ emissions from disturbances are implicitly included under CRF table 5A1 as losses in the year of event, while other non-$CO_2$ emissions are considered under 5(V); generally there is no subsequent change of the land use of burnt areas. The main types of disturbances across EU are forest fires (mainly Southern European countries) and wind storms (mainly in central Europe), while other type of disturbances generally have a localized effect and low magnitude, but also difficult to quantify in terms of biomass loss (e.g. insect outbreaks). Estimation of emissions from forest fires is made with Tier 1 method in case of small emissions (e.g. Austria) or with higher tiers where such emissions are significant (e.g. Portugal, Spain). Forest fires quite often affect the emission removal pattern in several countries (e.g. Portugal in 1990, 2003 and 2005; Italy in 2007), while the windstorms occasionally affect forests in Europe (e.g. France in 1999 and Denmark in 2000). Spain reports areas burnt ranging 20 – 250 kha annually.

### 7.2.2.2 Methodological issues for Forest remaining forest

Definitions of forest land are reported by EU-15's MS in their NIR 2011. In this EU-15 report, the consistency of the forest land representation is considered under two aspects: 1) within the country in terms of time and space and 2) across the MS within EU-15. The MS' forest definitions are not uniform, but slightly differ in terms of *quantitative* parameters, i.e., crown coverage, tree height and minimum land area (Table 7.11). Forest definitions implemented by the MS are in general consistent with reporting under other international processes (i.e. Food and Alimentation Organization's 2005 and 2011 FRA. Land for forestry administration purpose may be included or not in the forest land, thus additional *qualitative* criteria complement the forest definition of the MS (i.e. treatment of forest roads, nurseries, willow crops, etc (Table 7.12). Few countries have reported change of forest definition for the period since 1990, but apparently these changes do not affect the time series for activity data. Greece has a new forest definition starting 2003. Denmark change from questionnaire based to NFI (National Forest Inventory) but implemented method for GHG estimation ensure consistency in time of activiy data (i.e. reassessment of base year data based on earth observation information).

**Table 7.11 Information on forest definitions and related parameters in MS's National Inventory Report s under UNFCCC**

| Member State | Forest parameters | | | |
|---|---|---|---|---|
| | Crown cover (%) | Height (m) | Area (ha) | Minimal Width (m) |
| Austria | 30 | 2 | 0,05 | 10 |
| Belgium | 20 | 5 | 0,5 | - |
| Denmark | 10 | 5 | 0,5 | 20 |
| Finland | 10 | 5 | 0,5 | 20 |
| France | 10 | 5 | 0,5 | 20 |
| Germany | 10 | 5 | 0.10 | - |
| Greece | 25 | 2 | 0,3 | - |
| Ireland | 20 | 5 | 0,1 | 20 |
| Italy | 10 | 5 | 0.50 | - |
| Luxembourg | - | - | - | - |
| The Netherlands | 20 | 5 | 0,5 | 30 |
| Portugal | 10 | 5 | 0.50 | 20 |
| Spain | 20 | 3 | 1.00 | 25 |
| Sweden | 10 | 5 | 0,5 | 10 |
| United Kingdom | 20 | 2 | 0.10 | 20 |

The overall effect of different forest definitions on C stock changes at EU-15 level is difficult to assess, as it depends on numerous factors (i.e. land fragmentation, land use change frequency, transition period, land registry systems, GHG estimation methodology, etc.), but it is likely to be negligible.

**Table 7.12 Additional qualitative criteria for defining "forestland" (na – no additional information available in NIR 2011)**

| Member State | Forest definition and additional information and description of forestland (according NIR 2011) |
|---|---|
| Austria | Forestland includes permanently un-stocked basal areas that are directly connected with forest land in terms of space and forestry activity, and contribute directly to its management (i.e. hauling systems, wood storage places, glades, forest roads).<br>Areas which are used in short rotation with a rotation period of up to thirty years as well as forest arboretums, forest seed orchards, Christmas tree plantations and plantations of woody plants for the purpose of obtaining fruits such as walnut or sweet chestnut do not account as forests but represent cropland. Rows of trees and areas with woody plants in a park structure are not forest land. |
| Belgium | na (no additional information beyond forest parameters). |
| Denmark | Forestland includes temporarily non wooded areas, fire breaks, and other small open areas inside the forestland, Christmas tree are considered under forestland. |
| Finland | Includes productive forest land, part of the poorly productive forest land and forest roads. Parks and yards are excluded regardless of whether they meet the forest definition. |
| France | Includes forest roads, forest openings less than 20 m wide (e.g. for fire control), windbreaks and forest belts, as well as the poplar plantations and short rotations woody crops, if the criteria for forestland are met. 5 % of European forests are unmanaged on lands such as strong slopes or used for loisir, esthétique, cultural or military. Also, some 40 % of France's dependencies forestland is considered as unmanaged. |
| Germany | "Forest" within the meaning of the any area of ground covered by forest vegetation, irrespective of the information in the relevant cadastral survey or similar records. "Forest" also refers to cutover or thinned areas, forest tracks, firebreaks, openings and clearings, forest glades, feeding grounds for game, landings, rides located in the forest, further areas linked to and serving the forest including areas with recreation facilities, overgrown heaths and moorland, overgrown former pastures, alpine pastures and rough pastures, as well as areas of dwarf pines and green alders. Heaths, moorland, pastures, alpine pastures and rough pastures are considered to be overgrown if the natural forest cover has reached an average age of five years and if at least 50% of the area is covered by forest. Forested areas of less than 1,000 m2 located in farmland or in developed regions, narrow thickets less than 10 m wide, Watercourses up to 5 m wide do not break the continuity of a forest area. |
| Greece | na |
| Ireland | Forestland is also defined by minimum 50 % of conventional stocking. Includes recently clear felled areas. Tree grown for fruits or flowers, and shrub species (furze, rhododendron) are excluded. |
| Italy | na |
| Luxembourg | na |
| The Netherlands | The Netherlands has chosen to define the land use category "Forest Land" as all land with woody vegetation, now or expected in the near future (e.g. clear-cut areas to be replanted, young afforestation). "Forest Land" is further stratified in: a) "Forest" or "Forest according to the Kyoto definition" (FAD), i.e. all forest land which complies to the following (more strict than IPCC) definition chosen by the Netherlands for the Kyoto protocol: forests are patches of land exceeding 0.5 ha with a minimum width of 30 m, with tree crown cover at least 20% and tree height at least 5 meters, or, if this is not the case, these thresholds are likely to be achieved at that particular site. Roads in the forest less than 6 meters wide are also considered to be forest. This definition conforms to the FAO reporting and was chosen within the ranges set by the Kyoto protocol. B) "Trees outside Forests" (TOF), i.e. wooded areas that comply with the previous forest definition except for their surface (=< 0.5 ha or less than 30 m width). These represent fragmented forest plots as well as groups of trees in parks and nature terrains and most woody vegetation lining roads, fields etc… |
| Portugal | Forests (areas occupied by forests and woodlands which can be used for the production of timber or other forest products) and agro-forestry areas (annual crops or grazing land under the wooded cover of forestry species). The forest trees are under normal climatic conditions higher than 5 m with at least 30 % canopy closure. |

| | |
|---|---|
| Spain | Includes systems with vegetation currently below the thresholds of the forestlands (dehesa) but it is expected these to be exceeded in areas which are not under pasture or cropland. Dehesa is, in general, an anthropized forest system essentially composed by a layer of trees with presence of scrub and usually a herbaceous layer, with or without crops, which is subject of extensive agro-forestry use, thanks to which it maintains its own structure over time. If it is below the forestland then it is included under cropland. |
| Sweden | Permanent forest roads (width>5m) are not considered as forest land. All country forest are considered managed. |
| UK | Different definitions according the data source (i.e. forestry statistics definition used for GHG inventory includes integral open space, and felled areas that are awaiting restocking). |

Depending on the available data, various method have been used by MS to develop time series for the annual activity data (i.e. forest land area), at least from 1990 to date: by interpolation (over NFI cycles, or from various statistics and maps), extrapolation (for periods since last NFI cycles), and combining other sources of data (remote sensing) (Table 7-13).

**Table 7-13 Activity data sources and methodology for the subcategory 5A1 Forest land remaining Forest land**

| Member State | Description of reporting method |
|---|---|
| Austria | The FL remaining FL area is derived from NFI data, with annual area interpolated between inventory years and assumed constant in time since the previous national forest inventory (2000/2002) and latest (2007/2009). |
| Belgium | A grid of reference covers entire country on which a diagnosis of land use is carried on vectorial and raster thematic sets and layers images. |
| Denmark | A land use / land cover map was produced for 1990 and 2005 based on satellite images data, other data used for 1992-2005 and after 2005. |
| Finland | Estimation of the area of Forest land is based on successive NFI cycles (NFI 7-10) from different years in Northern and Southern Finland. The forest land category is sub-divided for organic and mineral soils. |
| France | The system is based on aerial photographs dataset combined with an annual “on-the-ground” survey of lands (defining both the land use and current activity), which allows a land use change matrix both annual (to capture rapid changes) and a 20-year span (to capture slower changes). For French Guyana a photointerpretation system based on Landsat and Spot, combined with permanent plots surveying just small share of total area, is used to estimate land use and changes. |
| Germany | Forest land area is computed based on two successive NFI (1987, 2002) for former Western Germany, while for former Eastern Germany it is estimated based on remote sensing and first NFI (2002), then linear extrapolation back to develop annual time series. NFI is integrated with a country wide GIS based "wall-to-wall" database (ATKIS). |
| UK | Forest plantations statistics established over 1920-1990 is used for modeling C stocks changes. Forests in existence before 1920 are considered not to have significant long term changes in their carbon pool stocks. |
| Greece | Approach 1/2 is used for land representation, by combining several sources and databases: 1st National Forest Inventory (1994), annual Agricultural census, afforestation registry and statistics, general geographical data of National Statistical Service of Greece (i.e. decennial survey). Land use change matrix is available. |
| Ireland | Forest land area is obtained from sectoral Forest Inventory and Planning System data of 1995 and the total forest area provided by Forest Service. |
| Italy | Area of forests in 1990 -2009 was calculated through a linear interpolation between 1985 and 2002 data (supplied by the 1st and 2nd NFI). Data for 2003-2009 is extrapolated, building on Statistics’ annual data on forest area (available only for 1990-2005). A number of rules are established to allow building of land use change matrix. |
| The Netherland | Country level harmonized and validated digital topographical maps of 1990 and 2004, linearly extrapolated till 2009. System allows wall-to-wall approach. |
| Portugal | Area data is given by Corine Land Cover maps (1990, 2006), NFI (for forest area on tree species) and annual cartography of burnt areas, involving linear interpolations and extrapolations to obtain full time series. |
| Spain | Forest land area is provided from a combination between CORINE LANDCOVER 1990-CLC90 and 2000-CLC00 (after the harmonization of their nomenclature) with Forest Maps of Spain, in order to identify the lands with trees crown cover over 10 %. Further on, annual estimation of area is obtained by linear intrapolation between 1990 and 2000, and then extrapolated. |
| Sweden | A national level systematic grid of permanent monitoring plots (NFI) provides estimates of the areas of all land-use categories and gross & net land-use transfers since 1983 on. |

Furthermore, the MS breakdown own forestland area on various *subdivision* types and levels of detail, according to available datasets. Breakdown criteria differ across EU-15 MS, although they are consistent across time series. It was done by groups of species or forest types (i.e. broadleaves/coniferous; evergreen/deciduous; species based classification – beech, oak, pine, spruce, etc), climate (i.e. temperate, tropical), soil and site type (i.e. lowland, organic or mineral soils), geographic criteria (regions of the country), and management type (clear cut, hedgerows, horticulture area, arable land, fallow land, permanent cultures, peat extraction area, pastures, hayfield, perennial converted to annual crops, annual crops remaining annual/perennial).

For forestland, the *definitions of pools* are reported by most MS. The contributions to the annual sink are 85% for the biomass pool, 11% for SOC and 4% for DOM. There are slight variations regarding the definition of the pools among MS (

Table 7-14), whose impact on the estimation of C stock changes and other GHG emissions may be low, but also difficult to assess in quantitative terms. For instance, forest inventories define the biomass pool according to the threshold of minimal diameter (i.e. DBH–stem diameter at breast height of sampled trees) as ranging from 0 to 7,5 cm. Concerning the belowground biomass, the information on what exactly it includes or excludes is rather poor. The litter and dead wood pools mostly differ in terms of threshold diameter and height/length, and decomposition time required considered. In soils, C stock changes are computed according to various soil depths. Usually, carbon stock in understory's biomass is only accounted for the purpose of forest fires emissions.

**Table 7-14 Forest carbon pools definitions in the EU-15's MS**

| Member State | Description of the pools |
|---|---|
| | ***Aboveground biomass*** |
| Austria | Stem wood over bark with a diameter at breast height over 5 cm. |
| Belgium | Tree and shrub species with circumference exceeding 20/22 cm at 1.50 m height (i.e 7 cm in diameter), while in coppices the stems under 7 cm diameter are also included. |
| Denmark | Biomass of living trees with a height over 1.3 m, under different schemes (i.e. trees larger than 40 cm are measured only within a 15 m circle). Smaller trees, shrubs and other non woody are not counted. Aboveground biomass is defined as living biomass above stump height (1 % of tree height). |
| Finland | Biomass of living trees with a height over 1.3 m. Understory is counted only to estimate the emission from forest fire. |
| France | Trees with DBH over 7.5 cm. Woody understory or annual/perennial non woody plants are not considered. |
| Germany | Trees with DBH over 7 cm. |
| United Kingdom | Modeled living woody biomass (complete individual cycle of trees, it does not include understory and annual/perennial non woody vegetation). |
| Ireland | Modeled complete individual cycle of living biomass (but not the understory and annual/perennial non woody vegetation). |
| Italy | All trees with DBH over 3 cm. |
| Portugal | Living biomass above the soil, including: stems, stumps, branches, bark and foliage, and forest understory (only for estimation of emissions from forest fires). |
| Spain | Trees DBH over 7.5 cm "at foot" is measured, while those under 7.5 cm are only counted. |
| Sweden | Biomass of living trees with a height over 1.3 m. Small trees, shrubs and other vegetation (i.e. herbs) are not counted. Aboveground biomass is defined as tree part above stump height (1 % of tree height). |
| Greece, The Netherlands – na ( there is no information available the NIR 2011) | |
| | ***Belowground biomass*** |
| Belgium | Diameter of estimated roots > 5 mm. |
| Denmark | In the NFI plots the stumps from trees harvested within a year from the measurement are measured for diameter. |
| France | Fine roots are included with the soil organic matter. |
| United Kingdom | Fine roots biomass is integrated by the carbon accounting model used. |
| Ireland | Modeled approach integrating fine roots. |
| Portugal | Living biomass of all roots (the lower limit of root diameter, if any, is not explicitly defined). |
| Sweden | Biomass of living trees below stump height (1 % of tree height) down to a root diameter of 2 mm. |
| Austria, Denmark, Finland, Germany, Greece, Italy, The Netherlands, Spain - na | |
| | ***Dead Organic Matter – Litter*** |
| Denmark | Non-living biomass which is not included in other classes, under various status of decomposition on top of mineral or organic soil. It includes the litter, fumic and humic layers. |
| Finland | Non-living biomass with a diameter less than 10 cm in various status of decomposition (allocated by model in compartments: fine woody litter, coarse woody litter, extractives, celluloses and lignin-like compound). |
| France | Non-living dead wood lying on soil with maximum 7.5 cm diameter, dead leaves, humic and fumic layers, fine roots (which are not taken into account in the biomass). |
| Germany | The litter was considered to comprise all dead organic cover with a fraction < 20 mm. For some 80 % of points, the fraction > 20 mm was also included in the litter sample. |
| United Kingdom | Litter is integrated by the model. |
| Ireland | Modeled approach. |
| Portugal | Non living biomass on top of mineral soil, in various stages of decomposition (include fumic, humic), (considered only in forest fires). |
| Sweden | Non-living biomass not classified in other classes, under various stages of decomposition, on top of mineral or organic soil: litter, fumic and humic layers. Litter includes, as well: a) live fine roots (<2 mm) from O horizon; b) coarse litter with "wood stem diameter" between 10-100 mm, and c) fine litter from the previous season or earlier. |
| Austria, Belgium, Greece, Italy, The Netherlands, Spain: na | |
| | ***Dead Organic Matter - Dead wood*** |

| | |
|---|---|
| Austria | Only standing dead wood. Litter is included with the soil. |
| Belgium | Dead wood of any dimension is measured or estimated by NFI. |
| Denmark | Standing deadwood with a DBH larger than 4 cm. Lying dead wood with a diameter of more than 10 cm, whose length is recorded. The degree of decay is recorded on an ordinal scale. |
| Finland | Non-living biomass which is not contained in litter (described by model as coarse woody litter input, larger than 10 cm in diameter, from natural mortality of trees and harvesting residues) |
| France | Standing trees, dead for less than 5 years, plus 10 % from the wood which is annually harvested |
| Germany | NFI 2002 collected data on fallen dead wood with a thicker-end diameter of at least 20 cm; standing dead wood with a diameter of at least 20 cm at breast height and trunks with either a height of at least 50 cm or a cut surface diameter of at least 60 cm. NFI 2008 collected data on all dead-wood objects with a thicker-end diameter of at least 10 cm. Data collection was for both NFIs on 3 species groups and 4 decomposition class. |
| United Kingdom | Dead wood is included in carbon accounting model |
| Ireland | Modeled approach |
| Greece | Dead wood that remain on site after fire is assumed to fully decompose in 10 years |
| Portugal | Non living woody biomass on top of mineral soil, in various stages of decomposition (considered only in forest fires) |
| Sweden | Fallen dead wood or standing dead snags, with a minimum "diameter" of 100 mm and a length of at least 1.3 m |
| Germany, Italy, The Netherlands, Spain: na | |
| ***Soil Organic Carbon*** | |
| Austria | Fumic and humus, the litter layers are unitary considered with mineral soil layers to 50 cm depth. |
| Belgium | Modeled approach (depth is not defined). |
| Denmark | Organic carbon in the mineral soils below the litter, fumic and humic layers and all organic carbon in soils classified as Histosols. It is for 30 cm depth between top of the mineral soil or, alternatively, from the soil surface (if histosol). |
| Finland | Modeled organic carbon in mineral soils with undefined depth. Organic soils are considered under peatlands, with a site being classified as peatland if the organic layer is peat or if more than 75% of the ground vegetation is peatland vegetation. |
| France | Organic carbon in the first 30 cm layer of any mineral or organic soils. |
| Germany | C content in mineral soil (0 – 30 cm). |
| United Kingdom | Modeled approach, assessing soils carbon stock change on non-defined depth. |
| Italy | Organic carbon in mineral soils to 30 cm depth. |
| Ireland | Modeled approach, assessing soils carbon stock change on non-defined depth. |
| Portugal | Organic carbon in mineral soils down to 30 cm. |
| Sweden | Organic carbon in the mineral soils below the litter, fumic and humic layers and all organic carbon in soils classified as histosols, down to a depth of 50 cm. |
| Greece, The Netherlands, Spain: na | |

It should be considered that what is not reported under a pool is usually reported under another one (e.g., fine roots are accounted for as either litter or soil organic matter). Based on that as far as the completeness of the inventory is ensured, the comparability of national GHG inventories is also ensured as far as the C stock changes could be summed up. Thus, as far as the component biomass is reported under various pools the lack of fully matching definitions is not a major problem, except that the different turnover may introduce higher uncertainty in the estimation. For certain pools or parts of the pools which are very difficult to address due to lack of data (i.e. fine roots or litter), it is commonly assumed that there is no annual change.

Net $CO_2$ removals or emissions are estimated by methods that quantitatively assess the change of the C stocks in forest carbon pools. The method used is either the "stock change" or "gain-loss" (as defined by IPCC GPG LULUCF 2003), according to the availability of data (

Table 7-15). The gain-loss method is implemented by using country specific statistics on harvest and forest fires, and it is often based (or at least complemented) by yield models (e.g. UK, Italy, Ireland).

**Table 7-15** **Sources of data and basic methodological information for estimating of the C stock changes in biomass in the subcategory 5A1**

| Member State | Description |
|---|---|
| Austria | Austrian NFI provides data on growing stock volume increment and drain (harvest, other losses). Country specific conversion factors and biomass functions are applied to account for tree branches, foliage and below ground biomass. |
| Belgium | Regional, but National Forest Inventories like, datasets. Solid wood volumes of each species (aboveground woody biomass: stem + branches) is obtained from forest inventories data. Country specific BEFs are used. |
| Denmark | For 2009, data from 1st NFI cycle is directly used in the volume functions developed for the most common Danish forest tree species. Harvested wood is obtained from Statistics Denmark, to which non-commercial wood from thinning operations in conifers (not accounted in statistics), is added annually using a 20% constant factor. BEFs from neighboring countries. |
| Finland | Biomass increment is estimated based on individual tree measurements (DBH, tree height) in last three successive NFIs and country specific biomass models. Loss is calculated from annual statistics, and includes logging, fuel wood and unrecovered natural losses. |
| France | Gain-loss method is used. NFI delivers data on forest growth, while loss by harvest statistics (both commercial and non commercial). BEFs, allocation in roots, as well as C content in wood are country specific. |
| Germany | "Stock-Change-Method" is used with data from forest inventories (for former Western Germany). Biomass functions, country specific volume expansion factors and IPCC default root-to-shoot ratio. For former Eastern Germany data from forestry management plans is combined with NFI 2002 and 2008. |
| UK | Forest plantations statistics established after 1990 is used for modeling C stocks changes. |
| Greece | C stock change in living biomass is approached, forest increment from FMP (forest management plans) data disaggregated by forest type, with IPCC default factors for root/shoot ratio, wood density and BEFs. Loss was estimated from commercial round wood feelings, fuel wood gathering and wildfires. |
| Ireland | Annual increment is estimated using a model which calculates total standing carbon content of forests year-on-year, based on Irish forest yield tables by species, involving country specific BEFs and wood density. |
| Italy | Model applied at regional scale because of availability of forest-related statistical data. The growing stock volume of the previous year is increased by the annually calculated increment of the current year and reduced by the losses due to harvest, mortality and wildfire in the current year. Aboveground and belowground biomass were obtained by using country specific BEFs. Commercial wood harvest data has been obtained from statistics. |
| The Netherlands | Model incorporating IPCC Method I based on NFI plots, using the equations from a European database. |
| Portugal | C stock change in biomass is estimated by default method and NFI data. All parameters are country specific. |
| Spain | The “stock change method” is used with NFI data. For the regions which still miss the last recent inventory data, an average of all the other regions is computed and used as a proxy. |
| Sweden | C stock change method that integrates Swedish NFI and Swedish Forest Soil Inventory in the same sample design and plots. Aboveground & belowground biomass per trees in permanent sample plots is obtained by biomass functions. |

The “stock change” method is used in conjunction with regional or NFI data. Actually, NFIs represent the primary source of information for the GHG inventory in all EU-15’s MS. The use of remote sensing and aerial photographs or their derived products such as Corine Land Cover maps are also used in few cases especially to derive past data (i.e. Spain, Portugal). NFIs provide basic input both for forest-land and conversions to/from forest land areas as well as the necessary data for the estimation of C stock changes in various pools under the implemented method. Methods for the collection of data in NFIs are typically based on repeated measurements in permanent sample plots (

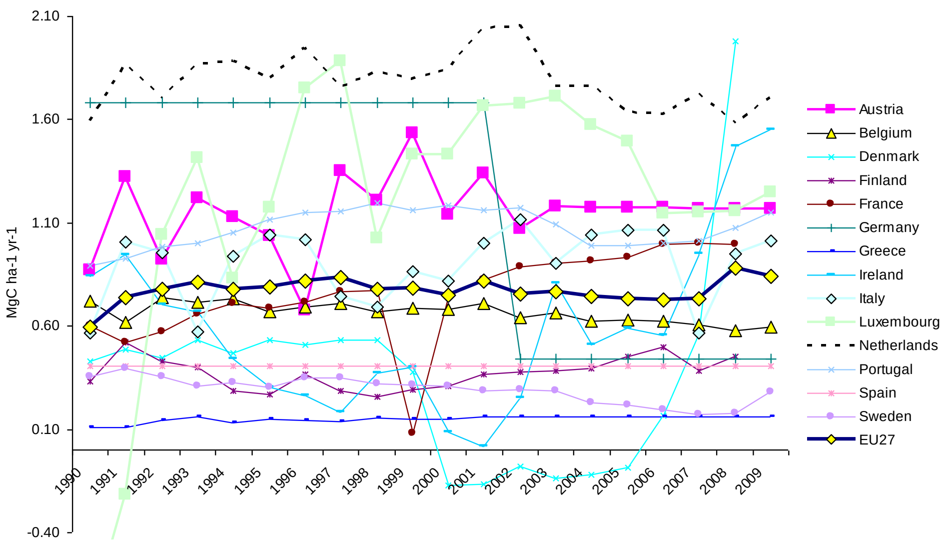
Table 7-16), but the design differ among MS in terms of spatial density and frequency of field survey. Recent years, the EU-15 MS have made considerable efforts to adjust their forest inventories to the specific requirements of UNFCCC/KP reporting, together with slight harmonization at European scale. Also, efforts have been made to adjust the inventory cycles to the first commitment period.

**Table 7-16 Relevant information on the National Forest Inventories (NFI) of MS**

| Country | Type of survey | Frequency | Latest survey |
|---|---|---|---|
| Austria | Sample based inventory, 300 $m^2$ plot area, 4 x 4km grid across all the country, includes all land use categories. | 5-10 years since 1961 | 2000-2002 |
| Belgium | Regional forest inventories, with same approach for both Wallon and Flemish Regions. 1.0 x 0.5km grid, plot areas of 10 are. Grid is oriented from the east to the west on the National Geographic Institute maps. | ~ 10 years, since 1980 | 1999 -2000 |
| Denmark | Questionnaire-based Forestry Census (till 2000). Since 2002, continuous sample-based NFI with partial replacement, 2 x 2km grid. Annually, 1/5 of the total of more than 7000 plots are visited and measured. | Forest Census 10 years, since 1881. Continuous NFI | Censuses in 1990 and 2000. First NFI cycle (2002-2006) |
| Finland | Sample-based (systematic cluster sampling) inventory, cover all land use classes with cycles of 8-10 years. Now with cycles of 5 years, different grids 6 x 6km to 10 x 10km according the region, and cover all country in a year | 10 years, since 1921 | 2004-2008 (10th NFI) |
| France | NFI, sample based, systematic clusters, 1 x 1km, cover all the country in a year. | Continuous, since 1962 | 2004-2006 |
| Germany | Terrestrial random-sampling inventory with permanently marked sampling points in a 4 x 4km grid. An interim inventory with 8 x 8 km grid in 2008. | Two NFIs so far (1986-1989; 2001-2002), 10 years | 2008 |
| Greece | Sample-based (currently NFI data is no more used for GHG estimation). | One so far. | 1992 |
| Ireland | Forest Inventory and Planning System and forest census, increment and harvest statistics. | Since 1958 | 1995 |
| Italy | Sample-based. The new inventory uses a 3-phase sampling approach, 3x3km grid. Plots are representative of the forest composition within a region. | First in 1985, second on-going. | 2003-2008 |
| Luxembourg | Sample-based: simple systematic sampling; points on a 0.1x0.05km grid | Every 5-10 years. Only 1 so far. | 1998-2000 |
| The Netherlands | Sample-based NFI. | ~ 10 years, since 1940 | 2001-2002 |
| Portugal | Qualitative sampling based on aerial photointerpretations over a national grid. | ~ 10 years, since 1965 | 2005/2007 |
| Spain | Sample-based NFI. | Planned every 10 years, since 1964 | 1997-2007 |
| Sweden | Sample-based since 1983, with an area measured each year. | 5-10 years, since 1923 | Ongoing |
| United Kingdom | National Inventory of Woodland and Trees between 1995 and 1999 and new National Forest Inventory based on geoprocessing of aerial data (2009-2014). | Various, NFI since 1924 | 1999 |

Furthermore, considerable efforts have been made to improve and transform the information on forest inventory timber volume into C stock change. These efforts include, e.g., developing new country specific biomass functions (e.g. Austria, Finland, Ireland and Spain), biomass expansion factors (BEFs), as well as inter-calibration and harmonization exercises (i.e. with projects).

**Figure 7.4** **Implied net carbon stock change factor for biomass pool in 5A1 (Mg C/ha year)**

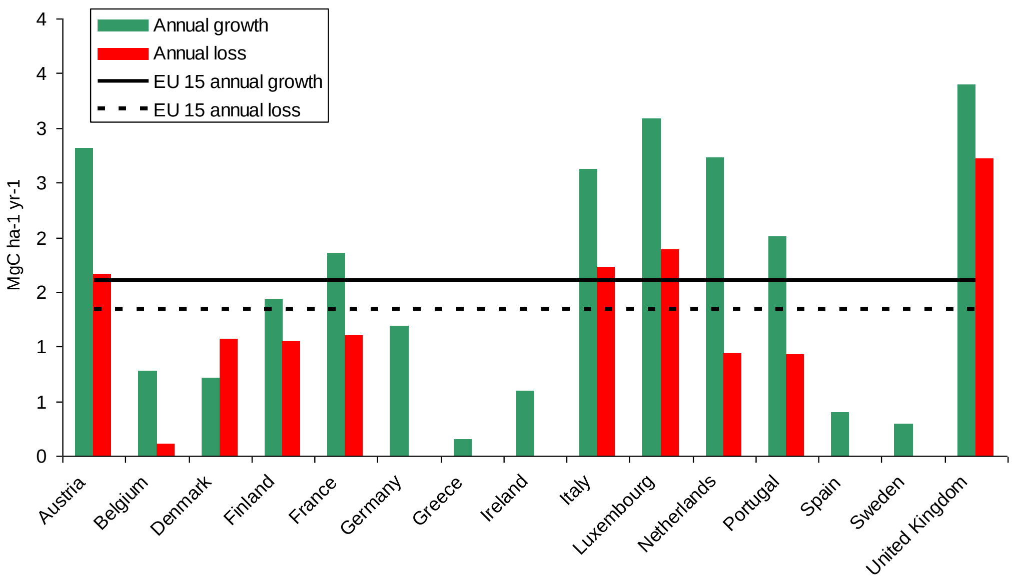



In 2011 submissions the multiannual simple average of IEF for net C stock change in biomass is 0.77 (in 2009 submission it was reported 25 % higher) with a range across MS's time series between -0.82 and 2.05 Mg C/ha (see Figure 7.4). The decrease is explained by the new data reported by Germany (current IEF is 26 % of previously reported one). Recalculations in 2011 revised downward IEFs for many MS with most notable decrease reported by Spain (i.e. -52%) and increase by Portugal (i.e. +226 %). At the EU level, there is 3 % decrease of overall average IEF compared to previous value. Interestingly, with exception of Belgium, Germany, Netherland and Sweden, all other MS reported increase of IEF by some 30-40 % when comparing the last 5 years (i.e. 2004-2009) with the period including base year (i.e. 1990-1994). Nevertheless, there is a general decreasing of IEF values for many MS that could be explained by better data availability and increased wood harvest over last decade.

In the most intensive forestry systems (i.e. Finland, Sweden) the annual net C stock change is, in general, smaller than in countries from Central Europe or with less intensive managements. Also, low IEF values are caused by various disturbances (i.e. major windstorm in France in 1999). Variable IEF in Ireland, Luxemburg or Netherland is explained by high dynamic of the small total country forestland area (high dynamic of deforestation, afforestation and very low share of "remaining" forestland).

Biomass growth and loss vary across MS according eco-climatic conditions and management approaches (Figure 7.5). With recent improvement in UK by consistent reporting of forestland on subcategories (5A1 and 5A2), UK revised downward its IEF values. High values of IEF for biomass growth and loss under artificial plantations of very productive species are reported, while the net change is comparable to other countries (e.g. Austria, Ireland and Netherlands). Lowest IEF for net biomass change is shown by Greece (under low natural forests productivity and fire incidence).

**Figure 7.5** **Multiannual simple average IEF for "growth" and "loss" of biomass in 5A1 (1990-2009, only net biomass changes displayed for MS reporting stock change methods)**




Denmark estimated %A1 as source in 2009, likely under unbalanced stands age and current rate of harvesting (of old forest). Germany reports a significant drop of the annual sink since 2002 caused by the use of two different datasets for former East Germany land: aggregated forest management plans for 1990-2002 and since 2002 the new federal forest inventory (harmonized over all the country and the key data source for future GHG reporting). Previous forest inventory overestimated the forest growth.

The methods used by the MS to estimate the C stock changes in SOC and DOM are adapted to existing data and information, and they could be connected with NFI or not (Table 7.17).

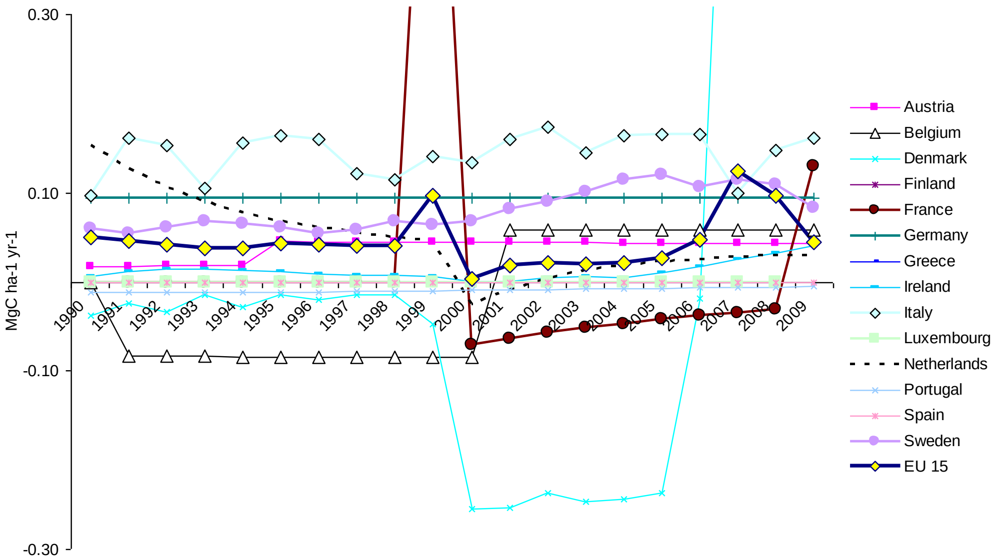
**Table 7.17** **Sources of data and methodology for estimating of C stock change in dead organic matter (DOM) and soil organic carbon (SOC) on land subcategory 5A1. DOM is often reported separately on dead wood (DW) and litter (LT).**

| Member State | Description |
|---|---|
| Austria | NFI database, assuming a ratio of DW between deciduous/coniferous as their stands proportion. LT and SOC are modeled. |
| Belgium | DW is determined from NFI data. LT pool is considered neutral. SOC is estimated based on various datasets and research projects and activities. |
| Denmark | Database on soil sampling in successive moments in time (first in 1985, roughly every 10 years). NFI soil database is used for scaling the sampled plots to total forest area. |
| Finland | LT and SOC in mineral soils are estimated using a model-based method. In organic soils, country specific measured emission factors were used in estimating decomposition of peat, combined with a model to estimate aboveground C stock changes. DW data is provided from NFI. |
| France | DW is provided by the NFI and a 10 % of the harvest is considered as LT (emitted in the year of the event). An annual removal of 2,4 kg/ha $CH_4$ is also counted by undisturbed forest soils. |
| Germany | Both LT and DW are computed based on country datasets (NFIs, Biosoil, soil inventory). SOC is preliminary reported under Tier 1 (on going research in 2011). |
| United Kingdom | Forests in existence before 1920 are considered to have all pools neutral. C pools changes in post 1920 till 1990 afforestation are modeled. |
| Greece | Tier 1 for SOC and DOM. For wildfires affected areas there is a Tier 2 approach for DOM with country specific data. |
| Ireland | SOC and DW are considered neutral. LT C stock change is modeled with country specific data, it is also assumed that there is no litter input in the first 7 years since plantations establishment. |

| | |
|---|---|
| Italy | C stock change in DW estimated by applying the IPCC default dead mass conversion factor. LT and SOC are linearly regressed with country specific equations from the aboveground carbon stock, on available stratification of forests (on forest type, groups of forests types). |
| The Netherlands | DW is computed based on fix rate of tree mortality and DW decomposition rate applied to harvest statistics. LT is computed with a stock change method based on several datasets. SOC is assumed to not change during the period 1990–2009. |
| Portugal | DOM is based on country specific data. SOC is considered neutral. |
| Spain | DOM and SOC are considered as neutral. |
| Sweden | DW is provided by NFI dataset and Forest Soil Inventory database. Carbon in the LT is separately estimated for three different compartments: coarse litter, annual litter fall and fine litter. SOC, both in mineral and organic soils is determined from NFI datasets and country specific factors and models. |

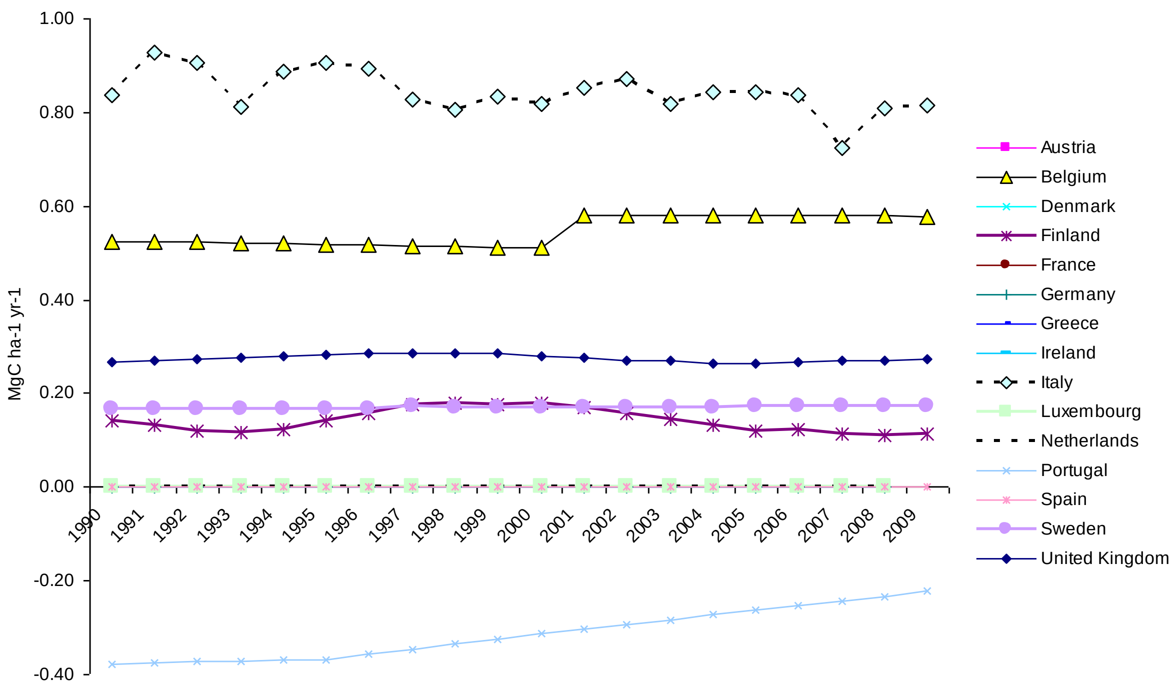
Majority of MS report either SOC, DW or LT under Tier 1 of IPCC, i.e. assuming no C stock change in these pools (see Table 7-8), because historical databases available allow reporting DW and SOC rather than LT. DOM is reported as a sink by most MS, with the highest annual sink reported by the Italy (relies on country specific data, DW seems overestimated by the use of IPCC default DW Conversion factor apparently without consideration of the annual decomposition). At the EU-15 level, DOM is a multiannual average sink of 0.05 Mg C ha-1 yr-1, with a range from -0.12 to 0.25 Mg C ha-1 yr-1 (Figure 7.6), practically unchanged since last year. France revised estimates caused by the windstorm in 1999, allocating major emissions in 1999 (compared to last year when they were allocated to 2000), despite for pre-storm interval DOM was considered neutral. While DOM litter is reported as a neutral pool by Belgium, DW is reported as a sink for decades based on data available in only 2 years (1990 and 2008), then extrapolated to upward and backward toward median year 2000.

**Figure 7.6 Implied net carbon stock change factors in DOM in 5A1 (Mg C ha-1 yr-1). (Outliers in the graph are France which reports 0.74 and Denmark 0.92 Mg C ha-1 yr-1)**




SOC in mineral soils are reported as small annual sinks with exception of Portugal which reports a source. At the EU-15 level, the C stock change factor for SOC in mineral soils is 0.24 Mg C ha-1 yr-1, with a range from -0.38 to 0.95 Mg C ha-1 yr-1 (Figure 7.7). Belgium revised its previous estimates, and current submission IEF is some half of previous estimates. The range is considerable and further effort for understanding the reasons behind it is underway.

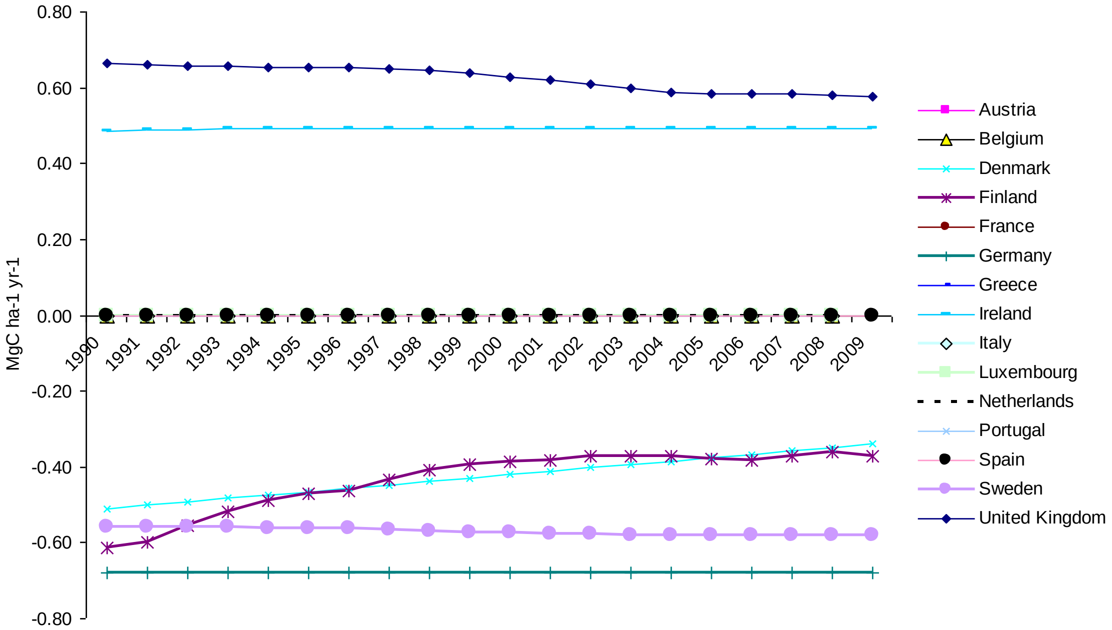
**Figure 7.7** **Implied net carbon stock change factor in SOC for mineral soils in 5A1 (Mg C ha-1 yr-1)**




Highest change SOC C stock in 5A1 is reported by Italy (country specific data, apparently statistically weak: p-values and n–sample size not mentioned, based on empiric datasets) and Belgium (based on country specific data, supported by the information that all forests are younger than 40 years old, thus under active accumulation of C in the soils).

In organic soils, multiyear simple average IEF is -0.17 Mg C ha-1 yr-1 (i.e. source), with a variation from 0.66 to -0.68 Mg C ha-1 yr-1 (apparently there is no mistake on the sign in the CRF tables for UK and Ireland that both report organic soils as sinks). In forests on organic soils, these emissions neutralize 65 % of the annual sink in the biomass. Data is reported based on country specific data (more information could be find in sub-chapter 7.6).

**Figure 7.8** **Implied net carbon stock change factor in SOC for organic soils in 5A1 (Mg C ha-1 yr-1)**




## 7.2.3 *Land converted to forest land (CRF 5A2)*

### 7.2.3.1 Overview of Land converted to forest land

According to data submitted by the MS, in 2009 the area of subcategory 5A2 - Land Converted to Forest Land was around 4% of the total forest land area, and increased by about 45 % since 1990 (Table 7.18). This increase is partly due to the fact that many MS report with the time series starting in 1990. Spain apparently reports the largest land area under this subcategory, while the highest decrease of conversion to forest area is reported by Austria and UK. However, Italy reports with only one year transition period, so total area under conversion to forest since 1990 is the largest in EU-15. Although the application of different approaches is allowed by the IPCC GPG LULUCF 2003 (as long as they are used consistently by MS), it is not possible an easy comparison of activity data within EU-15. The issue has been noted during past reviews of the EU inventory, and efforts to further harmonize approaches on reporting land use changes is part of the continuous harmonizing effort at EU level.

**Table 7.18** **Trend of activity data in subcategory 5A2 – land converted to forest land – in the EU-15 MS (kha)**

| Member State | Year | | | | | Difference |
|---|---|---|---|---|---|---|
| | 1990 | 1995 | 2000 | 2005 | 2009 | 2009 to 1990 |
| Austria | 387 | 373 | 271 | 233 | 220 | -43% |
| Belgium | 0 | 5 | 11 | 16 | 20 | na |
| Denmark | 1 | 10 | 22 | 31 | 43 | 6009% |
| Finland | 213 | 246 | 253 | 209 | 165 | -22% |
| France | 1,061 | 1,251 | 1,275 | 1,243 | 1,229 | 16% |
| Germany | 18 | 107 | 196 | 286 | 357 | 1900% |
| Greece | 0 | 6 | 23 | 32 | 33 | na |
| Ireland | 175 | 222 | 257 | 286 | 272 | 55% |
| Italy | 78 | 78 | 78 | 78 | 78 | 1% |
| Luxembourg | 14 | 14 | 13 | 11 | 9 | -37% |
| The Netherlands | 3 | 18 | 33 | 47 | 59 | 1900% |
| Portugal | 359 | 359 | 359 | 359 | 359 | 0% |
| Spain | 23 | 287 | 781 | 1,013 | 1,092 | 4584% |
| Sweden | 514 | 396 | 372 | 418 | 749 | 46% |
| United Kingdom | 610 | 498 | 450 | 400 | 330 | -46% |
| **EU15** | 3,456 | 3,870 | 4,393 | 4,663 | 5,017 | 45% |

At EU-15 level, in 2009 5A2 is reported as a sink of 31,502 $GgCO_2$, about double than in 1990 (Table (Table 7.19) but slightly less than 2008.

**Table 7.19** **5A2 Land converted to Forest Land: MS' contributions to $CO_2$ net emissions**

| Member State | Net $CO_2$ emissions (Gg) | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$) | (%) | (Gg $CO_2$) | (%) | | |
| Austria | -4,402 | -2,538 | -2,479 | 7.9% | 59 | -2% | 1,923 | -44% | T2 | CS |
| Belgium | NO | -219 | -223 | 0.7% | -4 | 2% | -223 | - | T1,CS | CS |
| Denmark | 11 | -45 | -145 | 0.5% | -100 | 222% | -156 | -1483% | T3 | CS,D |
| Finland | 579 | 235 | 188 | -0.6% | -46 | -20% | -391 | -67% | T2,T3 | CS |
| France | -4,017 | -7,571 | -7,311 | 23.2% | 260 | -3% | -3,294 | 82% | CS,T2 | CS |
| Germany | 934 | -4,476 | -4,779 | 15.2% | -303 | 7% | -5,713 | -612% | CS,T1,T2 | CS |
| Greece | NE,NO | -351 | -351 | 1.1% | 0 | 0% | -351 | - | T1 | D |
| Ireland | 16 | -329 | 287 | -0.9% | 616 | -187% | 272 | 1740% | T1,T3 | CS,D |
| Italy | -782 | -1,339 | -1,390 | 4.4% | -50 | 4% | -608 | 78% | T1,T2 | D,CS |
| Luxembourg | -113 | -83 | -78 | 0.2% | 5 | -6% | 35 | -31% | T1 | CS,D |
| Netherlands | -3 | -639 | -706 | 2.2% | -67 | 11% | -703 | 24930% | T2 | CS |
| Portugal | -2,956 | -2,742 | -2,683 | 8.5% | 59 | -2% | 272 | -9% | D | D,CS |
| Spain | -97 | -6,398 | -6,516 | 20.7% | -118 | 2% | -6,418 | 6599% | T1,CS | D,CS |
| Sweden | 198 | -4,728 | -1,914 | 6.1% | 2,814 | -60% | -2,112 | -1065% | T2,T3 | CS |
| United Kingdom | -5,842 | -3,645 | -3,404 | 10.8% | 241 | -7% | 2,438 | -42% | CS,T3 | CS |
| **EU-15** | **-16,474** | **-34,868** | **-31,502** | **100.0%** | **3,367** | **-10%** | **-15,028** | **91%** | | |

In 2009 the largest $CO_2$ removals were reported by France, Spain and Germany. Ireland and Finland report this subcategory as a source likely under unbalanced afforestation area in time and transfer of lands to 5A1, after transition period. Most MS reported a decrease in annual removal compared to previous year.

#### 7.2.3.2 Methodological issues for Land converted to forest land

Methods used to identify the area under conversion, as well as to report emissions factors and emissions estimation, are sometimes different from those used for subcategory 5A1 (Table 7.20).

**Table 7.20 Background information on sources of data and methodologies used in subcategory 5A2**

| Member State | Description |
|---|---|
| Austria | Approach 3 for land use change, based on NFI which captures changes to/from forestland. NFI records data on the type of land in the neighborhood of the inventory plot and data on conversion from last inventory. The split into the subcategories of previous or following land uses is done with the same ratio as the results for the NFI 2000/02. C stock change in biomass is estimated based on national scale annual increment (a constant value over the 20 years transition) and loss, with country specific conversions factors, using the default method. Reference C stock in mineral soil for all land uses provided by Austrian soil inventories for forests. |
| Belgium | Activity data results from the country wide grid of points in the reference years. SOC is estimated based on reference C stocks with various land uses, available from various national datasets and research activities. |
| Denmark | Activity data are determined by interpolations on maps in 1990 and 2005 built on satellite imagery datasets. Biomass C stock change is estimated using biomass functions with country expansion factors.<br>For DOM detection change is based on NFI data. C stock change in SOC is under estimation based on research projects, old databases and under development a NFI joint system. |
| United Kingdom | C pools changes in post 1990 afforestation are modeled based on country forestry statistics. |
| Finland | Data on land conversions is derived by successive NFIs. Mean biomass annual increment is estimated as an average of current stock per area unit divided by the number of years since the conversion. Change of the soil C stock is modeled. |
| France | Land conversion area is determined by an approach combining datasets of aerial photographs with an annual on-the-ground survey of lands (assess both land use and occurring activities). NFI provides data to estimate C stock change in biomass and DOM. National reference C stocks in soils on each land uses type. French Guyana is only partially assessed (where relevant for conversions) by a photo interpretation system based on remote sensing combined with permanent plots, while biomass data are delivered by field measurements. |
| Germany | Time series start in 1990. Based on NFIs (1987, 2002) in Western Germany and on management plans and NFI 2002 in Eastern Germany, the area of conversion is deducted and assumed linearly distributed in time. Previous land use is reported only for the former Western Germany. Data from 2002 is extrapolated till 2007 and starting with 2008 the absolute value of land use changes from and to forestland is provided by federal cadastral system. NFI datasets and single tree biomass functions are used. For SOC there is used country specific emission factors for each type of conversion. Litter was estimated from national datasets. No dead wood accumulation is determined after field measurements. |
| Greece | Afforestation area is provided from statistics, disaggregated by forest types. Changes in carbon pools are estimated using a Tier1 methodology and data from the GPG for LULUCF for all type of conversions. Carbon stock changes in the dead wood and litter pools were assumed to be zero under a Tier 1 assumption. C stock changes in soils were estimated according to Tier 1. |
| Ireland | Annual area is a spatially explicit GIS database for after 1990, with detailed information given by LPIS (including on the previous land use). Afforested area maps superimposed on Soil map and CORINE 1990 Land Cover Map supported the identification of the soils types. Biomass C stock is modeled. No change is demonstrated for SOC and DOM pools based on country specific data. |
| Italy | Land use change matrix starting 1990 has been assembled based national land use statistics of land use, combined with NFI. NFI provides data for biomass increase. Reference soil C stocks on land use are available. |
| The Netherlands | A land use matrix is available with land-use changes calculated by comparing the digitized map (for the period 1988-1992 for 1990) with those from 1999-2002 for 2000). In 2005/2006, afforestation and deforestation were evaluated based on field studies. Changes in carbon stocks in living biomass, DOM and SOC are the same as in subcategory 5A1. |
| Portugal | Conversion area data is given by Corine Land Cover maps (1990, 2006) and NFI. DOM (only litter) stocks are country specific. Reference C stocks in soils are derived based on ICP Forest Level I/ Biosoil data. |
| Spain | Area data is given by national statistics. For all pools, the method for C stock change estimation is Tier 1, with some country specific factors. Annual average increment in aboveground biomass is estimated based on the Map of Potential Forest Productivity of Spain, and country average BEFs and root-to-shoot ratios, computed for each province. SOC and DOM pools are considered small sinks, thus Tier 1 is applied. |

| | |
|---|---|
| Sweden | NFI provides explicit gross & net land-use transfers from the base year onward. Estimation of C stock change in living biomass is based on NFI data and country specific biomass functions. C stock change in DOM and SOC are based on NFI data and land use specific decay functions. |

Heterogeneity in the approaches used by MS for subcategory 5A2 suggests caution in interpreting differences in the implied carbon stock change factors. For instance, possible reasons of differences may include time series length and their starting point (on the transition period adopted), use of averaged or annual biomass growth, emissions from previous land use or the attribution of emissions from previous land use pools in the first year of conversion. In some case, the combined effect of transition period length and high annual variation of past/current planted area over time may generate even emissions for some years (i.e. Ireland). MS developed land identification systems which are able to track or at least to define the previous land use.

DOM is a small sink with IEF ranging from 0.01 to 0.75, with the average of 0.30 Mg C ha-1 yr-1. Changes in SOC pool in mineral soils under 5A2 seems rather controversial as EU's QAQC does not have enough data to consider particular features of land (i.e. land history, land management), as far as all reported numbers rely on measurements and published references. Average C stock change is 0.22 Mg C ha-1 yr-1 with a range from -0.45 to 1.35. This excludes Italy which reports very high value assuming only 1 year transition period (based on scientific facts (international bibliography quoted) that majority of emissions occur over first years of the transition (see subtitle *Land converted to Cropland*, Italy's 2011 NIR). Nordic countries (Denmark, Finland, Ireland, Sweden, UK) report decrease of the C stocks in soils.

Tier 2 is practically used exclusively for reporting emissions/removal from conversions (also for "remaining" cropland or grassland), but not for "forest remaining forestland". Part of the EU-15 MS report based on Tier 3 (e.g. Denmark, UK) or Tier 1 based on IPCC default data (i.e. Greece, Ireland). Spain and Belgium developed reference C stocks in soils on administrative regions bases (e.g. NUTS 3 in Spain) (Table 7.21).

**Table 7.21 Reference C stock in mineral soils on forestland/grassland/cropland reported by the MS**

| MS | Land use | Reference C stock (tC/ha)* | Comments (i.e. depth) |
|---|---|---|---|
| Austria | Forestland | 121 | 0-50 cm, includes litter above the mineral soil |
| | Cropland | 60 | 0-50 cm, includes litter above the mineral soil |
| | Permanent cropland (vineyard) | 58 | 0-50 cm, includes litter above the mineral soil |
| | Grassland (intensive use) | 81 | 0-50 cm, includes litter above the mineral soil |
| | Grassland (extensive use) | 119 | 0-50 cm, includes litter above the mineral soil |
| Belgium | Forest Land | 99/94 | Walonia / Flanders |
| | Cropland | 44/50 | Walonia / Flanders |
| | Grassland | 88/82 | Walonia / Flanders |
| | Peatland | 100 | Belgium |
| Finalnd | Cropland | 59.1/74.6 | IPCC derived reference for high activity soils/sandy soils |
| Greece | Cropland | 48 | National average IPCC derived |
| France | Forestland | 70 | Depth not specified |
| | Cropland | 40 | Depth not specified |
| | Grassland | 65 | Depth not specified |
| Italy | Grassland | 78.9 | For undisturbed soil grasslands |
| | Cropland | 56.7 | Depth of 30 cm |
| Spain | Grassland | 94.5 | Values are valid at country level for the transition from cropland to grassland. Various depths 30-100 cm as available in the databases |

| | | | |
|---|---|---|---|
| | Cropland | 71 | Values are valid at country level for the transition from cropland to grassland. Various depths 30-100 cm as available in the databases |
| United Kingdom | All land use categories | | Reference C stock for all regions and all land use, 1 m soil depth |

**- more values of the reference C stocks are provided by the GHG National Inventory Report 2011 of Austria and Italy*

For C stock change in SOC of organic soils, the IEF ranges from -2.0 by Finland up to +0.99 Mg C ha-1 yr-1 in case of organic soils on grassland and wetlands conversions by Ireland and UK (reported as sinks only over recent years, while as sources earlier). All reporting MS provide estimates based on country specific data and measurements (i.e. in Finland, the DOM and SOC C stocks change are simulated based on the inputs of aboveground and belowground litter and dead wood and emission from soil).

## 7.3 Cropland (CRF 5B)

### *7.3.1 Overview of the Cropland category*

In European Union, this category includes arable lands for annual and permanent crops and set aside land. Based on the MS submissions, cropland area in EU-15 covers 89877 kha in 2009 (5% less than in 1990), equal to 26 % of total reported land area.

European Environment Agency[34] (2008) reports that in the EU-15, the utilized agricultural area declined from 49,5 % in 1995 to 45,0 % in 2005, with the area of arable land felling from 30,6 % to 27,4 % in the same period, reflecting mainly set-aside policy and increase of the area of settlements. Set aside land was a practice to withdraw land from current cropping requested to decouple the production by payments within the EU, in order to reduce production of cereals since the early 1990's.

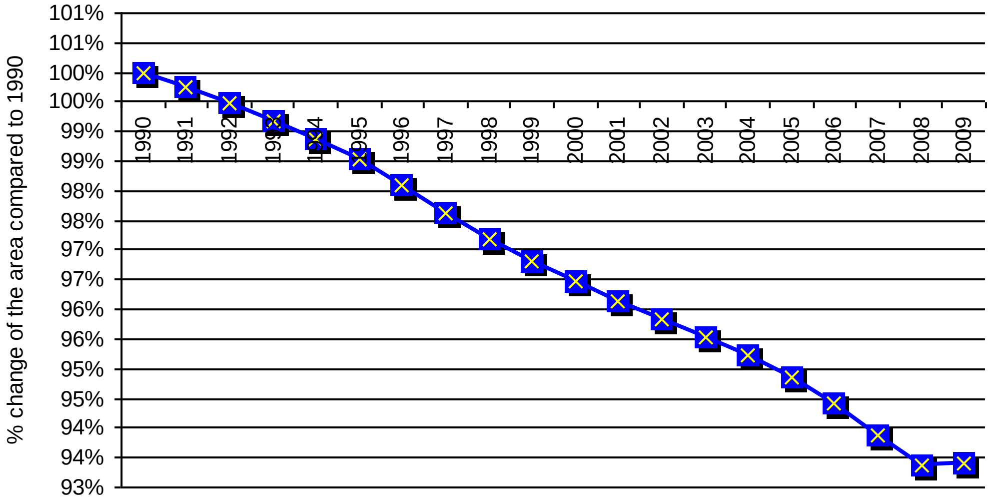
### *7.3.2 Cropland remaining cropland (CRF 5B1)*

#### 7.3.2.1 Overview of Cropland remaining cropland

According to MS' CRFs, the area of "cropland remaining cropland" constantly decreases by 7% since 1990 (Figure 7.9).

[34] Agricultural statistics, 2008 edition, Main results 2006-2007, Eurostat Pocketbooks, http://epp.eurostat.ec.europa.eu/agriculturalstatistics 2008

**Figure 7.9** **The relative trend of Cropland remaining Cropland over the period of 1990-2009 (% to 1990)**




MS show decrease of cropland area, with the exception of France and Luxembourg. The largest decreases are registered by Italy, Spain and Portugal (

Table 7.22). Overall, at the EU-15 level, the area of cropland remaining cropland decreased by 7 % from 1990 to 2009.

**Table 7.22 Trend of activity data in subcategory 5B1 - Cropland remaining cropland in EU-15's MS (kha)**

| Member State | 1990 | 1995 | 2000 | 2005 | 2009 | Difference 2009 to 1990 |
|---|---|---|---|---|---|---|
| Austria | 1,425 | 1,413 | 1,388 | 1,385 | 1,341 | -6% |
| Belgium | 979 | 953 | 928 | 902 | 887 | -9% |
| Denmark | 2,917 | 2,882 | 2,848 | 2,814 | 2,784 | -5% |
| Finland | 2,411 | 2,391 | 2,358 | 2,348 | 2,336 | -3% |
| France | 13,904 | 13,864 | 14,141 | 14,525 | 14,744 | 6% |
| Germany | 14,249 | 13,951 | 13,652 | 13,354 | 13,157 | -8% |
| Greece | 3,944 | 3,906 | 3,848 | 3,802 | 3,732 | -5% |
| Ireland | 405 | 397 | 380 | 326 | 302 | -25% |
| Italy | 11,170 | 11,173 | 10,618 | 10,012 | 9,213 | -18% |
| Luxembourg | 37 | 36 | 37 | 41 | 44 | 18% |
| The Netherlands | 999 | 971 | 942 | 914 | 891 | -11% |
| Portugal | 3,131 | 2,746 | 2,377 | 2,074 | 1,833 | -41% |
| Spain | 21,175 | 20,871 | 20,317 | 20,026 | 19,838 | -6% |
| Sweden | 3,071 | 3,015 | 2,962 | 2,890 | 3,068 | 0% |
| United Kingdom | 5,972 | 5,972 | 5,972 | 5,972 | 5,972 | 0% |
| **EU-15** | 85,789 | 84,541 | 82,767 | 81,383 | 80,142 | -7% |

At EU-15 level, in 2009 subcategory 5B1 was a source of 18,960 Gg$CO_2$, i.e. 27 % higher than in 1990 (Table 7.23) and 1% compared to 2008.

**Table 7.23** **5B1 Cropland remaining cropland: MS' contributions to net $CO_2$ emissions**

| Member State | Net $CO_2$ emissions (Gg) | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$) | (%) | (Gg $CO_2$) | (%) | | |
| Austria | -152 | 52 | 71 | 0.4% | 20 | 38% | 223 | -147% | T2,T1 (for biomass of parts of perennial | CS, D (biomass of parts of perennial cropland) |
| Belgium | 1,033 | 929 | 929 | 4.9% | 0 | 0% | -105 | -10% | CS,T2 | CS |
| Denmark | 3,174 | 2,503 | 1,349 | 7.1% | -1,154 | -46% | -1,824 | -57% | T2,T3 | CS |
| Finland | 5,153 | 4,652 | 4,810 | 25.4% | 158 | 3% | -343 | -7% | D,T1 | D |
| France | 1,054 | 993 | 1,102 | 5.8% | 109 | 11% | 48 | 5% | CS,T2 | CS |
| Germany | 22,724 | 24,963 | 24,681 | 130.2% | -282 | -1% | 1,957 | 9% | D,CS,T2 | CS |
| Greece | -1,205 | -801 | -737 | -3.9% | 64 | -8% | 468 | -39% | T1,T2 | CS,D |
| Ireland | 20 | -21 | -28 | -0.1% | -7 | 32% | -48 | -240% | T1 | D |
| Italy | -19,977 | -12,928 | -12,299 | -64.9% | 629 | -5% | 7,677 | -38% | T1 | D,CS |
| Luxembourg | -6 | 8 | 8 | 0.0% | 0 | 0% | 14 | -231% | T1 | CS,D |
| Netherlands | IE,NA,N | IE,NA,N | IE,NA,N | - | - | - | - | - | NA | NA |
| Portugal | -169 | -379 | -359 | -1.9% | 20 | -5% | -190 | 112% | D | D,CS |
| Spain | -929 | -3,777 | -3,171 | -16.7% | 606 | - | -2,242 | - | T2 | D,CS |
| Sweden | 2,375 | 1,595 | 1,655 | 8.7% | 61 | 4% | -720 | -30% | T1,T2,T3 | CS |
| United Kingdom | 1,793 | 906 | 949 | 5.0% | 43 | 5% | -844 | -47% | CS,T3 | CS |
| **EU-15** | **14,888** | **18,693** | **18,960** | **100.0%** | **267** | **1%** | **4,072** | **27%** | | |

Nevertheless, 5B1 represents an active sink in those MS where there are large areas of permanent croplands under active management. Mediterranean countries reports sink (e.g. Italy) or almost neutral land category (i.e. France), as owing large areas of permanent croplands (i.e. olive groves, vineyards), although removal is steadily decreasing since 1990. In fact, overall EU-15 removal since 1990 is dominated by Italy's permanent cropland, while overall emission is dominated by Germany's cropland (share linked to the biomass growth in Italy). Overall, in Germany, this land subcategory is a source, turning entire LULUCF into a source, with biomass C stock changes reported as removal for 2009 (including of both annual and perennial crops) and significant emissions associated with organic soils. Other countries report soils as relatively small sources.

### 7.3.2.2 Methodological issues for Cropland remaining cropland

The definitions of croplands are not always transparently reported by the MS, but when available they appear to match well the IPCC definition (Table 7-24). In some cases, the match with IPCC definition required aggregating or disaggregating existing national data and statistics. Quite often, cropland may not be clearly separated from grassland, and the approaches applied to report a land under either cropland or grassland may vary from one MS to another. Fact is that all 15 MS have developed consistent land use change matrices.

**Table 7-24** **Information on cropland definitions and/or description (na – definition not available in NIR 2011)**

| Member State | Definition/description (according NIR 2011) |
|---|---|
| Austria | Arable land, including annual and perennial crops (used in short rotations, with rotation period of up to thirty years), as well as forest arboretums, forest seed orchards, Christmas tree plantations and orchards (e.g. walnut or sweet chestnut) and rows of trees and areas with woody plants in parks and green areas, and house garden. |
| Denmark | Land with annual crops, wooden perennial crops, area with hedgerows and "other agricultural area" (i.e. small undefined areas lying inside the cropland area). It includes farmlands, commercial plantations with perennial crops (fruit trees, orchards and willow), houses gardens, hedgerows (perennial trees/bushes not meeting the forest definition) in the agricultural landscape, as well as willow plantations on agricultural land for bioenergy purposes. |

| | |
|---|---|
| Finland | Area under arable crops, grass covered (for less than 5 years), set-aside, permanent horticultural crops, green-houses and kitchen gardens. |
| Germany | Annual crops and cropland with perennial crops (long-lived crops: fruit crops, osiers, poplars, Christmas tree farms, nurseries). Area for cultivation of vegetables, fruit and flowers. |
| Greece | Annual and perennial crops as well as temporary fallow land. Forest plantations – mainly consisting of poplar trees - are considered as Cropland. Includes perennial woody crops, i.e. tree crops and vineyards. |
| Ireland | Permanent crops and tillage areas (including set-aside), as recorded by annual statistics. |
| Italy | Annual crops and perennial woody crops (e.g. woody plantations, that don't meet national forest definition, olive groves or vineyards). |
| The Nether-lands | Arable and tillage land, including rice-fields, and agro-forestry systems where the vegetation structure falls below the thresholds used for the Forest land category, and nurseries (including tree nurseries). Rotation between crop-land and grassland is frequent, but data on where exactly this is occurring are as yet lacking and data is reported under the actual use in the current year. |
| Portugal | Arable land, permanent crops, heterogeneous agricultural areas. |
| Spain | Cultivated land, including cultivated areas in the dehesa (definition in Table 7.12). Annual crops (including fal-low lands), perennial crops (olive grooves, wines and other woody crops) and mix of annual and permanent crops are included, except when they qualify as forest land. |
| Sweden | Regularly tilled agricultural land. |
| United King-dom | Non-forest biomass from yield improvements (from improved species strains or management, rather than fertili-zation or nitrogen deposition) and fenland drainage (in England only) which were drained many decades ago for agriculture purpose (although there was no land use change). |
| | Belgium, France, Luxembourg - na |

Net fluxes of GHG in cropland remaining cropland are reported mainly for soils, which is the most significant pool in terms of C stock changes, while for biomass, the C stock changes are reported only for multi-annual woody crops (i.e. orchards, vineyards, Christmas trees, fruits, bushes, plantations). The soil pool definitions vary among MS, in terms of the estimated soil depth (e.g. 20 cm in Finland and Finland; 100 cm in Denmark; no depth is specified in case of modeled approaches) and as well as the threshold content for organic matter in organic soils. Methods used for the estimation of emissions and removals depend on data type and their time series availability (Table 7.25).

**Table 7.25 Background information on C stock change estimation sources of data and methodology in the sub-category 5B1**

| Member State | Description |
|---|---|
| Austria | Activity data is compiled from Statistic Austria (based on IACS*). For crops not covered by the IACS the data are revised and estimated by expert judgment. Annual C stock change in biomass is considered according to the type of permanent woody crops (Tier 1 for orchards, vineyards and house gardens and Tier 2 for energy crops, Christmas tree) and estimated based on country specific total biomass carbon stock at harvest/removal. C stock in mineral soils is computed from na-tional reference C stocks and country specific average C stock change factors adjusted according to the technology and management change. |
| Belgium | Activity data for SOC is derived based on landscape units distribution generated by the topological intersection of the 1990 version of the Corine Land Cover (CLC) geo-dataset and the digitized Soil Association map of Tavernier et al. (1972). C stock for each type of unit is estimated for the years 1960, 1990 and 2000, based on several databases and mod-eling approaches. C stock change in biomass is not yet estimated. |
| Denmark | Activity data by Statistics Denmark in a GIS analysis of the country's agricultural area combined with LPIS databases and detailed climate, soil maps, mineral & organic soils and cropland & grasslands, based on aerial photos for 1990 and 2005 analyzed to monitor and detect changes in the landscape. Further on stratified on administrative criteria. C stock change in horticultural biomass is estimated based on the country's average stock biomass for each crop type, while for hedgerows is modeled with NFI data. The estimation of the SOC stock change in mineral soils is modeled at county level validated against available long term field measurements. For organic soils, emission factors are country specific. |
| Finland | Cropland area is derived from NFI and Yearbook of Farm Statistics. Based on soil analysis the area is stratified on miner-al & organic soils, low/high activity soils and fallow/till/no-till lands. C stock change in woody biomass is determined by country specific data for perennial crops. C stock changes in soils are computed from reference soil C stocks and IPCC default factors. $CO_2$ emissions from cropland on organic soils are computed based on national emission factors on land categories and use. |

| | |
|---|---|
| France | Unitary land assessment system foe all lands (described under 5A1). C stock changes are considered neutral in all pools. |
| Germany | Cropland area is multi-source provided via GIS digitized maps, within “wall to wall” approach, built by the landscape model (ATKIS - Amtliches Topographisch-Kartographisches Informationssystem), CORINE land cover (CLC – 1990, 2000), digital soil map of Germany (BUEK 1000) and German Official Statistic data (land use surveys in 1991, 1999, 2003), harvests survey in 1989 – 2005, revision of NUTS 3 in 1998 and NFI). The approach allows estimating the area of land uses and the ratio of organic/mineral soils. Emissions from organic soils are estimated using a Tier 3 methodology, with country specific emission factors. Mineral soils are considered to be in $CO_2$-equilibrium. |
| United Kingdom | Non-spatially-explicit land use land use data is provided from countries statistics. A dynamic model of carbon stock change is used with the land use change matrices to estimate soil C stock changes due to land use change. |
| Greece | Area data on cropland dynamic is provided by national statistics. The default IPCC method is combined with a Tier 2 methodology to estimate C stock changes in biomass in permanent woody crops. Tier 1 emission factor data is used for the estimation of C stock changes in mineral soils, with IPCC default C stock change factors and C stock reference in mineral soils. A weighted average value for reference soil organic carbon stock is computed at national level, based on default reference data. |
| Ireland | Annual statistics for tillage crops. For C stock change in biomass, Tier 1 is assumed. Tier 1 is applied for C stock change estimation in mineral soils. Soil types on land uses are derived from GIS analysis of the 2004 dataset of LPIS, superimposed on the General Soil Association Map of Ireland. Reference C stocks are established in details for each soil type, and then assimilated with IPCC defaults, while adjusted by unique national values of stock change factors. |
| Italy | Time series of national land use statistics is available. Tier 1 based on highly aggregated area estimates for generic perennial woody crops has been used to estimate only aboveground biomass carbon stock change. Biomass plantations C stock change is modeled at regional scale (NUTS2). No change for mineral and organic soils was assumed. |
| The Netherlands | Activity data is obtained from land use maps complemented with digitized and digital topographical. Soil carbon content is based on the soil map of The Netherlands combined with detailed descriptions of randomly selected and analyzed soil profiles. C stocks changes in soils are obtained based on 1990 and 2004 measured data, with interpolation in-between and extrapolation to 2009. C stock change is considered zero in all other pools. |
| Portugal | Area data is provided by Corine Land Cover maps (1990, 2000), NFI and Agricultural Statistics. Data for permanent biomass is based on neighbor countries values. Soil C stock change is estimates with country specific data. |
| Spain | Activity data is obtained from CLC 1990 and 2000 and Forest Map of Spain. Change amongst all type of permanent crops is given by own statistics. C stock change in biomass is estimated only for perennial woody crops based on CS data on each main type of crop: olives, wines and other woody crops. Soil C stock change factors are adjusted on climatic regions. |
| Sweden | Activity data is provided by a national level systematic grid of permanent monitoring plots. Mineral soils C stock change is modeled at regional level (use among others of the results of a nationwide survey of agricultural soils). For organic soils the annual carbon loss is calculated on country specific emission factors. |

** IACS - Integrated Administrative Control System EU subsidy payment scheme.*

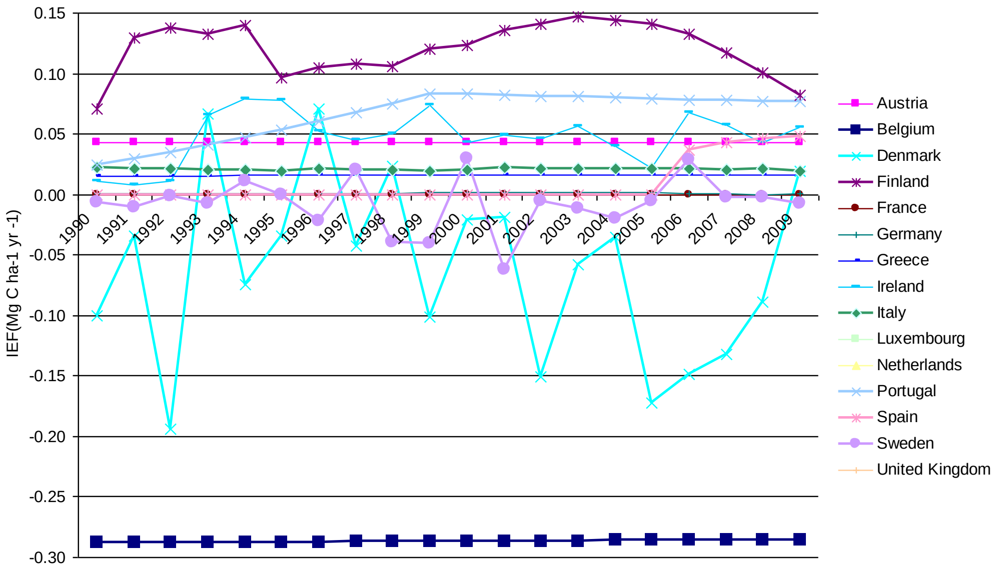
Although this subcategory is highly heterogeneous (in terms of soil, ecological conditions, management practices, crop type), relatively few MS report it on subdivisions (which are likely available with the MS spreadsheets, but not transparent in their NIRs). Such approach would allow better understanding of the differences at continental scale.

Different C stock change factors for living biomass vary by different types of permanent crops and management across Europe, especially from North (i.e. bush-type currant crops) to South (i.e. olives crops and agro-forestry systems). At EU level, there is annual removal of 0.03 Mg C ha-1 yr-1 (with the highest IEF values in Italy of 0.4 Mg C ha-1 yr-1). Under dynamics of perennial cropland in some years it may associate with emissions (e.g. 1994-2009 in Austria under decreasing of their area or in Denmark and Portugal). In some countries, the biomass C stock change is considered neutral (e.g. France).

For the estimation of C stock changes in mineral soils of cropland, most countries apply Tier 1 or 2 for emission factors and method, while few MS report using Tier 3 methodology based on models (e.g. Denmark). Reference C stock (t C/ha) in mineral soils varies between countries (seeTable 7.21). Actually, Tier 2 also assumes that the country develop its own C stock change factors. These factors are (according GPG for LULUCF, 2003) the tillage/management factor ($F_{MG}$), the land use factor ($F_{LU}$) and the organic material input factor ($F_I$). Noteworthy is that practically none of EU-15's MS developed its own factors and they all apply default IPCC ones, either directly selected or slightly modifying and adapting them by expert judgment. Nevertheless, Austria derived own factors by weighting C stock changes in mineral soils based on available crop and management statistics since 1985. It was taken into account the changes in agricultural land management (e.g. increase of biological agriculture), tillage (e.g. crop residues remain on the fields) and crop rotation (increase of legumes and greening of arable areas) starting from 1990 soil C stocks and agricultural land use pattern. With the changes in agricultural practices the computed factors showed an increasing trend in time of soil C stock (i.e. $CO_2$ removal equivalent to 45 kg C ha-1yr-1).

Overall, the soils are reported as small sinks, with IEF for the C stock changes close to zero over the entire period since 1990 (Figure 7.8), consistent to last year reporting.

**Figure 7.10 Implied C stock change factor in SOC mineral soils in 5B1 (Mg C ha-1yr-1)**




Overall EU-15 average is 0.01, with extremes IEF values reported by Belgium with -0.28 (based on CS data) and 0.12 Mg C ha-1yr-1 in Finland. Denmark reports based on model dependent on actual air temperature and agricultural annual residues input in the soils which may explain the shape pattern for IEF and total emissions/removal since 1990.

Organic soils under cropland are reported under Tier 1 (involving IPCC default EF) or Tier 2 involving country-specific emission factors (e.g. Finland, Sweden, UK). In Ireland there are no annual crops on organic soils. Some countries developed differentiated EF on type of crops or soil status (e.g. DK on soil management type). Emission factors range from -11 in to some -2.5 Mg C ha-1y-1 in UK and Ireland). View of organic soils in EU-15 is provided under sub-chapter 7.6.

### 7.3.3 Land converted to cropland (CRF 5B2)

#### 7.3.3.1 Overview of Land converted to cropland

At the EU-15 level, area reported under "land converted to cropland" increased by 14% since 1990 (Table 7.26). Overall, the area under conversions is some 15 % of total cropland area, and it mainly originates in non-forest lands (1 % only is deforestation). France, but especially UK, reports significant share of their 5B area as being under conversion. Most of such conversions are reported as occurring from grassland (> 90 % of area) and explained by the practice of swift shift from one use to another by current farming. Each of them represents around 40% of total EU-15 area reported under such conversions.

**Table 7.26 Trend of activity data in subcategory 5B2 - Land converted to cropland – in EU-15 MS (kha)**

| Member State | Year | | | | | Difference 2009 to 1990 |
|---|---|---|---|---|---|---|
| | 1990 | 1995 | 2000 | 2005 | 2009 | |
| Austria | 83 | 79 | 74 | 71 | 96 | 16% |
| Belgium | NO | 25 | 50 | 75 | 92 | na |
| Denmark | 1 | 3 | 6 | 8 | 10 | 1664% |
| Finland | 38 | 39 | 49 | 79 | 112 | 192% |
| France | 4,241 | 4,211 | 3,987 | 3,629 | 3,816 | -10% |
| Germany | 89 | 89 | 89 | 89 | 36 | -60% |
| Greece | 0 | 0 | 0 | 0 | 0 | na |
| Ireland | NO | 13 | 20 | 57 | 97 | na |
| Italy | 14 | 0 | NO | NO | NO | na |
| Luxembourg | 8 | 8 | 8 | 8 | 7 | -12% |
| The Netherlands | 14 | 14 | 14 | 14 | 14 | 0% |
| Portugal | 100 | 99 | 96 | 87 | 80 | -20% |
| Spain | NO | NO | NO | NO | NO | na |
| Sweden | 31 | 50 | 63 | 88 | 81 | 159% |
| United Kingdom | 3,899 | 4,384 | 4,824 | 5,085 | 5,294 | 36% |
| **EU-15** | 8,519 | 9,015 | 9,282 | 9,292 | 9,735 | 14% |

Emissions decreased by 14 % since 1990 (Table 7.27). Land converted to cropland is an important source at the EU-15 level: although 5B2 area is about 4% of the area under 5B, the annual emissions are 40 % more than 5B1's. Most of the emissions occur in case of conversion from forest land and from grassland. In 2009, the largest emissions are reported by France and UK (comparable to 1990).

**Table 7.27 5B2 Land converted to cropland: MS' contributions to net $CO_2$ emissions**

| Member State | Net $CO_2$ emissions (Gg) | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$) | (%) | (Gg $CO_2$) | (%) | | |
| Austria | 375 | 343 | 372 | 1.1% | 29 | 8% | -4 | -1% | T2 | CS, D (biomass of parts of perennial cropland) |
| Belgium | NO | 639 | 649 | 2.0% | 9 | 1% | 649 | - | T1,CS | CS |
| Denmark | 26 | -2 | -2 | 0.0% | 0 | 3% | -29 | -109% | T2,T3 | CS |
| Finland | 292 | 1,596 | 1,731 | 5.3% | 135 | 8% | 1,439 | 492% | D,T1,T3 | CS |
| France | 14,896 | 14,786 | 14,372 | 44.2% | -415 | -3% | -524 | -4% | CS,T2 | CS |
| Germany | 5,915 | 4,949 | 2,422 | 7.4% | -2,527 | -51% | -3,492 | -59% | D,CS,T2 | CS |
| Greece | 0 | 0 | IE,NO | - | - | - | - | - | T1 | CS,D |
| Ireland | NO | 359 | 214 | 0.7% | -146 | -41% | 214 | - | T2 | D |
| Italy | 1,028 | NO | NO | - | 0 | - | -1,028 | - | T1 | D,CS |
| Luxembourg | 40 | 18 | 18 | 0.1% | 0 | 2% | -23 | -56% | T1 | CS,D |
| Netherlands | 35 | 48 | 49 | 0.2% | 1 | 1% | 14 | 41% | T2 | CS |
| Portugal | 1,221 | 713 | 693 | 2.1% | -20 | -3% | -528 | -43% | D | D,CS |
| Spain | NO | NO | NO | - | - | - | - | - | NA | NA |
| Sweden | 31 | 182 | 290 | 0.9% | 109 | 60% | 259 | 822% | T2,T3 | CS |
| United Kingdom | 13,902 | 11,939 | 11,744 | 36.1% | -196 | -2% | -2,158 | -16% | D | CS |
| **EU-15** | **37,762** | **35,571** | **32,551** | **100.0%** | **-3,020** | **-8%** | **-5,211** | **-14%** | | |

### 7.3.3.2 Methodological issues for Land converted to cropland

MS main data sources for estimation of the C stock changes and $CO_2$ emissions are in

Table 7.28.

**Table 7.28 Background information on C stock change estimation sources of data and methodology in subcategory 5B2**

| Member State | Description |
|---|---|
| Austria | Data from NFI and IACS data base. Conversions between and within cropland and grassland are assessed based on “land use change factor” determined by a field estimation conducted in 2001–2003, then extrapolated to all years for the entire time series 1990–2009. C stock change in biomass is based on default and country specific factors. Soils C stock change is estimated by reference C stocks for different land uses and a default transition period of 20 years. |
| Belgium | Only conversion from forestland is estimated based on average living biomass C stock. SOC is computed based on regional reference C stock in soils. |
| Denmark | Data derived from remote sensing in 1990 and 2005, combined with data in LPIS. It is further stratified with the soil map in both mineral and organic soils & cropland and grasslands (further broken down for: annual crops, set-a-side, grass in rotation and permanent grassland). |
| Finland | Data from NFI. Woody biomass and DOM data are also given by NFI. Mineral soils C stock change is computed based on country specific C stock references assuming 20 years transition period. |
| France | Integrated land use conversion matrix. Only emissions from conversion from forests are estimated based on biomass, DOM and SOC NFI data. |
| Germany | GIS digitized maps, within integrated “wall-to-wall” approach covers entire land including conversions. A computation procedure derives C stock changes for relevant pools. |
| United Kingdom | Land use data is provided from statistics, broken down on geographical regions. Changes in biomass and SOC due to land use change depends on a matrix of change based on repeated land surveys, linked to a dynamic model of carbon stock change and a database of soil carbon density for the UK. |
| Greece | Data was provided by local forest service offices. |
| Ireland | GIS LPIS* database. Computation of emissions assumes a correlation between soil type and grassland use. Deforestation data is given by NFI. Only above-ground biomass change is estimated as the difference between initial and final carbon content of biomass for the lands converted. SOC emissions are estimated based on a Tier 1 methodology. Data on biomass on converted forestland is given by Forest Service databases |
| Italy | Land use change matrix is constructed based on time series of national land use statistics, with annual effective conversions derived under a hierarchy of expert judgment assumptions on well known patterns of land-use changes in the country, further on combined with the target that the total national area to remain constant. Conversions from forest are derived based from administrative records at regional level collected by National Institute of Statistics. |
| The Netherlands | The activity data is derived from land use matrix and soil maps. Digitized soil maps are combined with soil profile details for 1990 and 2004. Then, annual change is interpolated over 1990-2004 and extrapolated after 2004. |
| Portugal | Conversion area is provided by Corine Land Cover maps (1990, 2000), NFI and Agriculture Statistics, involving linear interpolations and extrapolations to obtain full time series. Soil C stock change is based on country specific data |
| Spain | There are no detected conversions to croplands. |
| Sweden | Activity data is provided by NFI. Biomass data for conversion from forests is given by NFI. C loss in soils is computed from oxidation rate, soil bulk density and soil carbon concentration. |

** LPIS – Land Parcel Information System (used by MS to implement the Common Agricultural Policy of the EU).*

Lower tiers are generally used in estimating and reporting C stock changes in this land subcategory, especially Tier 2 and enhanced Tier 1 by using country specific data with default methods.

At EU level, multiyear average C stock change factor *in case of conversions from forestland* to cropland ranges between 45-60 Mg C ha-1 yr-1 for the MS which report only one year transition period for all pools (i.e. Belgium, Germany) to values under 4 Mg C ha-1 yr-1 for the MS that report over longer transition period. High values of IEF are reported for early ‘90 by MS reporting time series starting the 1990.

In case of *conversions from grassland to cropland*, mostly soils emissions are reported. When biomass is reported, emissions are estimated using Tier 1 IPCC default values, as there is still lack of country specific data. Germany’s IEF is constant at 2.5 Mg C ha-1yr-1. On mineral soils, the C stock change factors are smaller for grassland than for forestland converted to cropland, with general values under 3 Mg C ha-1 yr-1. Only Germany reports high decrease of C stocks (some -20 Mg C ha-1 yr-1) under only 1 year transition period (scientifically justified in the NIR). Conversions of grassland to cropland on organic soils occur rarely (overall EU-15 emission of 136 Gg C), still there is reported high C stock changes of -3.75 Mg C/ha by Sweden and -11 Mg C/ha by Germany.

# 7.4 Grassland (CRF 5C)

## 7.4.1 Overview of Grassland (CRF 5C)

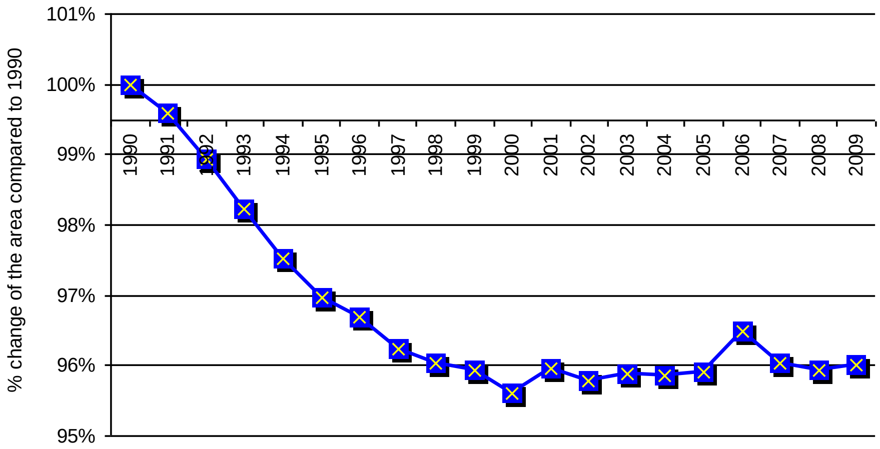
According to MS submissions, in 2009 the total grassland area was 15,3 % of total reported land area. The highest area of grasslands is in France (12,700 kha, or 18 % of country area), Spain (4,500 kha, or 15%) and the lowest in Finland (15 kha, or 0,1 %).

## 7.4.2 Grassland remaining grassland (CRF 5C1)

### 7.4.2.1 Overview of grassland remaining grassland

Area reported under this land subcategory is 4% less than in 2009 compared to 1990 (Figure 7.9).

**Figure 7.11 The relative trend of area of grassland remaining grassland over the period of 1990-2009 in EU-15 (% relative to 1990)**




The major part of this change was due to UK that reports a significant decrease apparently compensated by the increase in Germany and Portugal (

Table 7.29).

**Table 7.29 The trend of activity data in "grassland remaining grassland" subcategory 5C1 in EU-15's MS (kha, 1990-2009)**

| Member State | 1990 | 1995 | 2000 | 2005 | 2009 | Difference 2009 to 1990 |
|---|---|---|---|---|---|---|
| Austria | 1,876 | 1,863 | 1,868 | 1,767 | 1,719 | -8% |
| Belgium | 754 | 714 | 674 | 633 | 609 | -19% |
| Denmark | 117 | 114 | 111 | 109 | 107 | -9% |
| Finland | 133 | 121 | 126 | 163 | 164 | 23% |
| France | 11,917 | 11,389 | 11,261 | 11,302 | 10,968 | -8% |
| Germany | 5,929 | 6,155 | 6,382 | 6,609 | 6,789 | 15% |
| Greece | 4,797 | 4,796 | 4,794 | 4,793 | 4,792 | 0% |
| Ireland | 4,123 | 3,950 | 3,922 | 3,862 | 3,769 | -9% |
| Italy | 9,220 | 8,791 | 8,920 | 9,085 | 9,527 | 3% |
| Luxembourg | 79 | 79 | 78 | 75 | 73 | -8% |
| The Netherlands | 1,485 | 1,449 | 1,414 | 1,378 | 1,350 | -9% |
| Portugal | 286 | 420 | 636 | 987 | 1,265 | 342% |
| Spain | 4,720 | 4,622 | 4,535 | 4,470 | 4,427 | -6% |
| Sweden | 478 | 449 | 424 | 383 | 269 | -44% |
| United Kingdom | 9,814 | 9,119 | 8,129 | 7,827 | 7,675 | -22% |
| **EU-15** | 55,727 | 54,032 | 53,276 | 53,441 | 53,502 | -4% |

Category 5C1 grassland remaining grassland was a source of $CO_2$, with an amount of emissions in 2009 equal to some 70 % of 5B1 (despite their similar share of the areas). Total annual emissions in 2009 were 25 % and respectively 11 % less than in previous year and 1990, respectively (Table 7.30).

**Table 7.30** **5C1 Grassland remaining Grassland: MS' contributions to net $CO_2$ emissions**

| Member State | Net $CO_2$ emissions (Gg) | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$) | (%) | (Gg $CO_2$) | (%) | | |
| Austria | -96 | -87 | -87 | -0.8% | 0 | 0% | 9 | -9% | T2 | CS |
| Belgium | 658 | 400 | 400 | 3.8% | 0 | 0% | -258 | -39% | CS,T2 | CS |
| Denmark | 296 | 133 | 132 | 1.3% | -1 | -1% | -164 | -55% | T2 | CS,D |
| Finland | 319 | 525 | 509 | 4.9% | -16 | -3% | 190 | 60% | T1 | D |
| France | IE,NO | IE,NO | IE,NO | - | - | - | - | - | CS,T2 | CS |
| Germany | 10,133 | 10,356 | 12,356 | 118.5% | 2,001 | 19% | 2,224 | 22% | D,CS,T2 | CS |
| Greece | NO | NO | NO | - | - | - | - | - | T1 | NA |
| Ireland | 622 | 494 | 535 | 5.1% | 41 | 8% | -87 | -14% | T1 | D |
| Italy | -3,954 | -6,909 | -6,730 | -64.5% | 179 | -3% | -2,776 | 70% | T1 | D,CS |
| Luxembourg | IE,NO | IE,NO | IE,NO | - | - | - | - | - | NA | NA |
| Netherlands | 4,246 | 4,246 | 4,246 | 40.7% | 0 | 0% | 0 | 0% | CS,T2 | CS |
| Portugal | -198 | -829 | -840 | - | - | - | - | - | T2 | CS,D |
| Spain | NE,NO | NE,NO | NE,NO | - | - | - | - | - | NA | NA |
| Sweden | -920 | -293 | -466 | -4.5% | -173 | 59% | 454 | -49% | T1,T3 | CS |
| United Kingdom | 647 | 286 | 371 | 3.6% | 85 | 30% | -276 | -43% | CS | CS |
| **EU-15** | **11,753** | **8,321** | **10,427** | **100.0%** | **2,107** | **25%** | **-1,325** | **-11%** | | |

The largest contributor at EU-15 level is Germany (which reports a source) and Italy (which reports a sink). Several MS report NO (i.e. France reports no change in all pools according to Tier 2 methodology, after measurements and country specific data, while several MS report no change under Tier 1 for biomass (see Table 7.6). The C stock change in mineral soils on grassland is reported as not estimated by some half of the MS (e.g. Spain). Few MS report the existence of unmanaged grassland (e.g. Ireland, France).

### 7.4.2.2 Methodological issues for Grassland remaining grassland

The definition of grassland is not always reported in the NIRs, but available descriptions show good match with the IPCC definition, despite different management approaches across the EU (Table 7-31).

**Table 7-31** **Definition and description of grassland (na– definition/description is not available in NIR 2011)**

| Member State | Definition/description |
|---|---|
| Austria | Meadows cut once/twice/several times, cultivated pastures, litter meadows, rough pastures, alpine meadows and pastures and abandoned grassland. |
| Denmark | Contains grassland defined according grazing land under LPIS, heath land which may or may not be used for sheep grazing, as well as all other areas not meeting the definitions of forest land. The area of grassland is divided in "grazing land" and "other grassland". |
| Finland | Grassland includes area of grass cover (for more than 5 years), ditches associated with agricultural land and abandoned arable land. Abandoned arable land in this context means fields which are not used any more for agricultural production and where natural reforestation is possible or is already going on. |
| France | Natural grasslands are not included in the reporting, if not improved as to have production under a specific threshold. |
| Germany | Meadow and pasture areas that cannot be considered cropland. In addition, it includes land that is covered with trees and shrubs but that does not fall within the definition of "forest", as well as natural grassland and recreational areas. |
| Greece | Rangeland and pasture with vegetation that falls below the threshold of national forest definition and are not expected to exceed that without human intervention. Pastures that have been fertilized or sown are considered as cropland. |
| Ireland | Improved grassland (pasture and areas used for the harvesting of hay and silage) and unimproved grassland (rough grazing) in use as recorded by annual statistics. |

| | |
|---|---|
| Italy | Grazing lands, forage crops, permanent pastures, and set-aside lands since 1970, all shrub lands (data derived from NFI). It also includes other wood lands that don't fulfill forest definition. |
| The Nether-lands | Rangeland and pasture land is the land that is not considered croplands. It also includes all orchards (with standard fruit trees, dwarf varieties or shrubs) and the vegetation that falls below the threshold used in the forest land category and are not expected to exceed, without human intervention, the threshold used in the forest land category. The category includes: "Grasslands" - areas predominantly covered by grass vegetation (whether natural, recreational or cultivated) and "Nature" - natural areas (excluding grassland) consisting in heath land, peat moors and other nature areas, with many of them having occasional tree as part of the typical vegetation structure. |
| Portugal | Pastures. |
| Spain | Pasture land, including grazing land not included in cropland. It includes also pastures and meadows in the dehesa (forested pasture) that do not comply with the definition of forest. |
| Sweden | Agricultural land that is not regularly tilled. All grasslands are assumed managed. |
| United Kingdom | Area with broad well defined habitats: improved grassland, natural grassland, calcareous grassland, acid grassland, bracken, dwarf shrub heath, fen/marsh/swamp, bogs and mountains. |
| | Belgium, Luxembourg - na |

Quite often, grassland may not be clearly separated from cropland and/or wetlands, especially on land under conversion (e.g., in France and UK where a rolling conversion from and to cropland and grassland is reported up to 70 – 100 % of the total 5C area). The ability of the national GHG estimating systems to accurately assess the status of the land varies from one MS to another. The methods used by the MS to estimate the emissions related to grassland remaining grassland and conversions to grassland are described under the following subchapters. Lower tiers data are used for reporting emissions and removals for this land use category (Table 7.32).

**Table 7.32** **Background information from MS on C stock change estimation sources of data and methodologies in the subcategory 5C1**

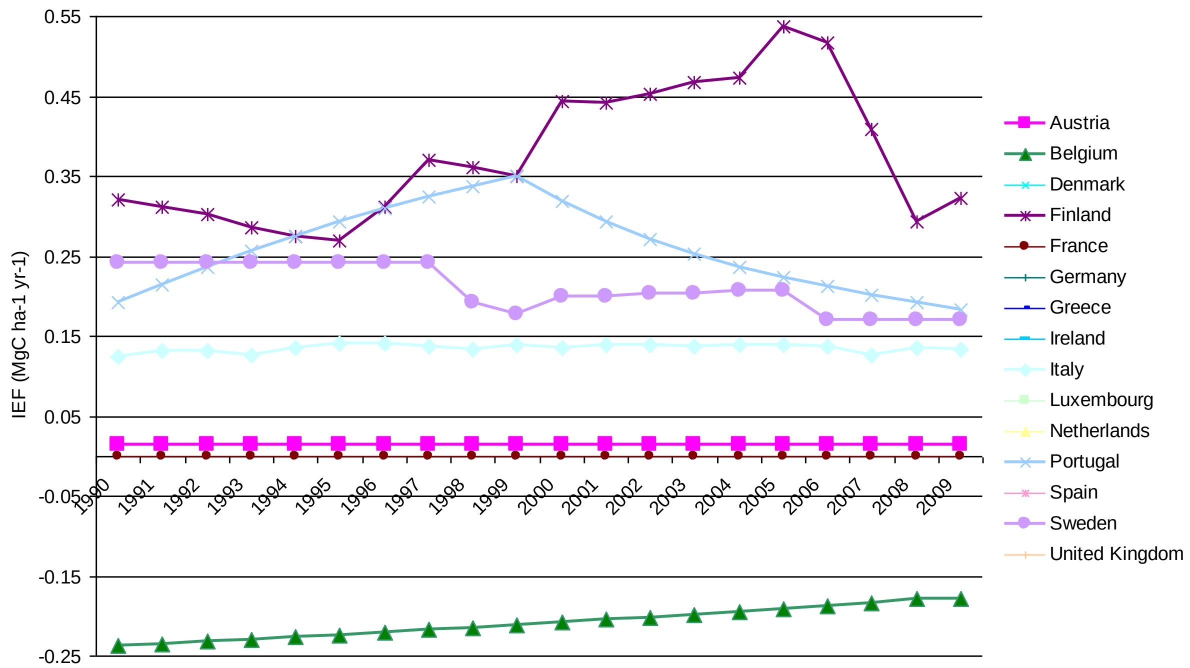
| Member State | Description |
|---|---|
| Austria | Activity data is compiled from Statistic Austria (based on IACS). Biomass is neutral. SOC is estimated based on national reference C stock and C stock change factors. Emission from organic soils was estimated based on area from soil inventories and Austrian Soil Information System and the IPCC default emission factors. |
| Belgium | Activity data is derived based on landscape units distribution generated by the topological intersection of Corine Land Cover (CLC1990) geo-dataset and digitized Soil Association map of Tavernier et al. (1972). Biomass is not estimated yet. SOC change is estimated based on a number of heterogeneous databases and modeling efforts. |
| Denmark | Grassland area is obtained by LPIS, with potential area reported under cropland. SOC is reported based on country specific data. |
| Finland | The area estimate of grasslands was derived from national statistics (Farm statistics for cropland area) and NFI data. C stock change in the biomass is not yet estimated. IPCC default soil C stocks for high activity and sandy grassland soils for wet temperate climate were used together with the default carbon stock change factors. For organic soils, both activity data and emission factor are country specific. |
| France | Matrix of explicit land use and land use changes, classifying managed and unmanaged grasslands (with natural grassland not counted under GHG inventory). For biomass, the C stock change is estimated only for woody biomass, with tree data delivered by NFI. All other pools are considered in equilibrium. |
| Germany | Integrated unitary system for land and land conversion classification, mapping and ranking in time (see Forestland). The approach allows for estimating the area of organic soils and their land use. Biomass C stock change is estimated based on country specific datasets. SOC stock change is considered based on national datasets and research. |
| Greece | The area is provided by agricultural statistics. No change in biomass. Aboveground grass and tree biomass are only considered for estimating emissions in case of wildfires. DOM and SOC are assumed to be neutral. |
| United Kingdom | Non-spatially-explicit land use land use data is provided from countries statistics. A dynamic model of carbon stock change is used with the land use change matrices to estimate soil C stock changes due to land use change. |

| | |
|---|---|
| Ireland | An approach 1 is available with the Central Statistic Office's statistics. The IPCC soil types on land use categories are derived by GIS LPIS analysis of superimposition of CLC 1990 with General Soil Association Map of Ireland (with peat areas entirely classified under wetlands). No biomass C stock change assumed under static management practices. For SOC, the IPCC default values are used to establish the reference C stocks, and they are corrected for by using $F_{LU}$, $F_{MG}$ and $F_I$ default factors to account for land use and farming practices. On organic soils, emissions are estimated using with the IPCC default factor. |
| Italy | A time series of national land use statistics is available (same procedure for all LU, see under 5A1 activity data). Grassland includes two categories: 1) Grazing land and Other wooded land. For Grazing land a Tier 1 methodology is been used, therefore, no change in carbon stocks in the biomass, SOC and DOM pools is assumed, and 2) Other wooded land (i.e. shrub lands) C stock changes in biomass is modeled and in litter pool estimated by linear relation against aboveground carbon. |
| The Netherlands | The activity data is derived from land use matrix and soil maps. C stock change in biomass is not estimated. Carbon content is based on the soil map of the Netherlands in combination with a national random check of map units that provides detailed descriptions of soil profiles. Country specific method is used to estimate emissions from the drainage of organic soils. |
| Portugal | Area data is given by Corine Land Cover maps (1990, 2006), NFI and Agricultural statistics, involving linear interpolations and extrapolations to obtain full time series of land use remaining in the same category. SOC data is country specific. |
| Spain | The activity data is obtained from CLC 1990 and 2000, and Forest Maps of Spain. All pools are considered neutral. |
| Sweden | All data is provided by the NFI. On organic soils country specific annual heterotrophic respiration is available. |

The estimation of emissions covers mainly soils; while biomass data is poorly reported (with only 4 MS reporting it). In general grassland biomass is an average sink of 0.05 Mg Mg C ha-1 yr-1. Denmark reports it as source. Sweden reports the average C stock change factor of 0.2 Mg C ha-1 yr-1 based on field inventory, while Italy of 0.03 Mg Mg C ha-1 yr-1.

Mineral soils C stock change is reported by six MS. On average, SOC is a sink of +0.09 Mg C ha-1 yr-1. Only Belgium reports it as a source (Figure 7-12).

**Figure 7-12 C stock change factors for SOC in mineral soils in 5C1**



### 7.4.3 Land converted to grassland (CRF 5C2)

#### 7.4.3.1 Overview of Land converted to grassland

The area of land converted to grassland represents some 20 % in the EU-15 of total reported grassland area, and it decreased 15 % compared to 1990 (

Table 7.33). From total conversions to grassland, 84 % was from cropland and 8 % from forestland. The highest share of cropland converted to grassland was reported by UK (58 % of total land converted in EU-15) and 34 % by France.

**Table 7.33** **Trend of activity data in the "land converted to grassland" subcategory 5C2 in EU-15's MS (kha, 1990-2009)**

| Member State | Year | | | | | Difference 2009 to 1990 |
|---|---|---|---|---|---|---|
| | 1990 | 1995 | 2000 | 2005 | 2009 | |
| Austria | 117 | 114 | 89 | 76 | 77 | -34% |
| Belgium | NO | 18 | 35 | 53 | 65 | na |
| Denmark | 3 | 17 | 32 | 46 | 56 | 1664% |
| Finland | 115 | 106 | 98 | 64 | 62 | -46% |
| France | 4,590 | 4,605 | 4,285 | 3,800 | 3,378 | -26% |
| Germany | 157 | 157 | 157 | 157 | 65 | -59% |
| Greece | 0 | 33 | 73 | 111 | 179 | na |
| Ireland | 26 | 165 | 163 | 131 | 125 | 374% |
| Italy | NO | NO | 103 | 111 | 189 | na |
| Luxembourg | 16 | 16 | 16 | 15 | 14 | -14% |
| The Netherlands | 16 | 16 | 16 | 16 | 16 | 0% |
| Portugal | 561 | 748 | 838 | 734 | 652 | 16% |
| Spain | 6 | 37 | 67 | 98 | 122 | 1900% |
| Sweden | 26 | 41 | 64 | 81 | 83 | 213% |
| United Kingdom | 3,233 | 3,674 | 4,134 | 4,667 | 5,095 | 58% |
| EU-15 | 8,867 | 9,746 | 10,170 | 10,159 | 10,177 | 15% |

In contrast to 5C1, 5C2 is a small sink of about 30,000 Gg$CO_2$ in 2009. The sink decreased by 38 % compared to 1990 and 8 % compared to 2008. The highest removals are reported by Italy, United Kingdom and France (Table 7.34). In time Germany turned to a small sink, but many MS relatively halved their removal in comparison to 1990.

**Table 7.34** **5C2 Land converted to Grassland: MS' contributions to the net $CO_2$ emissions**

| Member State | Net $CO_2$ emissions (Gg) | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$) | (%) | (Gg $CO_2$) | (%) | | |
| Austria | 557 | 315 | 288 | -1.0% | -27 | -9% | -269 | -48% | T2 | CS |
| Belgium | NO | -286 | -296 | 1.0% | -9 | 3% | -296 | - | T1,CS | CS |
| Denmark | 178 | 64 | 67 | -0.2% | 2 | 4% | -111 | -62% | T2 | CS,D |
| Finland | 250 | -19 | -11 | 0.0% | 8 | -43% | -260 | -104% | CS,T1,T3 | CS,D |
| France | -10,230 | -5,708 | -6,249 | 20.7% | -541 | 9% | 3,981 | -39% | CS,T2 | CS |
| Germany | -5,433 | -4,384 | -1,636 | 5.4% | 2,749 | -63% | 3,798 | -70% | D,CS,T2 | CS |
| Greece | 0 | 0 | NO | - | - | - | - | - | T2 | CS |
| Ireland | -128 | -204 | -309 | 1.0% | -105 | 51% | -181 | 142% | T2 | D |
| Italy | NO | -13,482 | -12,788 | 42.4% | 693 | - | -12,788 | - | T1 | D,CS |
| Luxembourg | 32 | 25 | 27 | -0.1% | 2 | 9% | -5 | -15% | T1 | CS,D |
| Netherlands | 394 | 548 | 556 | -1.8% | 8 | 1% | 162 | 41% | T2 | CS |
| Portugal | -288 | 208 | 247 | -0.8% | 40 | 19% | 535 | -186% | D | D,CS |
| Spain | -47 | -888 | -934 | 3.1% | -47 | 5% | -887 | 1898% | T2 | D,CS |
| Sweden | -188 | -137 | -107 | 0.4% | 30 | -22% | 81 | -43% | T2,T3 | CS |
| United Kingdom | -6,907 | -8,922 | -9,021 | 29.9% | -99 | 1% | -2,113 | 31% | D | CS |
| **EU-15** | **-21,810** | **-32,869** | **-30,164** | **100.0%** | **2,705** | **-8%** | **-8,354** | **38%** | | |

### 7.4.3.2 Methodological issues for Land converted to grassland

The methods for estimating the stock changes and emissions of $CO_2$ from these land categories are summarized in Table 7.35.

**Table 7.35 Background information from the MS on C stock change estimation sources of data and methodologies in subcategory 5C2**

| Member State | Description |
|---|---|
| Austria | The area is available based on IACS database. For both biomass and mineral soils, the annual change is estimated under Tier 2 as a difference between the country's specific soil C stock reference before and after the conversion, then linearly distributed over a 20-year transition period (only 10 years in case of conversion from croplands) |
| Belgium | Only conversion from FL is estimated based on average living biomass carbon stock for forest. SOC is computed based on regional reference C stock in soils |
| Denmark | Area converted from various land use is based on remote sensing data in 1990 and 2005, combined with data in LPIS. |
| Finland | Data on land conversions is available with successive NFI cycles, with conversions from forestland estimated with a model for all pools. Estimation of emissions from conversion of non-forest land to grassland involves IPCC default data. |
| France | Explicit land use and land use change identification. Biomass and DOM change are only considered in conversion from forestland. For SOC, reference C stocks are established for the main land use types. |
| Germany | GIS digitized maps, within integrated "wall-to-wall" approach covers entire land including conversions. A computation procedure derives C stock changes for relevant pools. |
| Greece | No changes in biomass are assumed as they originate in croplands. Soil emissions are estimated based on a Tier 1 methodology with IPCC default C stock change factors and C stock reference in mineral soils. |
| United Kingdom | Land use data is provided from statistics, broken down on geographical regions. Changes in biomass and soil carbon due to land use change depends on a matrix of change based on repeated land surveys, linked to a dynamic model of carbon stock change and a database of soil carbon density for the UK. |
| Ireland | GIS analysis of CLC 1990 superimposed on the General Soil Association Map of Ireland. A Tier 1 methodology is used for estimation of change in biomass carbon stock. Also, Tier 1 is used for C stock change in mineral soils. Reference C stocks are established for each soil type, then harmonized with IPCC default types, to which adjusted IPCC default factors $F_{LU}$, $F_{MG}$ and $F_I$ are applied to account for land use and farming practice. On organic soils, the Tier 1 assumption is used and emissions are estimated with IPCC default factors. |
| Italy | A time series of national land use statistics is available. Tier 1 is used, therefore, no change in carbon stocks in the biomass pool is assumed. No change in DOM is assumed. SOC change is assumed to occur in 1 year applied to reference C stocks for on land use categories. |
| The Netherlands | Activity data is derived from land use matrix and soil maps. Land converted to grassland includes all deforestations. Country specific method is used to estimate $CO_2$ emissions from soils that result from changes in land use. |
| Portugal | Conversion area data is given by CLC 1990 and 2006, NFI and agricultural statistics. SOC factors and references are country specific. |
| Spain | The activity data is obtained from CLC90, CLC00, CLC 06 and NFI data for conversions from forestland. C stock changes in biomass are estimated as not occurring (as there are only croplands conversions to grasslands). SOC change is estimated based on country specific soil C stock reference. |
| Sweden | The activity data and biomass data in conversion from forest are provided by NFI. For mineral soils, a C loss factor is computed from the C amount and the soil's fine earth content for soil layers. For organic soils C stock change is based on annual dead organic matter production from NFI and country specific annual heterotrophic respiration. |

On lands converted to grassland, the highest C stock change reported is related to the biomass on grassland converted from forestland.

At the EU-15 level, the overall IEF for net C stock change in biomass averages 0.95, with a range between -7.5 by Netherlands and 0.4 Mg C ha-1 yr-1 by Sweden. The IEF for C stock change in DOM vary between -0.01 and -2.31MgC ha-1 yr-1.

The annual change in SOC varies between 0.73-2.09 Mg C ha-1 yr-1, with exceptional values of some over 7 Mg C ha-1 yr-1 reported by Germany and 21 by Italy as far as entire associated built C stock is reported in the year of the conversion (with a justification provided in the NIR 2011).

## 7.5 Wetlands, Settlements and Other land

### 7.5.1 Wetlands (CRF 5D)

In the EU-15, the Wetlands (5D) area in 2009 was 5 % of total EU-15 land, 17,000 kha, with 6,300 kha in Sweden and Finland and, France and Germany around 800 kha each. The land included under this category has different definitions among MS (Table 7.36). There is no reported any flooded land in Europe (still Greece, Netherlands, Sweden report such area as NE), but France reports $CO_2$ and $CH_4$ emissions from such flooded area under 5G Other (CRF table 5).

**Table 7.36 Definitions and descriptions of land included by MS under the category 5D Wetlands**

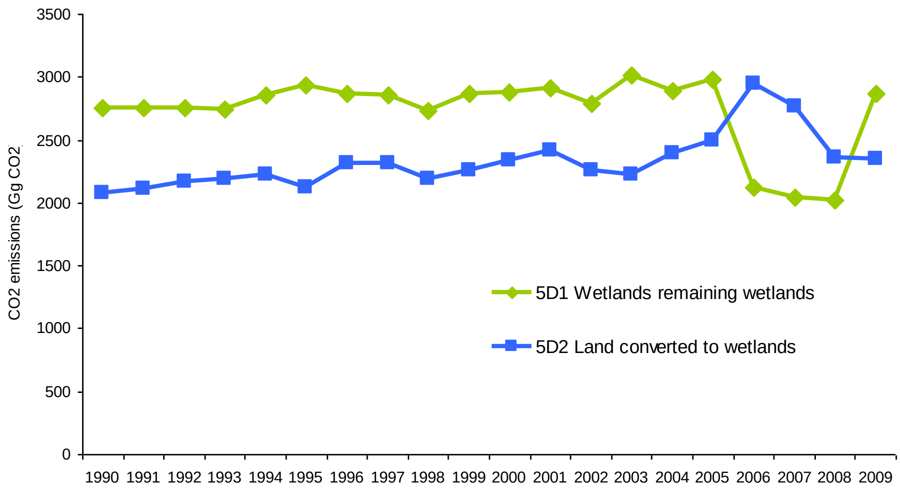
| Member State | Definition and supplementary elements for land classification |
|---|---|
| Austria | Rivers, lakes, mires and peat areas (protected areas, in general) as classified by national statistical system. |
| Belgium | Land covered or saturated by water for all or part of the year (e.g. peatland) and that does not fall into the other land category. It includes reservoirs as a managed subdivision and natural rivers and lakes as unmanaged subdivisions. |
| Denmark | Permanent wetlands, wetlands for peat extraction and re-established anthropogenic wetlands. Several subdivisions may be distinguished: unmanaged fully water covered wetlands (lakes and rivers); unmanaged partly water covered wetlands (fens and bogs); managed drained land for peat extraction; managed partly water covered wetlands (re-established wetlands on primarily former cropland and grassland). |
| Finland | Inland waters (reservoirs, natural lakes and rivers), as well as peat extraction areas and peatlands which do not fulfill the definition of other land uses. |
| Germany | Reporting in the wetlands category primarily covers emissions from organic soils that are released during peat extraction. Reporting has to cover $CO_2$ losses from extraction areas, and during extraction, as well as emissions resulting from spreading of peat. Also, it includes (but they are not reported) the few non-drained semi-natural bogs that have been largely free of anthropogenic impacts, flooded lands, water-storage facilities (dams, reservoirs, etc.) and settling basins that are used for energy production, irrigation, shipping and recreation, and that are flooded or drained, or that otherwise have large water-level fluctuations. |
| Greece | Land that is covered or saturated by water for all or the greatest part of the year (e.g. lakes, reservoirs, marshes), as well as river bed (including torrent beds) and that does not fall into the forest land, cropland, grassland or settlements categories. |
| France | Lands covered or saturated by water all year long or part of it. |
| Ireland | Natural unexploited wetlands. Wetland areas commercially exploited for public and private extraction of peat and areas used for domestic harvesting of peat. |
| Italy | Lands covered or saturated by water, for all or part of the year, harmonized with the definitions of the Ramsar Convention on Wetlands. |
| The Netherland | Land covered or saturated with water for all or part of the year and does not fall into the other land category. It includes reservoirs as a managed sub-division and natural lakes and rivers as unmanaged. |
| Portugal | Inland wetlands, costal wetlands, slat marshes, saline and intertidal flats. |
| Spain | Includes the lands covered or saturated by water all year long or part of it. |
| Sweden | Wetlands is assumed unmanaged (mires and areas saturated by fresh water) and managed (cca 10 000 ha used for peat extraction). |
| UK | Includes sites currently registered for commercial extraction where extraction activity is visible on recent aerial/ satellite photographs or by field visits. |

Under improving reporting system some countries still work on reclassification of national land (e.g Sweden reports 500 kha less in the year 2009 than in 2008). From total wetland area in the EU-15, the annual conversion to wetlands (5D2) represented only 4.4%, with absolute area of wetlands under conversion of roughly 700 kha in 2009 (24 % less than in previous year). This category is often subject to conversions to natural water regime and wetlands, in general established in areas of organic soils on grasslands. In 2009 the highest share of land under conversion is reported from Forestland and Other land category (each by 27%). Area of conversion to wetlands doubled since 1990, with the highest contribution of Sweden (area increased by 10 times since 1990).

Permanent wetlands are considered neutral (e.g. France, Portugal and Sweden). Germany reports under these category emissions from organic soils that are released during peat extraction and *nota bene* "Wetlands" was determined as key source in Germany's GHG inventory. UK does not report wetland as areas which might be included are consistently reported under Grassland or Other land, depending on the habitat type. In Ireland, peat areas are entirely classified under wetlands.

Overall, the $CO_2$ emission from wetlands has increased by 7% since 1990 (Figure 7.13). Only few MS report emissions on "remaining" areas (e.g. Germany and Finland only from soils; Ireland from biomass and soils). Trend changes annual emissions in both 5D1 and 5D2 over 2006-2009 are mainly due to Germany that reports different emission factors in living biomass.

**Figure 7.13 Emissions from Wetlands remaining wetlands (5D1) and Lands converted to wetlands (5D2)**




In Denmark, an equivalent of 0.5 t C/ha stock change (i.e. decrease) is considered for conversions to wetlands. To compute emissions from peatland extraction Denmark reports the use of a peat density factor of 200 kg per m3, a dry matter content of 0.5, an ash content of 0.02 and a C-content of 0.58 kg C per kg organic matter. In general, in case of land use change to water bodies, all MS use final reference carbon stock of 0 Mg C/ha, so all C from the previous land use is considered emissions.

Emissions of $CH_4$ and $N_2O$ from peat extraction activities (i.e. Finland, Denmark) are reported under Table 5(II), and these include emissions from active and temporarily set-aside peat extraction fields and abandoned non-vegetated peat extraction areas.

### 7.5.2 Settlements (CRF 5E)

In EU-15, the total reported Settlements (5E) area in 2009 is 19,800 kha. The lands included under this category have particular definitions across EU-15 MS (Table 7.37). All countries report increasing 5E areas between 5 % of UK and 49 % of Spain, compared to 1990. The area of land under conversion to settlements (5E2) is quite significant, being nearly 20% ot total settlements area. For the lands under conversion, the highest share was reported as under conversion form grassland (53%), cropland (30%) and forestland (16%).

**Table 7.37 Definitions and descriptions of land included by MS under the category 5E Settlements**

| Member State | Definition and supplementary elements for land classification |
| --- | --- |
| Austria | Includes buildings land: sealed, partly sealed and unsealed areas; parks and gardens; roads and railway tracks; excavation areas, and other not further differentiated settlement area. |

| | |
|---|---|
| Belgium | All developed land, including transportation infrastructure and human settlements of any size (i.e. including road sides) unless they are already included under other categories. |
| Denmark | Urban cores, industrial areas, roads, high build-up areas and low buildup areas. Low build-up areas are characterized as single-family houses surrounded by gardens, graveyards, sports facilities, etc (C is reported only for low build-up areas). |
| Finland | The combined area of NFI built-up land, traffic lines and power lines. Also parks, yards, farm roads and barns are included. Only the areas of settlements remaining settlements and lands converted to settlements are reported. |
| France | Corresponds to the artificialised land (settlements, parks, roads and infrastructure, etc.). |
| Germany | Open settlement and transport areas. |
| Greece | All developed land, including transportation infrastructure and human settlements of any size, unless they are already included under other land-use categories. |
| Ireland | Urban areas, roads, airports and the footprint of industrial commercial/institutional and residential buildings. |
| Italy | All artificial surfaces, transportation infrastructures (urban and rural), power lines and human settlements of any size, comprising also parks, have been included in this category. |
| The Netherlands | Urban areas and transportation infrastructure, and built-up areas. |
| Portugal | Artificial areas such as urban, industrial, commerce and transport units, mines, dump and construction sites and artificial non-agricultural vegetated areas. |
| Spain | All developed land, transport infrastructure and establishments of any size, unless they are included in other categories. |
| Sweden | Infrastructure such as roads and railways, power lines, municipality areas, gardens and gravel pits. |
| UK | Covers urban and rural settlements, farm buildings, caravan parks and other man-made built structures such as industrial estates, retail parks, waste and derelict ground, urban parkland and urban transport infrastructure. It also includes domestic gardens and allotments, linearly arranged landscape features such as hedgerows, walls, stone and earth banks, grass strips and dry ditches. |

There are not emissions reported with "remaining" areas, but under conversions to settlements (5E2) which have increased by 25% since 1990 (Table 7.38).

**Table 7.38 5E2 Land converted to Settlements: MS' contributions to the net $CO_2$ emissions**

| Member State | Net $CO_2$ emissions (Gg) | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$) | (%) | (Gg $CO_2$) | (%) | | |
| Austria | 320 | 203 | 202 | 1.1% | -1 | -1% | -118 | -37% | T2 | CS |
| Belgium | NO | 55 | 55 | 0.3% | 0 | 0% | 55 | - | T1,CS | CS |
| Denmark | 90 | 54 | 55 | 0.3% | 0 | 1% | -35 | -39% | T2 | D |
| Finland | IE,NE | IE,NE | IE,NE | - | - | - | - | - | NA | NA |
| France | 2,338 | 3,899 | 3,713 | 19.4% | -186 | -5% | 1,376 | 59% | CS,T2 | CS |
| Germany | 547 | 154 | 395 | 2.1% | 241 | 157% | -152 | -28% | D,CS,T2 | CS |
| Greece | 2 | 1 | NE,NO | - | - | - | - | - | T2 | CS |
| Ireland | 9 | 34 | 21 | 0.1% | -12 | -37% | 12 | 134% | T1,T2 | CS,D |
| Italy | 2,526 | 3,460 | 3,516 | 18.4% | 56 | 2% | 989 | 39% | T1 | D,CS |
| Luxembourg | 139 | 110 | 109 | 0.6% | -1 | -1% | -30 | -21% | T1 | CS,D |
| Netherlands | 212 | 296 | 300 | 1.6% | 4 | 1% | 88 | 41% | T2 | CS |
| Portugal | 536 | 1,336 | 1,351 | 7.1% | 15 | 1% | 815 | 152% | D | D,CS |
| Spain | 490 | 551 | 554 | 2.9% | 3 | 1% | 64 | 13% | T1 | D,CS |
| Sweden | 1,212 | 2,931 | 2,856 | 14.9% | -76 | -3% | 1,644 | 136% | T2,T3 | CS |
| United Kingdom | 6,937 | 6,069 | 6,023 | 31.5% | -46 | -1% | -914 | -13% | CS,T3 | CS |
| **EU-15** | **15,359** | **19,152** | **19,150** | **100.0%** | **-2** | **0%** | **3,791** | **25%** | | |

For the EU-15, the emissions from Settlements are difficult to be captured with reasonable certainty level, mainly under lack of data. Conversions to settlements are better reported, but in many cases for conversion from forestland the pools for which reporting is not mandatory were omitted by some MS because methods are not available the IPCC LULUCF GPG (2003). On average, conversion from forest land is associated with emissions from all pools, and the same applies to grassland conversions at emissions rates mentioned for conversions to other land uses (e.g. depends a lot if trees are removed or not). In lands under conversions to settlements, a detailed study in Austria showed an annual increase of the stocks of all vegetation strata (including ground vegetation) of 2.08, with woody biomass annual increase of 0.58 Mg C ha-1 yr-1. Other pools are not reported as there are no IPCC methods available for that.

### *7.5.3 Other land (CRF 5F)*

The area of category Other land (5F) covers at EU-15 level 23,200 kha in 2009. The land included under this category has particular definitions from MS to another (Table 7.39). The largest share of "Other land" is reported by Spain (11,300 kha), Sweden (4,600 kha), and UK (1,900 kha).

**Table 7.39 Definition and characteristics/descriptions of lands categorized by EU-15 MS under category 5F Other land**

| Member State | Definition and supplementary elements for land classification |
|---|---|
| Austria | Area with i) rocks and screes, ii) glaciers and iii) unmanaged alpine dwarf shrub heaths. This data is calculated as the difference of total country area and all other land uses, showing max 2 % difference by relevant cadastral data. |
| Belgium | Bare soil, rock, ice, and all unmanaged land areas that do not fall into any of the other five categories. |
| Denmark | Unmanaged area like moors, fens, beaches, sand dunes, lakes and other areas without human interference. |
| Finland | Mineral soils on poorly productive forest land, which do not fulfill the threshold values for forest, unproductive lands on mineral soils on rocky lands and treeless mountain areas. |
| France | All lands that do not correspond to any other land use categories (e.g.. rock areas). |
| Germany | Waste and swaths/aisles, glacier areas, scree slopes and sand bars and other land which can not be allocated under other land categories. "Other land" consists of areas that are neither influenced nor cultivated by people. |
| Greece | All land areas that do not fall into any of other land-use categories (e.g. rocky areas, bare soil, mine and quarry land). |
| The Netherlands | Surfaces of bare soil which are not included in any other category like: bare sands and the earliest stages of succession from sand in the coastal areas (beaches, dunes and sandy roads) or uncultivated land alongside rivers. It does not include bare areas that emerge from shrinking and expanding water surfaces (which are included in wetlands). |
| Ireland | Natural grasslands not in use for agricultural purposes. Water bodies, bare rocks. |
| Italy | Definition is not available in NIR 2011. |
| Portugal | Beaches, dunes, sand plains and bare rocks and shrubland. |
| Spain | Bare soil, rock areas, ice and other areas of land that do not fall into any of the other land category. |
| Sweden | Waste land and most of the mountain area in northwest Sweden. All Other land is assumed unmanaged. |
| UK | Inland rock, standing water and canals and rivers and streams. |

Other land category is sometimes used also to report unmanaged land areas (e.g. unmanaged grassland in Ireland, France and Spain). There are no reported emissions on 5F1 land category, but only in case of conversions to "Other land". For conversion from forestland, in many cases, the pools for which reporting is not mandatory were omitted by some MS because methods are not available the IPCC LULUCF GPG (2003). Emissions from 5F2 have been relatively steady since 1990 around 1000-2000 Gg $CO_2$eq., although it should be noted that the uncertainties are likely to be very high.

## 7.6 Emissions from organic soils in EU-15

At EU-15 level, organic soils cover over 14,000 kha, located especially in Northern MS. Compared to 1990 total organic soils area was 2 % higher in 2009, under likely reclassification or updating (mainly by Sweden which reported in 2009 a 4 % larger area than in 1990). A major issue is that organic soils emissions represents 24 % of total EU-15 net removal in 2009 or some 14% of the all GHG fluxes involved in LULUCF (as absolute value).

The highest area of organic soils is in Finland (~ 6,300 kha), Sweden (~ 5,000 kha), Germany (1,500 kha) and the UK (400 kha). Definitions of organic soils are not always transparently reported in the NIRs 2011 (Table 7-40), so presumably the other MS follow the IPCC GPG LULUCF 2003'FAO based definition.

**Table 7-40 Definitions and elements for defining organic soils, according to NIRs 2011**

| Member State | Definition and supplementary elements for organic soils area classification |
|---|---|
| Austria | Sites with soil having more than 17% content of organic carbon. |
| Denmark | 20 % organic matter with a soil depth of minimum 30 cm. Wet organic soils are also defined as having a water table within 0-30 cm below the surface and thus not suitable for driving with agricultural machineries. |
| Finland | More than 20% organic matter in the top 20 cm layer. Thus, both mull soils and peat soils are included. Organic soils area are considered as "peatland" if the organic layer is peat or if more than 75% of the ground vegetation consists of peatland vegetation. |
| Ireland | Peat soils are organic soils with a depth greater that 30 cm and peaty/mineral soils are a continuum between the peat and mineral categories. |
| Belgium, France, Germany, Greece, The Netherlands, Italy, Portugal, Spain, Sweden, UK - na – information on specific country parameters is not available in NIR 2011 (very often under lack of importance of such source in the country). | |

Methodologies to determine the characteristics of organic soils differ across MS. In Finland, as the country with highest organic soils area, mineral and organic soils activity data were derived from NFI data and geo-referenced soil database across all land uses. In Germany areas with organic soils is determined via a geo-referencing procedure with overlaying of General soil map of Germany and cadastral data for each type of land use. In Sweden, data is also provided by NFI combined with Swedish Forest Soil Inventory. Emissions factors are derived based on continuous monitoring or modeling (country specific data reported by MS is provided on land sub-categories sub-chapters).

Overall, in the EU-15, most of organic soils area is under Forestland, but most of the emissions come from Cropland and Grassland (Table 7.41). In Sweden, drained area covers some 20 % (approx. 1M ha) out of a total area of about 4.5 Mha of histosols on Forestland, while area on drained histosols on Cropland was approx. 145 kha (in 2009). Furthermore, most of the organic soils area (97%) is in the category "remaining" in the same category, with small share under various conversions. Area reported under conversion to Cropland increased, while all others decreased.

The highest IEFs are associated with stable cropland, conversions to cropland and grasslands under intensive management interventions, while organic soils in forestlands show the lowest IEF values.

**Table 7.41** **Total emissions and implied carbon stock change factors in EU-15 (average over 1990-2009)**

| Land use subcategory | Area in 2009 (kha) | Change of organic soils area compared to 1990 (%) | IEF (MgC ha-1 yr-1) | Net annual C stock change (Gg C) | Change of CO2 annual emissions compared to 1990 (%) |
|---|---|---|---|---|---|
| 5A1 | 11096 | 4% | -0.43 | -4722 | -23% |
| 5A2 | 347 | -10% | -0.23 | -80 | -63% |
| 5B1 | 1244 | 1% | -7.35 | -9137 | 2% |
| 5B2 | 60 | 150% | -4.96 | -298 | 76% |
| 5C1 | 1309 | -6% | -3.87 | -5064 | -2% |
| 5C2 | 37 | -43% | -2.15 | -80 | -61% |
| **Total** | 14094 | 2% | | -19380 | -7% |

Emissions from organic soils are included under relevant land use categories by the MS, where there is more detailed discussions available on the IEF. Here we only present data for different land use categories averaged over entire time series 1990-2009. Overall, $CO_2$ emissions at the EU-15 level steady decreased by 7 % compared to 1990 (to -71000 Gg $CO_2$ in 2009). Drop is mainly explained by the change in the emission factors that are comparatively smaller in 2009: by some 40 % by Denmark and Finland on Forestland and 20 % by Finland and Denmark on cropland, while UK reports much smaller values for all land uses. For Ireland, Germany and Sweden are practically not changed.

In general in the EU-15 MS, there are still small quantitative inconsistency in reporting organic soils under 5B1&5B2 and Table 4Ds1 regarding organic soils area under cultivation.

## 7.7 Other emissions from land uses: Tables 5(I)-5(V)

### *7.7.1 Direct $N_2O$ emissions from N fertilization source (CRF Table 5(I))*

This source category covers direct nitrous oxide emissions from forest land fertilization. Majority of MS report there is no fertilization of forest land, with few including it in the emissions reported under the agricultural sector, using appropriate notation keys in the CRF tables (Table 7.42). Only Finland, Sweden and the UK report $N_2O$ emissions under this source category. Sweden actually reports the highest amount of $N_2O$ emissions from N based fertilization occasionally applied to increase the wood production in some middle aged or older stands on mineral soils.

Table 7.42 **Direct $N_2O$ emissions from N fertilization (Gg $N_2O$)**

| Member State | $N_2O$ emissions (Gg) | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | |
|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg) | (%) | (Gg) | (%) |
| Austria | NA,NO | NA,NO | NA,NO | - | - | - | - | - |
| Belgium | NA,NO | NA,NO | NA,NO | - | - | - | - | - |
| Denmark | IE,NA | IE,NA | IE,NA | - | - | - | - | - |
| Finland | 0.09 | 0.11 | 0.08 | 34.7% | 0 | -30% | 0 | -8% |
| France | NA,NO | NA,NO | NA,NO | - | - | - | - | - |
| Germany | NA,NO | NA,NO | NA,NO | - | - | - | - | - |
| Greece | NA,NO | NA,NO | NA,NO | - | - | - | - | - |
| Ireland | IE,NA | IE,NA | IE,NA | - | - | - | - | - |
| Italy | NA,NO | NA,NO | NA,NO | - | - | - | - | - |
| Luxembourg | NA,NO | NA,NO | NA,NO | - | - | - | - | - |
| Netherlands | NE,NO | NE,NO | NE,NO | - | - | - | - | - |
| Portugal | IE,NO | IE,NO | IE,NO | - | - | - | - | - |
| Spain | NO | NO | NO | - | - | - | - | - |
| Sweden | 0.19 | 0.16 | 0.15 | 63.9% | 0 | -7% | 0 | -21% |
| United Kingdom | 0.02 | 0.00 | 0.00 | 1.4% | 0 | -24% | 0 | -81% |
| **EU-15** | **0.29** | **0.28** | **0.23** | **100.0%** | **0** | **-17%** | **0** | **-20%** |

For all MS activity data results from national or sectoral statistics, either in terms of total amount and type of synthetic fertilizer annually applied (i.e. Finland, Sweden) or as a fixed application rate and total annually fertilized area (i.e. UK), with IPCC default emission factor for $N_2O$ emissions from N-inputs used in all cases. The IEF of the $N_2O$-N emissions per unit of fertilizer is roughly around 0.01 kg $N_2O$-N/kg N ha-1 yr-1.

On the whole, $N_2O$ emissions from this source show a further decrease by 17 % in 2009 compared to 2008 and 20% compared to 1990. Total EU-15 emissions from fertilization of forests soils in 2009 from this category is 0.28 Gg $N_2O$, knowing that some important share of such emissions is reported under Chapter 4 Agriculture.

### *7.7.2 $N_2O$ emissions from drainage of soils (CRF Table 5(II))*

This source category covers non–$CO_2$ GHG, respectively direct $N_2O$ and $CH_4$ emissions from drainage of soils ($CO_2$ emissions are reported under other land categories, usually under Wetlands, while indirect $N_2O$ emissions are reported under Chapter 4 Agriculture). Nevertheless, according to UNFCCC (decision 13/CP.9) and based on Appendixes 3a.2 and 3a.3 of the GPG LULUCF 2003, it is not mandatory for Parties to estimate emissions from this source. Accordingly, most countries do not report them considering them also negligible (NO or NE in Table 7.43). EU-15 drainage area reported by MS has increased by 6% compared to 1990, reaching 1,020 kha in 2009 (also reported with a transition period, likely 20 years). Out of total area under drainage, 84 % of total area occurs on forestland, while drainage of organic soils (including peatland) occurs on 65% of total area. Overall non-$CO_2$ emissions practically did not change in time summing up 0.5 Gg $N_2O$ (Table 7.43) and 1.7 Gg $CH_4$ in 2009 (Table 7.44), with insignificant changes for individual reporting countries.

**Table 7.43** **$N_2O$ emissions from drainage of soils (Gg)**

| Member State | $N_2O$ emissions (Gg) | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | |
|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg) | (%) | (Gg) | (%) |
| Austria | NA,NO | NA,NO | NA,NO | - | - | - | - | - |
| Belgium | NA,NO | NA,NO | NA,NO | - | - | - | - | - |
| Denmark | 0.0509 | 0.0399 | 0.0393 | 8.1% | 0 | -1% | -0.0117 | -14% |
| Finland | 0.19 | 0.25 | 0.24 | 49.4% | -0.0160 | -6% | 0.0510 | 10% |
| France | NA,NO | NA,NO | NA,NO | - | - | - | - | - |
| Germany | 0.14 | 0.14 | 0.14 | 29.8% | 0 | 0% | 0 | 3% |
| Greece | NE,NO | NE,NO | NE,NO | - | - | - | - | - |
| Ireland | 0.05 | 0.06 | 0.06 | 12.3% | 0 | -1% | 0 | 31% |
| Italy | NA,NO | NA,NO | NA,NO | - | - | - | - | - |
| Luxembourg | NA,NO | NA,NO | NA,NO | - | - | - | - | - |
| Netherlands | NE | NE | NE | - | - | - | - | - |
| Portugal | NO | NO | NO | - | - | - | - | - |
| Spain | NO | NO | NO | - | - | - | - | - |
| Sweden | NA,NE | NA,NE | NA,NE | - | - | - | - | - |
| United Kingdom | 0.01 | 0.00 | 0.00 | - | - | - | - | - |
| **EU-15** | **0.44** | **0.50** | **0.48** | **100.0%** | **0** | **-3%** | **0** | **11%** |

In Denmark and Ireland, $N_2O$ emissions from peatland are estimated based on the organic matter's C:N-ratio and default IPCC emission factor of 1.25%, while the activity data is provided by sectoral statistics. In Finland a Tier 2 methodology is used, with directly measured based CS emissions factors for $CO_2$, $N_2O$ and $CH_4$, while the activity data (annual area of extraction active peatlands, set aside peat lands, industrial stocks) are compiled from statistics.

**Table 7.44** **$CH_4$ emissions from drainage of soils (Gg)**

| Member State | $CH_4$ emissions (Gg) | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | |
|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg) | (%) | (Gg) | (%) |
| Austria | NA,NO | NA,NO | NA,NO | - | - | - | - | - |
| Belgium | NA,NO | NA,NO | NA,NO | - | - | - | - | - |
| Denmark | NA,NE,NO | NA,NE,NO | NA,NE,NO | - | - | - | - | - |
| Finland | 1.44 | 1.76 | 1.70 | 100.0% | -0.0620 | -4% | 0 | 26% |
| France | NA | NA | NA | - | - | - | - | - |
| Germany | NA,NE | NA,NE | NA,NE | - | - | - | - | - |
| Greece | NE,NO | NE,NO | NE,NO | - | - | - | - | - |
| Ireland | NA,NE | NA,NE | NA,NE | - | - | - | - | - |
| Italy | NA,NO | NA,NO | NA,NO | - | - | - | - | - |
| Luxembourg | NA,NO | NA,NO | NA,NO | - | - | - | - | - |
| Netherlands | NE | NE | NE | - | - | - | - | - |
| Portugal | NO | NO | NO | - | - | - | - | - |
| Spain | NO | NO | NO | - | - | - | - | - |
| Sweden | NA,NE | NA,NE | NA,NE | - | - | - | - | - |
| United Kingdom | NA,NE | NA,NE | NA,NE | - | - | - | - | - |
| **EU-15** | **1.44** | **1.76** | **1.70** | **100.0%** | **0** | **-4%** | **0** | **18%** |

IEF for $N_2O$ emission per area on drained land vary between 0.09 to 1.84 kg $N_2O$-N/ha/year in case of drainage of organic soils on wetlands (in Denmark, respectively Finland) and from 0.09 to 0.4 for mineral soils on deforested lands (by Denmark, respectively Germany). IEF for $CH_4$ emissions per drained area is reported some 21 kg $CH_4$/ha by Finland.

### 7.7.3 $N_2O$ emissions from disturbances associated with conversion to crop-land (CRF Table 5(III))

This source category covers direct $N_2O$ emissions from land area converted to cropland. Under intensive soil management on cropland, any conversion to cropland is likely associated with a temporary increase in the mineralization of organic matter followed by the drop of total C stock and the restructuration of the C content on the soil profile. At the EU-15 level, land reported under conversions to cropland steadily decreased over time by 13 % since 1990, to 9,305 kha (also reported for 20 years transition period). Most of these conversions occur in France, which reports large areas of conversion from Grassland to Cropland (some 3.5 mil ha in 2009, decreasing by 100 % since 1990) and from forestland (around 123 th ha). Notably, 99 % of areas under conversion occur on mineral soils across the EU-15. Belgium and The Netherlands reported it as NE, likely considered it as negligible in case of small area of transitions from forestland, but seems an incompleteness in case of transitions from grassland (both reports such higher areas). Overall, decreasing trend of $N_2O$ emissions from past years continues in 2009, with 12% less than in 2008 and 22% less than in 1990. Total EU-15 emissions reported in 2009 from this category is 8.3 Gg $N_2O$ (Table 7.45), with the highest contribution from France, United Kingdom and Germany.

**Table 7.45 $N_2O$ emissions from disturbances associated with land-use conversion to cropland (Gg)**

| Member State | $N_2O$ emissions (Gg) | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | |
|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg) | (%) | (Gg) | (%) |
| Austria | 0.14 | 0.16 | 0.16 | 1.9% | 0.00 | 2% | 0.02 | 13% |
| Belgium | NE | NE | NE | - | - | - | - | - |
| Denmark | 0.01 | 0.00 | 0.00 | 0.0% | 0.00 | 0% | -0.01 | -87% |
| Finland | 0.01 | 0.03 | 0.03 | 0.4% | 0.00 | 6% | 0.02 | 166% |
| France | 4.88 | 4.39 | 4.43 | 53.1% | 0.04 | 1% | -0.45 | -9% |
| Germany | 2.32 | 2.34 | 1.15 | 13.8% | -1.18 | -51% | -1.17 | -50% |
| Greece | NO | NO | NO | - | - | - | - | - |
| Ireland | NA,NO | 0.08 | 0.08 | 0.9% | 0.00 | 0% | 0.08 | - |
| Italy | 0.39 | NA,NO | NA,NO | - | - | - | - | - |
| Luxembourg | 0.01 | 0.01 | 0.01 | 0.1% | 0.00 | -1% | 0.00 | -9% |
| Netherlands | NE | NE | NE | - | - | - | - | - |
| Portugal | 0.28 | 0.18 | 0.18 | 2.1% | 0.00 | -3% | -0.10 | -36% |
| Spain | NO | NO | NO | - | - | - | - | - |
| Sweden | 0.07 | 0.25 | 0.27 | 3.2% | 0.02 | 7% | 0.20 | 279% |
| United Kingdom | 2.52 | 2.08 | 2.04 | - | - | - | - | - |
| **EU-15** | **10.63** | **9.51** | **8.34** | **100.0%** | **-1.16** | **-12%** | **-2.29** | **-22%** |

In general, the methodology corresponds to Tier 1, which allows the estimation based on: 1) annual emission of carbon due to soil mineralization (IPCC default), 2) C:N, the average ratio in the soil (CS or IPCC default); 3) the emitted proportion of $N_2O$ from N content (a constant of 1.25 % according the IPCC); 4) the ratio of 44/28 to convert N to $N_2O$; and 5) soil carbon stock (often IPCC default reference C stock) and 6) CS activity data (e.g. land conversion statistics). IEF $N_2O$-N emissions per area converted on both mineral and organic soils is reported around 20 kg $N_2O$-N/ha in Germany, 7.4 kg $N_2O$-N/ha by Denmark, while all other reporting MS's IEF of around 0.2-0.8 kg $N_2O$-N/ha. Such differences still need to be understood as MS rely on IPCC default method and data, with only C:N ratios generally derived from national datasets and this may not explain such significantly different IEFs (probably the transition period is not considered by Germany and Denmark which apparently report 1 year transition period or because mixing mineral and organic soils, with values are some 10 time higher on organic soils, but not fully transparent in the NIR).

### 7.7.4 $CO_2$ emissions from agricultural lime application (CRF Table 5(IV))

This source category covers direct $N_2O$ emissions from liming. Liming occurs especially in croplands (85% of applied amount, estimated based on activity data in NIRs 2011) and on permanent grassland (14%), while a very small amount is used on Forestland.

At the level of the EU-15, consumption of lime has decreased by almost 17% since 1990, with a total EU-15 of some 10.9 mn tons applied in 2009, with 83 % applied on cropland and the rest on grassland. Similarly, the total EU-15 emissions decreased by same percent since 1990 (Table 7-46). Some MS reduced notably the emissions from lime applications (i.e. Denmark, Netherlands).

**Table 7-46 $CO_2$ emissions from agricultural lime application**

| Member State | Net $CO_2$ emissions (Gg) | | | Share in EU-15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | |
|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg) | (%) | (Gg) | (%) |
| Austria | 90.30 | 88.24 | 88.12 | 1.8% | 0 | 0% | -2 | -2% |
| Belgium | NA,NO | NA,NO | NA,NO | - | - | - | - | - |
| Denmark | 622.92 | 230.82 | 186.24 | 3.9% | -45 | -19% | -437 | -70% |
| Finland | 617.87 | 289.52 | 312.04 | 6.5% | 23 | 8% | -306 | -49% |
| France | 1,053.95 | 992.56 | 1,101.77 | 22.8% | 109 | 11% | 48 | 5% |
| Germany | 1,275.72 | 1,796.89 | 1,748.38 | 36.2% | -49 | -3% | 473 | 37% |
| Greece | NO | NO | NO | - | - | - | - | - |
| Ireland | 355.04 | 262.21 | 307.32 | 6.4% | 45 | 17% | -48 | -13% |
| Italy | NA,NO | 17.80 | 16.77 | 0.3% | -1 | -6% | 17 | - |
| Luxembourg | 0.59 | 2.86 | 4.07 | 0.1% | 1 | 42% | 3 | 591% |
| Netherlands | 183.15 | 91.05 | 91.05 | 1.9% | 0 | 0% | -92 | -50% |
| Portugal | NE,NO | NE,NO | NE,NO | - | - | - | - | - |
| Spain | NO | NO | NO | - | - | - | - | - |
| Sweden | 169.79 | 104.49 | 104.49 | 2.2% | 0 | 0% | -65 | -38% |
| United Kingdom | 1,430.19 | 725.19 | 874.85 | 18.1% | 150 | 21% | -555 | -39% |
| **EU-15** | **5,799.52** | **4,601.62** | **4,835.10** | **100.0%** | **233** | **5%** | **-964** | **-17%** |

The activity data are available from official national or sectoral statistics (e.g. agriculture sectors) or from field studies. All reporting countries relays on emission factor is the IPCC default one (*EF limestone* =0.120, and *EF dolomite*=0.122). The majority the MS do not differentiate between dolomite or lime, rather, they use a unique emission factor, as the share of dolomite in total amount applied is small (around 15 %). Commercially available products are discounted in terms of water content to only account for the limestone content in the calculations (i.e. Finland).

### 7.7.5 $CO_2$, $CH_4$ & $N_2O$ emissions from Biomass Burning (CRF Table 5(V))

This source category covers $CO_2$, $CH_4$ and direct $N_2O$ emissions from biomass burning, as well as emissions of other GHG ($NO_x$ and CO). It includes emissions both from wildfires and controlled burning, on any type of land use (i.e. Forestland, Cropland, Grassland, Wetland and Settlement). Controlled burning in managed forests is not anymore a common practice in the EU-15, with few exceptions (i.e. Finland, Sweden, UK, Spain reports it as NE) or Grassland (UK) for confined activities. Wildfires are reported on grassland (e.g. Greece, still NE by Netherlands, Spain and Sweden), forestland (some MS still reporting it as NE) or wetlands (NE by Ireland and Netherland). Only UK reports non-$CO_2$ emissions from conversion to settlements.

The majority of emissions is generated from wildfires in forests (both remaining and conversion lands), or from wildfires in grasslands (in Southern MS). In general, $CO_2$ emissions from forest fires are reported under 5A Forest land, while $CO_2$ for the other land categories and non-$CO_2$ gases emissions are reported under 5(V). Compared to previous years, following a EU QA/QC team recommendation, there is more harmonized and comparable reporting on area basis, by almost all MS,. Still, few report emissions from some categories of fires based on burnt mass (i.e. Portugal, France).

Total EU-15 emissions reported in 2009 for this category is 0.4 Gg $N_2O$, 53 Gg $CH_4$ and 1.462 Gg $CO_2$, with the mention that most of MS report the $CO_2$ emissions from burning biomass as NO or IE, while often $CH_4$ and $N_2O$ emissions are reported as NE by some MS. Overall, $CO_2$ emissions have decreased by 65 % since 1990 (Table 7.47). The $CH_4$ emissions decreased by 28% (Table 7.48) and those of $N_2O$ by 36% (Table 7-49), but their trends are related to wildfire incidence, which is characterized by a large inter-annual variability.

**Table 7.47 $CO_2$ emissions from Biomass Burning**

| Member State | Net $CO_2$ emissions (Gg) | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | |
|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg) | (%) | (Gg) | (%) |
| Austria | IE,NA,NO | IE,NA,NO | IE,NA,NO | - | - | - | - | - |
| Belgium | NO | NO | NO | - | - | - | - | - |
| Denmark | NO | NO | NO | - | - | - | - | - |
| Finland | 3.86 | 8.55 | 4.96 | 0.3% | -4 | -42% | 1 | 28% |
| France | 1,594.01 | 158.23 | 428.97 | - | - | - | - | - |
| Germany | IE,NA,NE, | IE,NA,NE, | IE,NA,NE, | - | - | - | - | - |
| Greece | IE,NA,NO | IE,NA,NO | IE,NA,NO | - | - | - | - | - |
| Ireland | 12.26 | 8.38 | 4.30 | 0.3% | -4 | -49% | -8 | -65% |
| Italy | IE,NA,NO | IE,NA,NO | IE,NA,NO | - | - | - | - | - |
| Luxembourg | NE,NO | NE,NO | NE,NO | - | - | - | - | - |
| Netherlands | NA,NE,NO | NA,NE,NO | NA,NE,NO | - | - | - | - | - |
| Portugal | 2,360.31 | 156.65 | 675.57 | 46.2% | 519 | 331% | -1,685 | -71% |
| Spain | 0.18 | 9.52 | 29.54 | - | - | - | - | - |
| Sweden | 18.80 | 144.81 | 28.69 | 2.0% | -116 | -80% | 10 | 53% |
| United Kingdom | 181.43 | 345.85 | 290.77 | 19.9% | -55 | -16% | 109 | 60% |
| **EU-15** | **4,170.86** | **831.99** | **1,462.80** | **100.0%** | **631** | **76%** | **-2,708** | **-65%** |

**Table 7.48** **$CH_4$ emissions from Biomass Burning**

| Member State | Net $CH_4$ emissions (Gg) | | | Share in EU-15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | |
|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg) | (%) | (Gg) | (%) |
| Austria | 0.03 | 0.01 | 0.01 | 0.00% | 0 | 12% | -0.02 | -72% |
| Belgium | NO | NO | NO | - | - | - | - | - |
| Denmark | NO | NO | NO | - | - | - | - | - |
| Finland | 0.19 | 0.06 | 0.05 | 0.10% | -0.01 | -12% | -0.14 | -73% |
| France | 56.64 | 44.32 | 45.34 | 84.10% | 1.02 | 2% | -11.3 | -20% |
| Germany | 0.43 | 0.16 | 0.22 | 0.40% | 0.06 | 41% | -0.21 | -49% |
| Greece | 1.19 | 0.91 | 1.07 | 2.00% | 0.17 | 18% | -0.11 | -10% |
| Ireland | 0.05 | 0.04 | 0.02 | 0.00% | -0.02 | -49% | -0.03 | -65% |
| Italy | 6.96 | 2.2 | 2.61 | 4.90% | 0.42 | 19% | -4.35 | -62% |
| Luxembourg | NE,NO | NE,NO | NE,NO | - | - | - | - | - |
| Netherlands | NA,NE,NO | NA,NE,NO | NA,NE,NO | - | - | - | - | - |
| Portugal | 0.04 | 0.05 | 0.23 | 0.40% | 0.18 | 387% | 0.19 | 495% |
| Spain | 8.23 | 1.03 | 2.94 | 5.50% | 1.91 | 185% | -5.29 | -64% |
| Sweden | 0.08 | 0.63 | 0.13 | 0.20% | -0.51 | -80% | 0.04 | 53% |
| United Kingdom | 0.79 | 1.51 | 1.27 | 2.40% | -0.24 | -16% | 0.48 | 60% |
| **EU-15** | **74.64** | **50.91** | **53.9** | **100.00%** | **2.99** | **6%** | **-20.75** | **-28%** |

**Table 7-49** **$N_2O$ emissions from Biomass Burning**

| Member State | Net $CO_2$ emissions (Gg) | | | Share in EU-15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | |
|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg) | (%) | (Gg) | (%) |
| Austria | 0.00044 | 0.00011 | 0.00012 | 0.00% | 1E-05 | 12% | -0.0003 | -72% |
| Belgium | NO | NO | NO | - | - | - | - | - |
| Denmark | NO | NO | NO | - | - | - | - | - |
| Finland | 0.001 | 0 | 0 | 0.10% | -5E-05 | -12% | -0.001 | -73% |
| France | 0.49 | 0.31 | 0.33 | 84.30% | 0.025 | 8% | -0.1596 | -32% |
| Germany | 0.01 | 0 | 0 | 0.90% | 0.001 | 41% | -0.0033 | -49% |
| Greece | 0.01 | 0.01 | 0.01 | 1.90% | 0.0012 | 18% | -0.0008 | -10% |
| Ireland | 0 | 0 | 0 | 0.00% | -0.0001 | -49% | -0.0002 | -65% |
| Italy | 0.05 | 0.02 | 0.02 | 4.50% | 0.0029 | 19% | -0.0299 | -62% |
| Luxembourg | NE,NO | NE,NO | NE,NO | - | - | - | - | - |
| Netherlands | NA,NE,NO | NA,NE,NO | NA,NE,NO | - | - | - | - | - |
| Portugal | 0 | 0 | 0 | 0.80% | 0.0025 | 387% | 0.0026 | 495% |
| Spain | 0.06 | 0.01 | 0.02 | 5.10% | 0.0132 | 185% | -0.0363 | -64% |
| Sweden | 0 | 0 | 0 | 0.20% | -0.0035 | -80% | 0.0003 | 53% |
| United Kingdom | 0.01 | 0.01 | 0.01 | 2.20% | -0.0017 | -16% | 0.0033 | 60% |
| **EU-15** | **0.62** | **0.36** | **0.4** | **100.00%** | **0.0403** | **11%** | **-0.2252** | **-36%** |

On site burning of biomass (controlled burning) is prohibited in most of the EU MS, therefore, emissions are reported as not occurring in the CRF tables. Emissions from biomass burnning in power plants are always reported in the energy sector. The methodology used to report emissions for fires is always Tier 2 for $CO_2$ with activity data provided by national statistics and country specific emission actors, whereas Tier 1 data is used for estimation of $CH_4$ and $N_2O$ emissions.

# 7.8 Cross-cutting issues (EU-15)

## 7.8.1 Uncertainties

MS uncertain emisions or removal amounts on each land subcategory and GHG types are aggregated up to EU-15 by error propagation approach, under Tier 1 of IPCC. Across the EU-15, the aggregated uncertainty of the estimates of $CO_2$ emissions/removals in 2009 at the subcategory level varies between 18 % in 5A2 and 116 % in 5B1 (Table 7.50).

**Table 7.50 Tier 1 based overall uncertainty under various assumption of covariation among MS's estimates on LULUCF land subcategories and GHG (uncertainty is considered as percentage of half the 95 % confidence interval divided by estimated source/emissions).**

| Land use subcategory and GHG | LU category uncertainty without any MS correlation (%) | LU category uncertainty with MS totally correlated (%) | LU subcategory uncertainty for EU (%) | Comments |
|---|---|---|---|---|
| 5A1 $CO_2$ | 18% | 32% | 18% | No correlation assumed among MS estimates. Most of data is CS, independent. |
| 5A2 $CO_2$ | 26% | 48% | 26% | No correlation assumed among MS estimates. Most of data is CS, independent. |
| 5B1 $CO_2$ | 116% | 180% | 116% | No correlation assumed among MS estimates. Most of data is CS, independent. |
| 5B2 $CO_2$ | 53% | 69% | 53% | No correlation assumed among MS estimates. Most of data is CS, independent. |
| 5C1 $CO_2$ | 108% | 159% | 159% | MS estimates assumed totally correlated. Reporting under Tier 1 of biomass and DOM data for almost all countries. SOC is country specific estimated and reported. |
| 5C2 $CO_2$ | 53% | 80% | 53% | No correlation assumed among MS estimates. Most of data is CS, independent. |
| 5ABC $CH_4$ | 44% | 49% | 49% | MS estimates assumed totally correlated. Generalized reporting under Tier 1. |
| 5ABC $N_2O$ | 41% | 55% | 55% | MS estimates assumed totally correlated. Generalized use of emission factor for emissions from forest fires, land conversion and fertilization |
| 5DEF $CO_2$ | 30% | 59% | 59% | MS estimates assumed totally correlated. Generalized reporting under Tier 1 of C stock changes in DOM and SOC. |
| 5DEF $CH_4$ | 41% | 46% | 46% | MS estimates assumed totally correlated. Generalized reporting under Tier 1. |
| 5DEF $N_2O$ | 19% | 21% | 21% | MS estimates assumed totally correlated. Generalized reporting under Tier 1. |

Compared to previous uncertainty analysis performed for the inventory year 2008 in the EU submission 2010, there are changes explained by: inter-annual variations of emissions/removals estimates and share of contributors of MS (underpinned by ecological processes and management measures); new nominal uncertainty values reported by MS, as well as recalculations and revisions of previous estimates (i.e. for the base year, LULUCF net removal reported in 2011 is 6 percentage points higher than that reported in 2010, with a similar recalculation for land category 5A1). Additionally, there was an increased transparency of reporting uncertainty and more consistency in implementing related guidelines by all MS (i.e. uncertainty was explicitly reported on land subcategories) which facilitated the uncertainty assessment at EU-15 level. Despite that, identification of co-variation parameters among MS estimates and the quantification of the related correlation coefficients are difficult (i.e. under lack of access to explicit datasets used by each MS). For these reasons a conservative approach is taken by considering that some MS estimates are totally correlated on some GHG and land sub-categories (see Table 7.50). Reasons for co-variation are mainly the use of Tier 1 and default IPCC parameters. These co-variation assumptions were made based on Table 7-8 *Summary of methods and C stock change factors used by countries to calculate emission and removals of different pools in the LULUCF sector*.

Overall uncertainty of LULUCF reached 24 % (12pp less than reported for the inventory year 2008, see Table 7.51). For major land use categories: 5A, 5B & 5C and all GHG, which represents 95 % of the sum of land use fluxes (if all estimates are considered as absolute positive amounts), the aggregated uncertainty in 2009 GHG inventory was 21%.

For example, overall EU-15 uncertainty for 5A1 is 18 % for 2009 inventory, compared to 29% estimated for the year 2008. Specifically for 2009 inventory, EU-15 simple average of AD nominal uncertainty is reported 3percentage points less, compared to 2008, and emission factors uncertainty is 10pp less. Major driver are the changes reported for large removal countries: Italy reports 10pp less for emission factors uncertainty, Spain recalculated the sink to half of previously reported and the nominal uncertainty by 7pp, Sweden significantly revised the annual removals (by some 3 times) and decreased the nominal uncertainty value from 84% reported last year to 25%.

In 5A2 shows there are two countries that reports high uncertainty fort he estimates: Finland's as high as 300% and Spain's emissions uncertainty of about 1000%.

For cropland and grassland, the uncertainty of GHG estimates is smaller for lands under conversion, explained partly by good quality data associated to transition to non-forest land (associated with deforestation activity under KP reporting). $CH_4$ and $N_2O$ emissions have very low contribution to EU-15 uncertainty, being quantitatively small and showing reduced uncertainty (< 50%), and despite assumed fully correlated they seem to not have large impact on overall uncertainty.

**Table 7.51 Tier 1 uncertainty estimation of GHG in the LULUCF inventory for the submission 2009 (uncertainty is considered as percentage of half the 95 % confidence interval divided by estimated source/emissions**

| | | | Uncertainty of 2009 annual net removal/emissions | | | | | | 1990-2009 trend uncertainty | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Land use subcategory | GHG emission/ removal in 1990 (Gg) | GHG emission/ removal in 2009 (Gg) | Emission/ removal in base year (Gg $CO_2$eq) | Emission/ removal in 2009 (Gg $CO_2$eq) | EU-15 aggregated uncertainty of AD * | EU-15 aggregated uncertainty of EF **,*** | Land use subcategory uncertainty for EU *** (%) | Uncertainty share of each GHG and LU subcategory (% of total LULUCF) | Type A sensitivity | Type B sensitivity | Uncertainty in trend in LULUCF emissions introduced by emission factor uncertainty***** | Uncertainty in trend in LULUCF emissions introduced by activity data uncertainty***** | Uncertainty introduced into the trend in total LULUCF emissions |
| 5A1 $CO_2$ | -277,318 | -319,015 | **-277,318** | **-319,015** | 10% | 42% | **18%** | 20% | -19% | 144% | -11% | -3% | 11% |
| 5A2 $CO_2$ | -16,474 | -32,140 | **-16,474** | **-32,140** | 15% | 75% | **26%** | 3% | 5% | 14% | 5% | 1% | 5% |
| 5B1 $CO_2$ | 14,888 | 18,251 | **14,888** | **18,251** | 14% | 70% | **116%** | -7% | 1% | -8% | 0% | 0% | 1% |
| 5B2 $CO_2$ | 37,762 | 32,337 | **37,762** | **32,337** | 13% | 75% | **53%** | -6% | 8% | -15% | 8% | 1% | 8% |
| 5C1 $CO_2$ | 11,753 | 9,892 | **11,753** | **9,892** | 16% | 111% | **159%** | -5% | 2% | -4% | 4% | 1% | 4% |
| 5C2 $CO_2$ | -21,810 | -29,855 | **-21,810** | **-29,855** | 16% | 105% | **53%** | 5% | 1% | 13% | 1% | 0% | 1% |
| 5ABC $CH_4$ | 72 | 52 | **1,515** | **1,089** | 13% | 52% | **49%** | 0% | 0% | 0% | 0% | 0% | 0% |
| 5ABC $N_2O$ | 12 | 9 | **3,569** | **2,759** | 16% | 69% | **55%** | -1% | 1% | -1% | 1% | 0% | 1% |
| 5DEF $CO_2$ | 21,673 | 24,452 | **21,673** | **24,452** | 18% | 99% | **59%** | -5% | 2% | -11% | 2% | 0% | 2% |
| 5DEF $CH_4$ | 4 | 5 | **92** | **103** | 17% | 66% | **46%** | 0% | 0% | 0% | 0% | 0% | 0% |
| 5DEF $N_2O$ | 0 | 0 | **86** | **80** | 18% | 74% | **21%** | 0% | 0% | 0% | 0% | 0% | 0% |
| ***Total*** | | | ***-224,265*** | ***-292,046*** | ***15%*** | ***76%*** | ***24%*** | ***24%*** | | | | | ***15%*** |
| *EU-15 LULUCF agregated uncertain amount (Gg $CO_2$)* | | | | | | | 69422 | | | | | | |

** - simple average of the uncertainty among MS (because AD methods are heterogeneous). AD is never correlated among MS*
*** - simple average of the uncertainty among MS. In some cases EF is already combined with AD.*
**** - EF could be correlated in the annual estimates of the MS. There are reasons for covariation among annual removal estimates of the MS (explained separately for each land category)*
***** - uncertainty estimated for half of the 95 % confidence interval of normal distribution*
****** - uncertainty in the trends in emissions introduced by both AD and EF are computed as Type A sensitivity*

Overall compared to 1990, LULUCF showed an increased annual removal by 30 %, due to increase by 15 % of $CO_2$ removal in 5A1, 38% in 5C2 and 95 % in 5A2 or decrease in emissions by 15% in 5B2. Overall uncertainty in the trend of LULUCF annual removal is 15%, with highest contribution of 5A1, 5B2 and 5A2. 5C has low contribution to the trend because its general lower uncertainty and smaller estimates compared to other land sub-categories. Most notable increase of emissions was shown by $CO_2$ emissions from aggregated land use categories 5D, 5E and 5F. Removal trend is also uncertain mainly under the influence of $CO_2$ removal on 5A1 and $CO_2$ emissions from 5B2 (Table 7.51). Under current national estimating system we assumed that both activity data and emissions factors are correlated in time (i.e. either provided by National Forest Inventories or Earth Observation techniques).

## 7.9 Verification

MS's NIRs report rather limited information on any thorough verification of the GHG inventory estimates, while there is none done at EU-15 level. To mention that MS of EU-15 are under double QA/QC checks: own one at the country level and another one which is achieved at EU-15 level under the EU GHG Monitoring Mechanism, with checks commonly fulfilled for the 15 MS (in fact for all 27 MS of the European Union). Currently, information on verification is reported more for the systems feeding data into national GHG estimation systems, but not on the national GHG estimation system itself.

Currently, verification actions are tightly linked to QA/QC process and mostly focus on double checks with independent available source of the factors, parameters and data used for the estimation of GHG. Most common verification action is double and multiple check and cross checks of the activity data and land use matrices. All EU-15 countries implement independent NFI and land statistics, either at country or regional level (i.e. projects, cadastre/land registry), even though only few report on the result of such verification. One example, Finland reports forest areas to FAO compared to statistics, while GHG inventory is based on NFI. Few implemented checks refer to lands involving forests, while for other land use the information is extremely poor.

Regarding the verification of the overall GHG estimates there is poor implementation or information provided in the NIRs. Only two countries perform verification (as defined by the IPCC GPG LULUCF 2003): Germany has set up an institutional approach while UK's is based on research projects. Germany and Italy report on the calculation of the C stocks and C-stock changes in biomass for forestland, with the estimates being in "good agreement" (Italy substantiates statistically the comparison in its NIR 2011). Also, inter-calibration of laboratories doing soil chemistry was performed as to make sure the soils data are comparable (i.e. Germany). Germany also performs analysis and comparison of own parameters and estimates with ones of other countries in the EU. Italy reports on the implementation of an interregional project (i.e. INEMAR) to carry out atmospheric emission inventories at local scale, with a module on the estimation of forest land related emission/removals (in 7 out of the 20 Italian regions), whose results will allow the validation of both methodology and estimates at country level. Other countries have institutional approaches to strengthen the GHG inventories quality like in Finland: Finnish Forest Institute has set up a management team to guide and supervise the reporting of LULUCF sector composed by national members with wide expertise. All changes in methods, activity data and emission or use of new factors and parameters are discussed and approved be the management team before they are introduced to the advisory board.

## 7.10 Time series consistency

Time series consistency has been checked for all MS as part of the QA/QC program of the EU-15 GHG inventory, in terms of land categories definitions and representation in time and space. Although most of inconsistencies found had small quantitative effect on emissions/removal, MS were strongly encouraged to correct them or at least to acknowledge and discuss the issue in their respective NIRs.

Current MS submissions represents a step ahead in increasing the transparency of land definitions and other descriptive elements of land classified by country under specific land subcategory.

Land use category and subcategory definitions are not fully consistent across the EU-15 MS, but they are consistent with IPCC definitions (IPCC GPG for LULUCF). Differences are given by slightly different treatment of particular lands (i.e. hedges or bush areas categorized either under the cropland, grassland or forestland; woody plantations either under cropland or forestland; inclusion or not of the access roads in forest area), which is mainly related to various definitions used historically. Meantime, one of the key features of the methodology implemented by the national GHG inventory systems is to ensure fully consistent definitions for involved parameters and data.

Contrary to previous years reports, in 2011, there was an improvement on reporting consistency of time series and land allocation on land sub-categories (e.g. small difference by country's official geographical area, or varied from year to year). Such small differences may occur due to improvements in the mapping systems and precision, inherent measurement errors, feature of assessment system, natural expansion of land. In general, the land reported under UNFCCC varies by 1-2 % than official geographical area or in time since 1990.

According to the GPG for LULUCF (2003), C stock changes and GHG emissions have to be reported for managed land, while "unmanaged" land is to be reported only if they are subject to land use conversion by human activity. In the EU-15 MS, all forest land, cropland, grassland and settlement are assumed to be managed, such as a limited area of existing wetlands (i.e. used for peat extraction: Sweden, Finland). Small area of unmanaged forest and grassland are reported by some countries (i.e. Ireland, France). Land included under Other land remaining Other land is, in general, assumed as unmanaged, although national approaches may be very specific (i.e. 10.9 mn ha in Spain, 3.9 mn ha in Sweden, 0.8 mn ha in France, 1.3 mn ha in Finland, 1.9 mn ha in UK).

## 7.11 Quality Assurance and Quality control

QA/QC activities and efforts for improving reporting occurred at both the national and the EU level. QAQC procedures are described in the MS's NIRs and are part of the national QAQC system. They were developed under country own initiative on the implementation of the requirements, and often improved at the request of ERTs (i.e. a specific QA/QC plan which is additional to data quality and management rules specific to each data source). Quality of data falls with relevant data administrators. A national system is justified by avoiding intra-sectoral double accounting or missing sources/pools. At the national level, MS have in place quality management systems, which are part of their respective national GHG estimation systems that establish protocols for channels of data and information for compilation and reporting, data storage and archiving, detailed institutional coordination and responsibilities, as well as adequate financial allocations. The national systems are designed to be continuously improved, by taking into account new practices and suggestions coming from the review of national reports or by independent assessments (i.e. scientific papers, institutional evaluation). Quality assurance includes peer and public reviews. The purpose of such systems is to ensure adequate levels of transparency, consistency, comparability, completeness, accuracy and timeliness, as requested both by international agreements and EU-15 GHG monitoring directive.

Furthermore, EU-15 and MS improved their reports through:

- continuous improvement of the reporting of land categories less reported in the past, as well as the fluxes on all lands;
- extended use of the Good Practice Guidance for LULUCF (IPCC 2003) and also AFOLU Guidelines (IPCC 2006, i.e. Finland for Harvested Wood Products);
- more complete and time consistent land use transition matrix and comparison with other statistics;
- key category analysis including categories and subcategories of LULUCF sector;

- using higher Tier than before (at least for some pools or subcategories, including country specific data);
- use of improved activity data and emission factors and more use of country specific data;
- developments in uncertainty assessment and estimation;
- improved documentation on methodology;
- conducting national and joint research projects especially on the problematic pools (i.e. soil carbon and dead organic matter). The approach also consists in making use of existing historical database and development of new, dedicated research.

In addition to national efforts, several activities were carried out by the Joint Research Centre of the European Commission with respect to data quality of the LULUCF sector at the EU-15 level, including:

- Annual checking of early versions of the MS national GHG inventories for errors and inconsistencies, and interaction with national representatives when relevant for clarification and improvement. During the checking of the 2011 submission, 240 findings (i.e. possible problems and unclear issues, also based on the latest review of the EU-15 GHG inventory) were communicated to the MS, ranging from problems in the use of notations keys, inconsistent land use data, outliers in IEF for all the categories, and various requests for clarifications.
- Efforts for improving and harmonizing Member State inventories, in close cooperation with the research community. Examples include:
    - Starting 2011, the implementation of the JRC prepared decission trees on notation keys a) *Use of notations keys for C POOLS - Tables 5(KP-I) of mandatory or elected activities* and b) *Use of notations keys for GHG SOURCES- Tables 5(KP-II) of mandatory or elected activities*. The purpose was to ensure more harmonized use of notation keys as to identify the incompleteness issues in due time and allow further automatic check, both for reporting under the Convention and Kyoto Protocol.
    - For the purpose of enhancing reporting, sharing experience amongst MS, also for the harmonization of methods for estimation, a series of technical workshops dedicated to UNFCCC reporting (including Kyoto Protocol), under the auspices of European Commission/Joint Research Center (DG ENV, DG JRC) were organized:
    - "JRC technical workshop on LULUCF issues under the Kyoto Protocol", held in *Brussels, November 9-10, 2010*
    - Technical workshop on projections of GHG emissions and removals in the LULUCF sector, Ispra (Italy), 27-28 January 2010.
    - Technical workshop on LULUCF reporting issues under the Kyoto Protocol, Ispra (Italy), November 13-14, 2008,
    - "Technical meeting on specific forestry issues related to reporting and accounting under the Kyoto Protocol" (Ispra, 27-29 November 2006, in collaboration with sink experts from EU, Japan, New Zealand and Canada,
    - "Improving the Quality of Community GHG Inventories and Projections for the LULUCF Sector", Ispra (Italy), September 22-23, 2005,

For further information on these two workshops, see **http://afoludata.jrc.ec.europa.eu/events**.

- The JRC's AFOLU DATA web site (**http://afoludata.jrc.ec.europa.eu/data&tools**) offer interrogative databases (e.g. BEFs, conversion factors, European forest inventories and yield tables, models and other tools) to promote transparent, complete, consistent and comparable estimates of greenhouse gas fluxes in the AFOLU sector in Europe, and for the use of researchers, inventory experts and GHG inventory reviewers.

### 7.11.1 Recalculations

Due to continuous methodological improvements, mainly driven by the implementation of the relevant requirements and ensuring consistency with KP supplementary reporting and accounting, like revision of activity data (e.g. revision or improvement of land use matrix) and the use of new or improved factors (e.g. biomass conversion and/or expansion factors), as well as reallocation of emissions between sectors and the correction of identified errors, there have been several recalculations in the 2011 submissions of the MS, this of EU-15's.

The overall quantitative effect over the total emission of LULUCF sector of the recalculations in 2011 is an annual decrease of net removals by 44,000 $GgCO_2eq$, with small variation between years. The general trend of the increasing sink over time, however, was maintained.

Many MS reviewed land data time series. Most significant re-allocation of 5A1 land area occurred in Greece, UK, Spain and France. In 5A2 less reallocation occurred with significant change in UK that split previous 5A2 lands on datasets based on 20 years transition period, while starting 2011 reports full country area (including other land with some 1.9 mn ha). France re-allocated significant area to 5B1 and 5C1.

Finland updated the estimates with actual data issued from latest NFI , while actualized the climatic data for the re-estimation of the C stock changes in soil organic carbon and dead organic matter of mineral forest soils. Germany fixed an error of double accounting of land converted to forestland and refined the activity data for soil emission estimation. Italy reviewed dead organic matter and soils pools with resulting data from a European project Biosoil.

For the inventory year 2008, Germany recalculations turned 5C2 from sink in emissions, and entire 5C in larger emissions than previously estimated (mainly because changes in biomass data). It also reported higher emissions from 5E2. In Sweden, the removal in 5A in 2008 is doubled compared to 2008 submission because of recalculations on 5A1 (total recalculation is some 20,000 Gg $CO_2$). Meantime all other land subcategories estimates suffered large relative changes. In the current submission, Italy almost doubled the 5C emissions for 2008 by reviewing the estimates from cropland converted to grassland.

Overall, for the inventory year 2008, with the latest MS submissions the largest recalculation of LULUCF sector were performed by Germany which halved the net removal estimated previously; Spain halved the sink because the recalculations of forestland and small changes in cropland; Denmark turned from a source to a sink after recalculation of forestland; Finland reduced the LULUCF sink by some 15 % under recalculation of forestland estimates; UK increased the sink by some 3 times under recalculation of emissions from cropland. Portugal increased the sink some 3 times after recalculation of forestland sink, and Sweden that increased the sink under doubling of forestland removal estimate.

# 8 WASTE (CRF SECTOR 6)

This chapter starts with an overview on emission trends in CRF Sector 6 Waste for EU-15 Member States. For each EU-15 key source, overview tables are presented including the Member States contributions to the key source in terms of level and trend, information on methodologies and emission factors. The quantitative uncertainty estimates for this sector and the sector-specific QA/QC activities are summarised in separate sections. This chapter furthermore includes an overview of recalculations. In a separate chapter, an overview of the sector for EU-27 is provided.

## 8.1 Overview of sector (EU-15)

CRF Sector 6 Waste is the fourth largest sector in the EU-15, contributing 2.76 % to total GHG emissions. Total emissions from Waste have been decreasing by 45 % from 184 Tg in 1990 to 102 Tg in 2009 (Figure 8.1). In 2009, emissions decreased by 3 % compared to 2008. The key sources in this sector are:

- 6 A 1 Managed Waste disposal on Land:($CH_4$)
- 6 A 2 Unmanaged Waste Disposal Sites:($CH_4$)
- 6 B 2 Domestic and Commercial Wastewater:($CH_4$)
- 6 B 2 Domestic and Commercial Wastewater:($N_2O$)

**Figure 8.1 Sector 6 Waste: EU-15 GHG emissions 1990–2009 from CRF in $CO_2$ equivalents (Tg)**

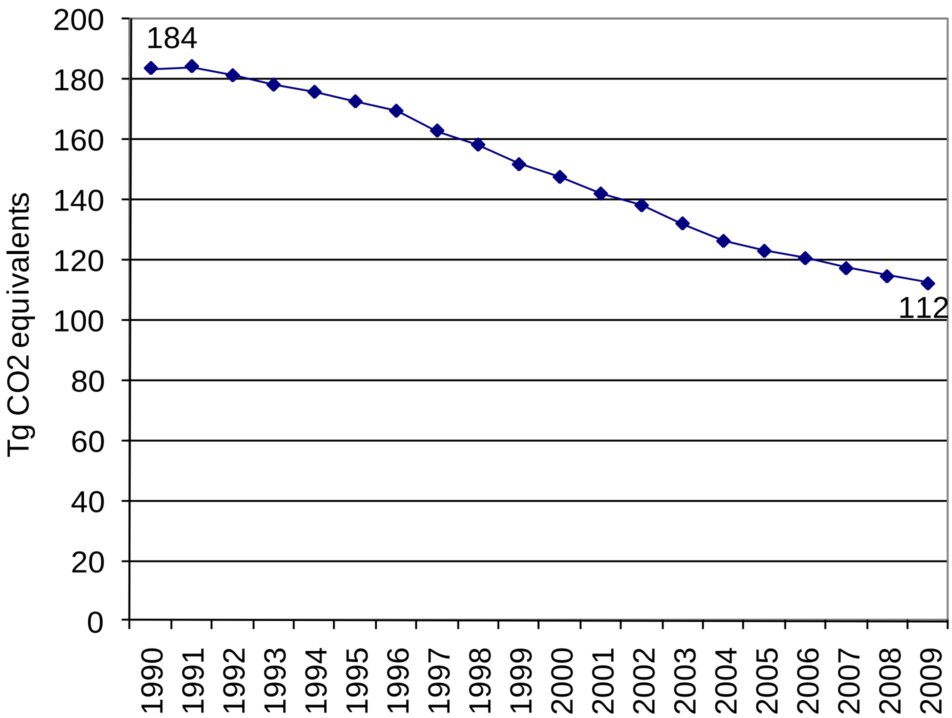
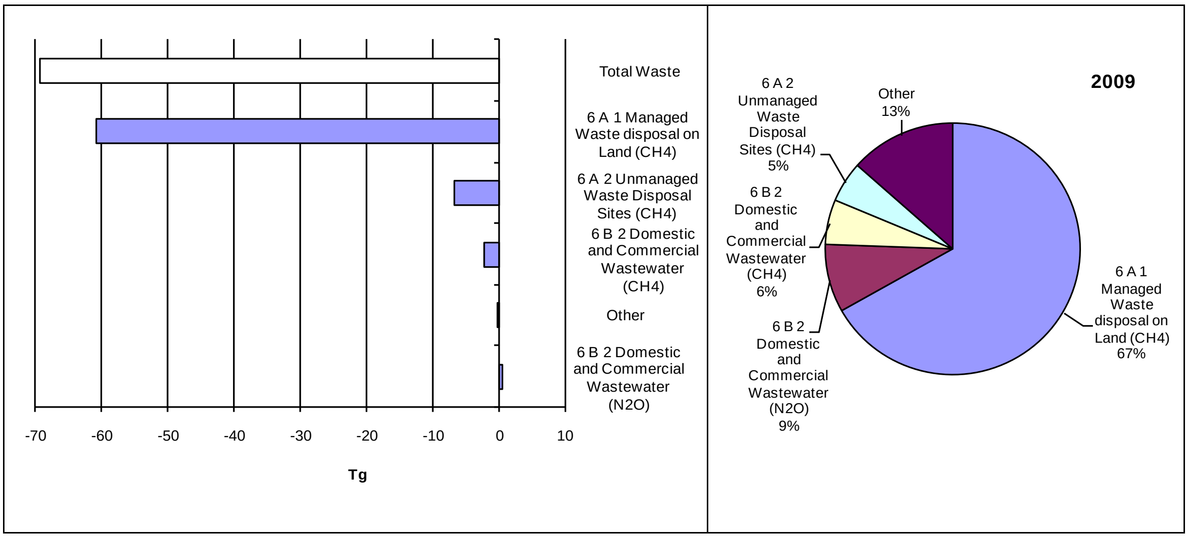



Figure 8.2 shows that $CH_4$ emissions from 6A1 Managed Waste Disposal on Land had the greatest decrease of all waste-related emissions, but still accounts for 67 % of waste-related GHG emissions in the EU-15.

**Figure 8.2** **Sector 6 Waste: Absolute change of GHG emissions by large key source categories 1990–2009 in $CO_2$ equivalents (Tg) and share of largest key source categories in 2009**




## 8.2 Source categories (EU-15)

### *8.2.1 Solid waste disposal on land (CRF Source Category 6A) (EU-15)*

Source category 6A Solid waste disposal on land includes two key sources: $CH_4$ from 6A1 Managed waste disposal on land and $CH_4$ from 6A2 Unmanaged waste disposal on land. Methane is produced from anaerobic microbial decomposition of organic matter in solid waste disposal sites. Source category 6A1 Managed waste disposal on land includes $CH_4$ emission arising from managed solid waste landfills. Methane recovery can also be reflected in this category. Source category 6A2 comprises corresponding $CH_4$ emissions from unmanaged landfills (without methane recovery).

Table 8.1 provides total greenhouse gas and $CH_4$ emissions by Member State from 6A Solid Waste Disposal on Land. $CH_4$ emissions from this category decreased by 45 % between 1990 and 2009 in the EU-15. Twelve EU-15 Member States reduced their emissions from this source, France, Greece, Portugal and Spain did not.

**Table 8.1** **6A Solid Waste Disposal on Land: Member States' contributions to total GHG emissions and $CH_4$ emissions**

| Member State | GHG emissions in 1990 (Gg $CO_2$ equivalents) | GHG emissions in 2009 (Gg $CO_2$ equivalents) | $CH_4$ emissions in 1990 (Gg $CO_2$ equivalents) | CH4 emissions in 2009 (Gg $CO_2$ equivalents) |
|---|---|---|---|---|
| Austria | 3,314 | 1,458 | 3,314 | 1,458 |
| Belgium | 2,630 | 424 | 2,630 | 424 |
| Denmark | 1,111 | 1,039 | 1,111 | 1,039 |
| Finland | 3,635 | 1,849 | 3,635 | 1,849 |
| France | 8,850 | 17,070 | 8,850 | 17,070 |
| Germany | 38,598 | 8,463 | 38,598 | 8,463 |
| Greece | 1,858 | 2,464 | 1,858 | 2,464 |
| Ireland | 1,173 | 1,082 | 1,173 | 1,082 |
| Italy | 15,254 | 12,741 | 15,254 | 12,741 |
| Luxembourg | 75 | 38 | 75 | 38 |
| Netherlands | 12,011 | 4,637 | 12,011 | 4,637 |
| Portugal | 3,033 | 5,294 | 3,033 | 5,294 |
| Spain | 4,979 | 11,949 | 4,760 | 11,938 |
| Sweden | 2,874 | 1,367 | 2,874 | 1,367 |
| United Kingdom | 56,002 | 15,870 | 56,002 | 15,870 |
| **EU-15** | **155,397** | **85,745** | **155,178** | **85,733** |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

Table 8.2 provides information on emission trends of the key source $CH_4$ from 6A1 Managed Waste Disposal on Land by Member State. $CH_4$ emissions from this source account for 1.8 % of total EU-15 GHG emissions. Between 1990 and 2009, $CH_4$ emissions from managed landfills declined by 45 % in the EU-15. Ten EU-15 Member States reduced their emissions from this source during that period, France, Greece, Italy, Portugal and Spain did not. In 2009, $CH_4$ emissions from landfills decreased by 3 % compared to 2008. A main driving force of $CH_4$ emissions from managed waste disposal on land is the amount of biodegradable waste going to landfills. Total municipal waste disposal on land declined by 33 % between 1990 and 2009. In addition, $CH_4$ emissions from landfills are influenced by the amount of $CH_4$ recovered and utilised or flared. The share of $CH_4$ recovery increased in all EU-15 Member States during that time period.

The Member States with most emissions from this source in 2009 were France, the UK, Italy and Spain. These MS account for 70 % of EU-15 emissions in this year. The largest reductions in absolute terms during 1990 and 2009 were reported by the UK and Germany. The emission reductions are partly due to the (early) implementation of the landfill waste directive or similar legislation in the Member States. The landfill waste directive was adopted in 1999 and requires the Member States to reduce the amount of biodegradable waste disposed untreated to landfills and to install landfill gas recovery at all new sites.

**Table 8.2** **6A1 Managed Waste Disposal on Land: Member States' contributions to $CH_4$ emissions and information on method applied and emission factor**

| Member State | $CH_4$ emissions (Gg $CO_2$ equivalents) | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg CO2 equivalents) | (%) | (Gg CO2 equivalents) | (%) | | |
| Austria | 3,314 | 1,576 | 1,458 | 1.9% | -118 | -7% | -1,856 | -56% | T2 | CS,D |
| Belgium | 2,630 | 482 | 424 | 0.6% | -58 | -12% | -2,206 | -84% | CS | CS |
| Denmark | 1,111 | 1,057 | 1,039 | 1.4% | -17 | -2% | -72 | -6% | CS,T2 | CS,D |
| Finland | 2,088 | 1,171 | 1,131 | 1.5% | -40 | -3% | -957 | -46% | T2 | CS,D |
| France | 5,166 | 15,800 | 15,922 | 20.8% | 121 | 1% | 10,756 | 208% | CR,T2 | CS |
| Germany | 38,598 | 9,870 | 8,463 | 11.0% | -1,407 | -14% | -30,135 | -78% | T2 | CS,D |
| Greece | 58 | 584 | 640 | 0.8% | 56 | 10% | 582 | 997% | T2 | CS,D |
| Ireland | NO | 951 | 918 | 1.2% | -33 | -3% | 918 | - | T2 | CS,D |
| Italy | 10,060 | 11,645 | 11,105 | 14.5% | -540 | -5% | 1,045 | 10% | T2 | CS |
| Luxembourg | 75 | 40 | 38 | 0.0% | -2 | -5% | -37 | -50% | T2 | D |
| Netherlands | 12,011 | 4,915 | 4,637 | 6.0% | -278 | -6% | -7,374 | -61% | T2 | CS |
| Portugal | 428 | 2,481 | 2,598 | 3.4% | 117 | 5% | 2,171 | 508% | T2 | CS,D |
| Spain | 4,014 | 10,521 | 11,090 | 14.5% | 570 | 5% | 7,076 | 176% | T2 | D,CR,CS |
| Sweden | 2,874 | 1,471 | 1,367 | 1.8% | -104 | -7% | -1,507 | -52% | T2 | D,CS |
| United Kingdom | 56,002 | 16,366 | 15,870 | 20.7% | -496 | -3% | -40,132 | -72% | T2 | CS |
| **EU-15** | **138,429** | **78,930** | **76,701** | **100.0%** | **-2,229** | **-3%** | **-61,728** | **-45%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

In response to the recommendation by the ERT (FCCC/ARR/2009/EC, para 81), an analysis for trends of emissions for those member States influencing most the European Union's trends is given. The UK decreased its $CH_4$ emissions steadily between 1990 and 2004 due to the implementation of methane recovery systems at UK landfill sites which reached a maximum in 2005, thus the British emission change between 2005 and 2009 is less noticeable.

The ERT also recommended to provide reasons for the increase of methane emissions from managed waste disposal on land for those MS showing the largest increase during the time series (France, Spain, Portugal, Italy and Greece) (FCCC/ARR/2009/EC, para 83).

$CH_4$ emissions on Spain increased continuously from 1990 and 2002 due to a growth of the annual municipal solid waste going to solid waste disposal sites by 108 %. During 2002 and 2004 no change in emissions could be observed; the reason for the interruption of the trend is the increase in the volume of biogas captured and burned in some of managed waste landfills in that time: a lot of landfills with biogas recovery systems were incorporated in the inventory. While in 2000 there were only 14 managed waste landfills with individual and detailed information in 2004 the number increased to 25.

Portugal, contributing with 3.4 % to EU-15 emissions in 2009, managed to slow down the increasing trend due to elevated biogas flaring in landfills; four new $CH_4$ recovery systems were established in 2005 and 2007.

France, contributing with 20.8 % to EU-15 emissions in 2009, increased its emissions at a constant rate until 2003; followed by a alleviated increase until 2009. Emissions followed the increased input of municipal waste going to landfills until 2000, which decreased afterwards. Following the in-country review in 2010, the capture rate of biogas has been revised which resulted in an increase in $CH_4$ emissions over the entire period. This recalculation is the reason why France, for this year's inventory takes the highest share in EU-15 emissions in 2009, whereas for last year's inventory the French share in EU-15 methane emissions from managed waste disposal on land was only 7 %.

Greece's share in total EU-15 emissions in 2009 amount to only 1 %, thus its contribution to the EU-15 emissions trend is marginal. The $CH_4$ generation varies during the time series; for the period 1990 to 1998 it increased steadily, taking into account that the starting year for the managed sites is the year 1990 and that quantities of municipal solid wastes for the period until 2000 was estimated on the basis of population figures and coherent assumptions regarding generation rates per capita and day. Since 2001, more accurate data was provided by the waste management sector of the Ministry of Environment, Energy and Climate Change (MEECC). $CH_4$ recovery was considered to have started in 1992, and increased steadily until now.

Germany, contributing with 11 % to EU-15 emissions in 2009, managed to reduce $CH_4$ emissions steadily until 2005 due to an equal increase of methane recovery until that year as facilities for gas collection were installed on almost all landfill sites; the collected part of the landfill gas increased continuously since 1990. At the same time, the emergence of landfill gas reduced, thus the collected gas volumes are reduced since several years.

In response to the recommendation by the ERT (FCCC/ARR/209/EC, para 82), EU confirmed with Sweden, that it also applied the tier 2 methodology for estimating $CH_4$ emissions from managed solid waste disposal on land like all other MS (Table 8.2).

As mentioned above, source category 6A Solid waste disposal on land includes two key sources: $CH_4$ from 6A1 Managed waste disposal on land and $CH_4$ from 6A2 Unmanaged waste disposal on land. The twenty largest EU key categories cover 70 % of total GHG emissions of which emissions from managed waste disposal on land are included, whereas $CH_4$ emissions from 6A2 Unmanaged waste disposal on land are not. Thus additional information with respect to a detailed analysis of review findings from UNFCCC inventory reviews is provided for 6A1 in EU-15 only. Table 8.3 summarizes the recommendations from the 2010 UNFCCC inventory reviews in relation to the category 6A1 Managed Waste Disposal on Land.

**Table 8.3 6A1 Managed Waste Disposal on Land: Findings of the 2010 UNFCCC inventory review in relation to $CH_4$ emissions and responses in 2011 inventory submissions**

| **Review findings and responses related to 6A1 Managed Waste Disposal on Land** | | |
|---|---|---|
| **Member State** | **Comment UNFCCC report of the review of the 2010 submission** | **Status in 2011 submission** |
| **Austria** | Austria estimated $CH_4$ emissions from solid waste disposal on land using the IPCC tier 2 method – the first order decay model. Background information on the countryspecific AD, including types of waste, and the sudden change in the volume of waste deposited as a result of a new regulation, is appropriately documented in the NIR. The ERT noted that the $CH_4$ generation potential (Lo) of each waste type is not fully explained in the NIR, which Austria informed the ERT during the centralized review that it would incorporate in its next annual submission. (FCCC/ARR/2010/AUT, para 94) | In NIR submission 2011 further details on the parameters of the calculation (L0, no. of considered years) are included. [NIR 2011] |
| | Austria applied the DOC value for 2004 for 2005 onwards, owing to the absence of information on the residual waste deposited in municipal solid waste disposal sites at the national level. The linear increase in the DOC values between 2000 and 2004 applied in the estimation is derived from the interpolation between two different data sources for 2000 and 2004, respectively. During the centralized review, Austria informed the ERT of the possibility of updating the DOC value for 2008 at the provincial level, which could then be applied to the whole country to adjust the 2004–2008 time series accordingly. The ERT recommends that Austria correct the DOC values with updated information, or re-evaluate the method of data collection for DOC, in order to increase the accuracy of the estimated emissions from this category in its next annual submission. (FCCC/ARR/2010/AUT, para 95) | The DOC for Residual Waste is updated in NIR submission 2011 based on new information on waste composition. Thereby the method for calculating the DOC has been slightly adjusted, leading to slightly revised DOC values for 2004 too. [NIR 2011, p. 412] |
| **Belgium** | Emissions from this category were estimated using two models, the multiphase and first order decay (FOD) model for the Flemish Region, and the FOD model for the Walloon Region. To improve transparency and understanding of the differences of the models used, the ERT recommends that, in the NIR of its next annual submission, Belgium list the parameters from each FOD model and the multiphase model in a single table by using the same terminology. (FCCC/ARR/2010/BEL, para 84) | Not yet addressed. [NIR 2011] |
| | In its NIR, Belgium described the different models used to calculate emissions. Nevertheless, the ERT noted a lack of transparency concerning the key parameters used in the models. In response to questions raised by the ERT during the review, Belgium provided more explanations and documentation on key parameters. The ERT welcomes this additional | |

| Review findings and responses related to 6A1 Managed Waste Disposal on Land | | |
|---|---|---|
| **Member State** | **Comment UNFCCC report of the review of the 2010 submission** | **Status in 2011 submission** |
| | information and recommends that Belgium improve the transparency of its NIR by including the parameters from each region and model in a single table in its next annual submission, as already recommended in the previous review.(FCCC/ARR/2010/BEL, para 85) | |
| **Denmark** | Denmark has made some changes in the parameters used in the FOD. The ERT considers that some of these changes need further justification and/or investigation. For example, the value for the oxidation factor set to 0.1 requires further justification than stating that solid waste disposal to land is being well managed. The ERT reiterates the previous recommendations that Denmark further investigate landfill practices and choose the value for the oxidation factor parameter according to recent scientific literature. (FCCC/ARR/2010/DNK, para 136) | Updated documentation of the Danish solid waste disposal on land being well managed has been implemented in the NIR to support the value for the oxidation factor as set to 0.1. However, an in dept investigation of the individual landfill practices have not yet been realised – improvements at this level are ongoing. [NIR 2011, p.584] |
| | The ERT also found that the increase of the parameter half-life (t1/2) from the previous 10 to the default 14 is not relevant for Denmark's wet climate. The ERT encourages the Party to adjust the value and appreciates its plans to further investigate MSW composition and to use individual half-life values for different waste types. (FCCC/ARR/2010/DNK, para 137) | Not yet adressed. [NIR 2011] |
| | The ERT was unable to follow the logic of the calculations and assessments of $CH_4$ emissions from solid waste disposal on land as presented in the NIR. The ERT reiterates the recommendation from the previous review that the Party provide a table in the NIR showing the different waste types disposed of as MSW or incinerated, together with their main characteristics, to increase transparency. The ERT appreciates Denmark's efforts in using a tier 2 uncertainty analysis. However, due to the complexity of the FOD estimation method for $CH_4$ emissions, the ERT encourages the Party to further investigate relevant distributions for different parameters in order to increase accuracy. (FCCC/ARR/2010/DNK, para 138) | The methodology and activity data has been described and provided at a more detailed level that should increase the transparency and ability for the ERT to follow stepwise the calculation procedure and results. An extended version of the Tier 2 uncertainty analysis has been performed applying defined uncertainty ranges for all input parameters. Details are shown in the NIR. [NIR 2011, p.585] |
| **Finland** | The ERT recommends that Finland provide additional data on the amount of landfilled industrial solid waste components and average DOC content in the NIR of its next annual submission. (FCCC/ARR/2010/FIN, para 91) | In its response to the draft annual review report, Finland promised to improve the transparency of reporting by providing in the next submission the mean DOC content of industrial solid waste excluding the highly varying amounts of inert wastes. Also, the waste components of industrial solid waste are presented in this submission.(Table 8.2-11 and Appendix_8c). [NIR 2011, p.376] |
| | The ERT recommends that Finland improve the QA/QC procedures concerning some inconsistencies between the NIR and the CRF tables on $CH_4$ recovery and from landfills and the amounts of construction and demolition waste. (FCCC/ARR/2010/FIN, para 92) | In its response to the draft annual review report, Finland promised to correct the annual waste amounts of CDW in the CRF Reporter and the inconsistencies on $CH_4$ recovery in the next submission. (Table 8.2-10, Appendix_8b and CRF Tables); [NIR 2011, p.376] |
| | The ERT identified that $CH_4$ recovery for 2008 from solid waste disposal sites estimated by the ERT using data provided in Annex 8b of the NIR is lower than the values reported by Finland in the NIR and the CRF tables and concluded that $CH_4$ emissions have been underestimated. The ERT agrees with the revised estimates and recommends that Finland report revised estimates for all years in the time series in its next annual submission. (FCCC/ARR/2010/FIN, para 95) | In its response to the draft annual review report, Finland promised to correct the time series presented in the NIR and in the CRF Reporter. (Table 8.2-10 and CRF Tables) [NIR 2011, p.376] |
| **France** | Review report (In-country review 2010) not yet available. | |
| **Germany** | Review report (In-country review 2010) not yet available. | |
| **Greece** | Accurate data on the composition of municipal solid waste are not available at the national level. For example, garden and park waste as well as other non-food putrescibles have been included in the general putrescibles category. As the DOC value of these waste types differs, their allocation to the same category is not in line with the Revised 1996 IPCC Guidelines. The ERT reiterates the recommendation made in the previous review report that Greece estimates these waste types separately using appropriate DOC values. (FCCC/ARR/2010/GRC, para 96) | The use of appropriate DOC values for waste types like garden (yard) waste and park waste is not possible yet, due to lack of available accurate data. However, the possibility of use of a more detailed composition data of waste landfilled is a continuously target for Greece. It must be noticed that the National Strategy for municipal wastes will be updated soon and any type of new information provided by it will be used. [NIR 2011, p.313] |
| | As the methane correction factor (MCF) and other parameters used for estimating emissions differ between unmanaged and uncategorized SWDS, Greece's allocation of all unmanaged SWDS to uncategorized is not in line with the IPCC good practice guidance. The ERT reiterates the recommendation made in the previous review report that Greece break down the unmanaged sites into the different IPCC categories, apply the appropriate $CH_4$ correction factors and recalculate the corresponding time series. The previous ERT also recommended that the DOCf value be revised; however, | Done (paragraph 8.2.2 of NIR). [NIR 2011, p.313] |

| Review findings and responses related to 6A1 Managed Waste Disposal on Land | | |
|---|---|---|
| **Member State** | **Comment UNFCCC report of the review of the 2010 submission** | **Status in 2011 submission** |
| | in the 2010 submission the DOCf remains at 0.77, which is higher than the default of 0.5 recommended in the IPCC good practice guidance. The value used by Greece is not adequately explained or justified in the NIR, which is not in accordance with the IPCC good practice guidance. The NIR states that Greece will change this value once a country-specific value has been estimated. The ERT recommends that, in the meantime, Greece recalculate its emission estimates applying the default DOCf value suggested in the IPCC good practice guidance. (FCCC/ARR/2010/GRC, para 98) | |
| **Ireland** | In the NIR, Ireland provides detailed information on the calculations and parameters applied to estimate $CH_4$ emissions from food, paper, wood and straw textiles, and disposable nappies. The ERT recommends that Ireland expand the information in its next annual submission to illustrate how all other waste streams are accounted for in the estimates. (FCCC/ARR/2010/IRL, para 103) | Additional information is provided in NIR 2011. (Chapter 8, section 8.2.2. and Annex H, Tables H.1 and H.2.) [NIR 2011, p.278] |
| | Ireland has recalculated the estimates of $CH_4$ recovery from solid waste disposal on land on the basis of a detailed study of landfill sites undertaken by external consultants. This study quantified the $CH_4$ recovered through landfill gas flaring for all years since the practice was introduced and validated the $CH_4$ utilization value in the annual energy balance. During the review, Ireland provided the ERT with information demonstrating that the efficiencies for flaring are based on international good practice standards. The ERT recommends that Ireland include the information provided during the review in its next annual submission to improve the transparency of the inventory. (FCCC/ARR/2010/IRL, para 104) | Additional information is provided in NIR 2011. (Chapter 8, section 8.2.3) [NIR 2011, p.278] |
| **Italy** | Italy uses the tier 2 method to estimate $CH_4$ emissions from solid waste disposal on land, using country-specific AD and a combination of country-specific EFs and IPCC default values. The ERT commends Italy for its implementation of the recommendation of the previous ERT in relation to including in the NIR information on how the amount of $CH_4$ recovered was estimated from the amount of energy produced. The ERT encourages Italy to include an explanation of the finding of the energy conversion efficiency factor used to calculate the $CH_4$ recovered in the NIR of its next annual submission. (FCCC/ARR/2010/ITA, para 80) | Additional explanation has been provided in the NIR (paragraph 8.2.2 – Landfill gas recovered). [NIR 2011, p.486] |
| | The ERT noted that tables with emissions data for solid waste disposal on land have been included in the uncertainty and time-series consistency chapter of the NIR. The ERT recommends that these tables be moved to before the uncertainty and time-series consistency chapter in order to improve transparency. FCCC/ARR/2010/ITA, (para 81) | Tables reporting methane and NMVOC emissions have been moved to paragraph 8.2.2. [NIR 2011, p. 487] |
| **Luxembourg** | Luxembourg reports the recovery of $CH_4$ emissions from solid waste disposal on land for 2001 onwards. During the review, the Party explained that $CH_4$ recovery started in 2000 but the corresponding data are not available. The ERT encourages the Party to report this activity for all the years in which it occurred, by collecting the necessary data or, if these are not available, by applying appropriate extrapolation methods following the IPCC good practice guidance. (FCCC/ARR/2010/LUX, para 75) | $CH_4$ recovery is reported from 2000 onwards. [NIR 2011, p.375] |
| **Netherlands** | Review report (Centralized review 2010) not yet available. | |
| **Portugal** | $CH_4$ emissions from solid waste disposal on land amounted to 4,916.46 Gg $CO_2$ eq in 2008. Within this category, emissions from municipal solid waste and industrial waste are estimated by using the IPCC first order decay (FOD) method and default parameters, except for degradable organic carbon, which was estimated using country-specific data on waste composition. The ERT reiterates the recommendation from the previous review report that Portugal explore the use of country-specific parameters in the FOD model for its next annual submission. The ERT noted that changes in emission trends are not well explained in the NIR and recommends that Portugal provide this information in its next NIR. (FCCC/ARR/2010/PRT, para 92). | There are no national studies that enable the use of country-specific parameters. The development of these can represent significant economic resources still not available. [NIR 2011, p.9-4] |
| **Spain** | Review report (Centralized review 2010) not yet available. | |
| **Sweden** | Review report (Centralized review 2010) not yet available. | |
| **United Kingdom** | A modified first order decay (tier 2) model from the 2006 IPCC Guidelines for National Greenhouse Gas Inventories was used to estimate $CH_4$ emissions from solid waste disposal on land. The AD were determined on the basis of different studies and were compared with data collected by the Environment Agency and the Scottish Environment Protection Agency. AD collected for England were scaled up to cover the whole of the United Kingdom. The ERT accepts this approach and recommends that the Party present a clear plan for the periodic update of the AD. (FCCC/ARR/2010/GBR, para 90) | Not yet adressed. [NIR 2011] |
| | The United Kingdom assumes a constant amount of commercial and industrial waste since 2002. The United Kingdom informed the ERT that new data on waste will be available at the end of 2010 from a survey on England, which will be used to revise this assumption. The ERT recommends that the United Kingdom update the AD used and provide recalculations in its next annual submission, ensuring time-series consistency and the transparent documentation of the recalculations. (FCCC/ARR/2010/GBR, para 91) | Updated ADs have been used in this submission. [NIR 2011, p.225] |

| Review findings and responses related to 6A1 Managed Waste Disposal on Land | | |
|---|---|---|
| **Member State** | **Comment UNFCCC report of the review of the 2010 submission** | **Status in 2011 submission** |
| | The recovery rate of $CH_4$ has increased over time, reaching over 71 per cent in 2008. The amount of landfill gas utilized for energy generation is estimated from information provided by trade associations and DECC. Data from the direct monitoring of flared landfill gas are not available and the amount of $CH_4$ recovered is estimated on the basis of the total available flaring capacity. Previous ERTs have recommended that the United Kingdom collect updated survey data, in accordance with the IPCC good practice guidance, in order to avoid a possible overestimation of the $CH_4$ recovery rates. In the NIR, the United Kingdom reports that Defra are currently reviewing the $CH_4$ emissions from landfills. The present ERT reiterates recommendations of previous ERTs that the Party update its AD on landfill gas and provide detailed information on data in its next annual submission. (FCCC/ARR/2010/GBR, para 92) | The overall landfill gas recovery rate (70% of methane produced) from 2005 onwards is based on industry estimates of gas collection efficiency at sites during the phase of maximal gas production, reduced to reflect estimated collection efficiency over the whole gassing life of a landfill. We have no evidence that gas collection efficiency has continued to increase since 2005, but further research is proposed to reduce this aspect of uncertainty. [NIR 2011, p.272] |

*Source: NIR 2011, UNFCCC inventory review reports, as published at UNFCCC: http://unfccc.int/national_reports/annex_i_ghg_inventories/inventory_review_reports/items/5687.php*

$CH_4$ emissions from 6A2 Unmanaged Waste Disposal on Land account for 0.16 % of total EU-15 GHG emissions in 2009. Between 1990 and 2009, $CH_4$ emissions from this source decreased by 56 % in all MS (except for Spain) due to a decreasing amount of municipal waste going to unmanaged waste disposal sites (Table 8.4). The increase of $CH_4$ emissions from unmanaged waste disposal on land in Spain did not occur steadily throughout the whole time series but peaked in 1999, thus also showing a decreasing trend from 1999 onwards. The trend of the waste amount in unmanaged landfills is due to two kinds of emissions: instant emissions, due to the waste burning, and emissions originated by wasted disposed in a series of years up to the current year. The latter emissions are estimated by Spain with the first order kinetic methodology as the processes for decomposition in landfill of the municipal waste have a maturing period of several years, which may range from one year for the more labile components up to over 35 years for those with the lowest biodegradation rate. The combination of both processes (burning of wastes disposed in the current year plus emissions from wastes disposed in the past) produces this reversal of $CH_4$ emissions trend in 1999.

This could similarly be observed for Portugal in 1998, due to a continuous reduction of waste disposal in unmanaged sites. Since 1997 there has been a continuous reduction of this disposal type; the majority of unmanaged dumping sites closed in 2002.

Not all Member States reported emissions from this source since all waste disposal sites in the countries are managed (Austria, Belgium, Denmark, Finland, Germany (due to first Waste Act since 1972), Luxembourg, the Netherlands, Sweden) or considered to be not significant sources (the UK). France, Italy and Greece are responsible for about 73 % of the total EU-15 emissions. France and Italy had large absolute reductions between 1990 and 2009. Since 2005, no waste is disposed on unmanaged landfill sites any more. However, emissions are still produced from the waste disposed in the past.

The reduction of emissions from unmanaged waste disposal on land in Italy is caused by legal acts. The first legal provision concerning waste management was issued in 1982. In this decree, uncontrolled waste dumping as well as unmanaged landfills are forbidden, but the enforcement of these measures has been concluded only in 2000. Thus the share of waste disposed into uncontrolled landfills has gradually decreased, and in the year 2000 it has been assumed equal to zero; nevertheless emissions still occur due to the waste disposed in the past years.

Following the Greek National and Regional Planning of Solid Waste Management (compiled in the end of 2003), the process of closure and rehabilitation of unmanaged sites is in progress, and unmanaged solid waste disposal sites in Greece are expected to decline (from 4690 unmanaged sites in 1987 to 2182 sites still operating in 2000 and further).

Table 8.4 shows that 100 % of the EU-15 emissions are estimated using higher tier methodologies.

**Table 8.4** **6A2 Unmanaged Waste Disposal on Land: Member States' contributions to $CH_4$ emissions and information on method applied and emission factor**

| Member State | $CH_4$ emissions (Gg $CO_2$ equivalents) | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg CO2 equivalents) | (%) | (Gg CO2 equivalents) | (%) | | |
| Austria | NO | NO | NO | - | - | - | - | - | NO | NO |
| Belgium | NO | NO | NO | - | - | - | - | - | NA | NA |
| Denmark | NO | NO | NO | - | - | - | - | - | NA | NA |
| Finland | IE,NO | NO | NO | - | - | - | - | - | NA | NA |
| France | 3,684 | 1,232 | 1,148 | 19.1% | -84 | -7% | -2,536 | -69% | CR,T2 | CS |
| Germany | NO | NO | NO | - | - | - | - | - | NA | NA |
| Greece | 1,787 | 1,658 | 1,579 | 26.3% | -78 | -5% | -208 | -12% | T2 | CS,D |
| Ireland | 1,173 | 176 | 163 | 2.7% | -12 | -7% | -1,010 | -86% | T2 | CS,D |
| Italy | 5,194 | 1,720 | 1,637 | 27.3% | -83 | -5% | -3,557 | -68% | T2 | CS |
| Luxembourg | NO | NO | NO | - | - | - | - | - | NA | NA |
| Netherlands | NO | NO | NO | - | - | - | - | - | NA | NA |
| Portugal | 1,006 | 678 | 623 | 10.4% | -55 | -8% | -383 | -38% | T2 | CS,D |
| Spain | 734 | 870 | 847 | 14.1% | -24 | -3% | 113 | 15% | T2 | D |
| Sweden | NO | NO | NO | - | - | - | - | - | NA | NA |
| United Kingdom | NO | NO | NO | - | - | - | - | - | NA | NA |
| **EU-15** | **13,578** | **6,333** | **5,997** | **100.0%** | **-336** | **-5%** | **-7,580** | **-56%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

Table 8.5 provides information on the contribution of Member States to EU recalculations in $CH_4$ from 6A Solid Waste Disposal on Land for 1990 and 2008 and main explanations for the largest recalculations in absolute terms.

**Table 8.5** **6A Solid Waste Disposal on Land: Contribution of MS to EU recalculations in $CH_4$ for 1990 and 2008 (difference between latest submission and previous submission in Gg of $CO_2$ equivalents and percent)**

| | 1990 | | 2008 | | Main explanations |
|---|---|---|---|---|---|
| | Gg CO2 equiv. | Percent | Gg CO2 equiv. | Percent | |
| Austria | 0 | 0.0 | 19 | 1.2 | Changes in number of years considered (waste type specific), DOC Residual Waste, landfill gas recovery |
| Belgium | 0 | 0.0 | 0 | 0.0 | |
| Denmark | 0 | 0.0 | 0 | 0.0 | |
| Finland | 0 | 0.0 | 67 | 3.6 | Improved activity data between rural and densely populated areas. Improved activity data in Vahti database. |
| France | 620 | 7.5 | 11,230 | 193.5 | Mise a jour taux de captage du biogaz suite à la revue CCNUCC |
| Germany | 2,688 | 7.5 | 2,352 | 31.3 | Revision of methane recovery from landfills |
| Greece | 60 | 3.3 | 213 | 9.5 | Use FOD methodology on the estimation of flared biogas. Revision of DOCf. Modification of methane correction factor and fraction of DOC dissimilated (DOCF). Updated activity data. |
| Ireland | 0 | 0.0 | 191 | 20.4 | Revised estimate of landfill gas flared and revised waste quantities to deposited at SWDS |
| Italy | 1,960 | 14.7 | 2,288 | 20.7 | - Industrial wastes disposed into MSW landfills have been added and revision of rapidly biodegradable fractions<br>- Revision of sludge time series and addition of industrial wastes. New waste composition from 2006 and revision of previous waste compositions |
| Luxembourg | 0 | 0.0 | 1 | 2.7 | 2004-2008: In 2010 a new MSW analysis was published, and thus the waste compostion between 2004 and 2008 was recalculated via interpolation, the previous MSW analysis was done in 2004/2005. |
| Netherlands | 0 | 0.0 | 19 | 0.4 | Improved final AD |
| Portugal | 0 | 0.0 | 111 | 2.3 | Industrial SWD: update of DOC value from new data for 2008. |
| Spain | 0 | 0.0 | 69 | 0.6 | New information available regarding solid waste disposal and CH4 recovery |
| Sweden | 0 | 0.0 | 5 | 0.4 | New acitivty data from waste statistics regulation |
| UK | 6,377 | 12.8 | -3,784 | -18.8 | - Major review and update to the model used to estimate emissions from landfilled waste.<br>- A new time series of waste sent to landfill and waste composition has been identified and is now used. |
| **EU-15** | **11,705** | **8.2** | **12,783** | **17.0** | |

## *8.2.2 Wastewater handling (CRF Source Category 6B) (EU-15)*

Source category 6B includes two key sources: $CH_4$ and $N_2O$ from 6B2 Domestic and commercial wastewater. Methane and nitrous oxide are produced from anaerobic decomposition of organic matter by bacteria in sewage facilities. $N_2O$ may also be released from wastewater handling and human waste. Domestic and commercial wastewater includes the handling of liquid wastes and sludge from housing and commercial sources (including human waste) through wastewater collection and treatment, open pits/latrines, ponds, or discharge into surface waters. $N_2O$ emissions from discharge of human sewage to aquatic environments are included here.

Table 8.6 shows total GHG, $CH_4$ and $N_2O$ emissions by Member State from 6B Wastewater Handling. Between 1990 and 2009, $CH_4$ emissions from wastewater handling decreased by 22 % in EU-15 (in 8 MS, whereas Denmark, France, Ireland, Italy, Spain, Sweden and the UK increased their methane emissions), $N_2O$ emissions from wastewater handling increased by 4 % (in 9 MS, whereas Belgium, Denmark, Finland, France, the Netherlands and Sweden reduced their emissions of nitrous oxide).

$CH_4$ emission trends for 6B Wastewater Handling are completely driven by trends in 6B2 Domestic and Commercial Wastewater for Austria, Belgium, Denmark, Germany, Luxembourg and the United Kingdom; the other MS additionally report $CH_4$ emissions from 6B1 Industrial Wastewater. Nevertheless, as emissions from 6B2 are key source category emissions, the trend of $CH_4$ emissions from 6B Wastewater Handling are mainly driven by emissions from 6B2 for these MS, too. Thus, in response to the recommendation by the ERT (FCCC/ARR/2009/EC, para 84), more information about the decrease and increase of $CH_4$ and $N_2O$ emissions from 6B Wastewater Handling are included in the following subchapters.

**Table 8.6 6B Wastewater handling: Member States' contributions to total GHG, $CH_4$ and $N_2O$ emissions from 6B**

| Member State | GHG emissions in 1990 (Gg $CO_2$ equivalents) | GHG emissions in 2009 (Gg $CO_2$ equivalents) | $CH_4$ emissions in 1990 (Gg $CO_2$ equivalents) | CH4 emissions in 2009 (Gg $CO_2$ equivalents) | $N_2O$ emissions in 1990 (Gg CO2 equivalents) | N2O emissions in 2009 (Gg CO2 equivalents) |
|---|---|---|---|---|---|---|
| Austria | 211 | 288 | 102 | 27 | 109 | 261 |
| Belgium | 514 | 417 | 219 | 122 | 294 | 294 |
| Denmark | 176 | 156 | 66 | 75 | 109 | 81 |
| Finland | 297 | 214 | 154 | 121 | 144 | 94 |
| France | 2,228 | 2,350 | 841 | 1,205 | 1,388 | 1,144 |
| Germany | 4,450 | 2,385 | 2,226 | 81 | 2,224 | 2,304 |
| Greece | 3,164 | 1,222 | 2,835 | 839 | 328 | 383 |
| Ireland | 129 | 161 | 15 | 16 | 114 | 145 |
| Italy | 3,822 | 4,687 | 1,990 | 2,723 | 1,832 | 1,964 |
| Luxembourg | 15 | 14 | 6 | 3 | 9 | 11 |
| Netherlands | 755 | 645 | 290 | 207 | 466 | 438 |
| Portugal | 2,942 | 2,397 | 2,481 | 1,874 | 460 | 523 |
| Spain | 2,315 | 3,570 | 1,243 | 2,304 | 1,072 | 1,265 |
| Sweden | 502 | 456 | 292 | 298 | 211 | 158 |
| United Kingdom | 1,524 | 1,709 | 278 | 336 | 1,246 | 1,372 |
| **EU-15** | **23,044** | **20,671** | **13,038** | **10,232** | **10,007** | **10,438** |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

$CH_4$ from 6B2 Domestic and Commercial Wastewater accounts for 0.18 % of total EU-15 GHG emissions. Between 1990 and 2009 emissions decreased by 27 %. Large decreases in absolute terms are reported from Germany and Greece, contributing to only 5 % of EU-15 emissions in 2009, whereas Spain, Italy and France had large emission increases (Table 8.7). Spain was responsible for 26 %, Italy for 23 % and France for 17 % of the EU-15 emissions from this source in 2009. Although these MS increased their emissions during 1990 and 2009, the trend of EU-15 emissions is nevertheless dominated by the large emission reductions in Germany and Greece.

Germany's reduction in $CH_4$ emissions occurred mainly during 1995 and 1998. The decrease of 76 % was due to the legal requirement to connect households to decentral wastewater treatment plants. For this reason many plants were build in the former GDR after the German reunification. Most of them were accomplished between 1995 and 1998 and started their work in this period of time.

The Greek $CH_4$ emissions decreased mainly during 1999 and 2001 (-56 %) due to the increased number of wastewater handling facilities under aerobic conditions. In Greece, domestic wastewater handling in aerobic treatment facilities shows a substantial increase since 1999, while in the industrial sector only a few units exist where wastewater is handled under anaerobic conditions; the penetration of such facilities increased from 32 % (of total population served) in 1999 and to 84 % in 2005.

The French $CH_4$ emissions showed an increasing trend from 1990 to 2001 and remained at constant level until 2009. The trend results mainly from wastewater treatment in autonomous system. In France the number of inhabitants connected to a septic system increased from 1990 to 2001 (the share of population connected to an autonomous system increased from 13 % in 1990 to 18 % in 2001), and then remained almost constant still 2009 even with a small decrease.

Sweden, for the inventory submission in 2011 estimated emissions from wastewater handling for the first time. Corresponding to a recommendation raised during the Centralized Review in 2010, the completeness of the EU- inventory has thus been improved.

The largest increase in $CH_4$ emissions from domestic and commercial wastewater during 2008 and 2009 could be found for Spain, due to an increment in the wastewater treated. In turn this increment was mainly caused by i) the increase in the population number and ii) the increase in the percentage of the whole population whose wastewater discharge are treated in the wastewater treatment plant.

**Table 8.7 6B2 Domestic and commercial wastewater: Member States' contributions to $CH_4$ emissions and information on method applied and emission factor**

| Member State | $CH_4$ emissions (Gg $CO_2$ equivalents) | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg CO2 equivalents) | (%) | (Gg CO2 equivalents) | (%) | | |
| Austria | 102 | 27 | 27 | 0.4% | 0 | 0% | -75 | -73% | D | CS,D |
| Belgium | 219 | 123 | 122 | 1.9% | 0 | 0% | -97 | -44% | T1,CR | D,CR |
| Denmark | 66 | 74 | 75 | 1.1% | 0 | 0% | 8 | 13% | D,CS | D,CS |
| Finland | 131 | 103 | 102 | 1.5% | -1 | -1% | -29 | -22% | D | CS,D |
| France | 795 | 1,144 | 1,150 | 17.4% | 6 | 1% | 355 | 45% | CR,T2 | CS |
| Germany | 2,226 | 91 | 81 | 1.2% | -10 | -11% | -2,145 | -96% | D | CS,D |
| Greece | 2,163 | 229 | 218 | 3.3% | -10 | -4% | -1,944 | -90% | D | D |
| Ireland | 13 | 10 | 10 | 0.2% | 0 | 2% | -3 | -21% | T1 | D |
| Italy | 713 | 1,507 | 1,514 | 22.9% | 7 | 0% | 801 | 112% | D | D |
| Luxembourg | 6 | 3 | 3 | 0.0% | 0 | -9% | -3 | -49% | T1 | CS |
| Netherlands | 190 | 173 | 184 | 2.8% | 11 | 6% | -7 | -4% | T2 | CS |
| Portugal | 1,056 | 765 | 754 | 11.4% | -11 | -1% | -302 | -29% | D | CS,D |
| Spain | 756 | 1,690 | 1,742 | 26.4% | 52 | 3% | 986 | 130% | D | D,CS |
| Sweden | 284 | 289 | 289 | 4.4% | 0 | 0% | 5 | 2% | CS,D,T1 | CS,D |
| United Kingdom | 278 | 350 | 336 | 5.1% | -13 | -4% | 58 | 21% | CS | CS |
| **EU-15** | **8,999** | **6,578** | **6,609** | **100.0%** | **30** | **0%** | **-2,391** | **-27%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

Table 8.8 provides information on the contribution of Member States to EU recalculations in $CH_4$ from 6B Wastewater handling for 1990 and 2008 and main explanations for the largest recalculations in absolute terms.

**Table 8.8** **6B Wastewater Handling: Contribution of MS to EU recalculations in $CH_4$ for 1990 and 2008 (difference between latest submission and previous submission in Gg of $CO_2$ equivalents and percent)**

| | 1990 | | 2008 | | Main explanations |
|---|---|---|---|---|---|
| | Gg CO2 equiv. | Percent | Gg CO2 equiv. | Percent | |
| Austria | 0 | 0.0 | -4 | -13.3 | update connection rate |
| Belgium | 0 | 0.0 | 0 | 0.0 | |
| Denmark | 36 | 117.7 | 27 | 57.3 | |
| Finland | 0 | 0.0 | 0 | 0.3 | Improved activity data between rural and densely populated areas. Improved activity data in Vahti database. |
| France | 6 | 0.7 | -102 | -7.8 | Modification du taux d'utilisation du lagunage naturel. Modification du taux de connexion |
| Germany | 0 | 0.0 | -9 | -9.2 | updated acivity data (Population) |
| Greece | 516 | 22.3 | 532 | 160.7 | Updated data for the fractions of industrial degradable organic component removed as sludge |
| Ireland | 0 | - | 0 | - | |
| Italy | 0 | 0.0 | -121 | -4.2 | Update of Total Inhabitants Equivalent values. Update of activity data (Industrial wastewater - beer) |
| Luxembourg | 0 | 0.0 | 0 | 0.0 | |
| Netherlands | 0 | 0.0 | 0 | 0.0 | |
| Portugal | 39 | 1.6 | -307 | -12.8 | - Updates (2008) on types of treatment and new estimates for total population<br>- Revision of activity data on industrial production (1990 and 2008); and revision of treatment types |
| Spain | 0 | 0.0 | 0 | 0.0 | |
| Sweden | 292 | 100.0 | 300 | 100.0 | New activity added |
| UK | -423 | -60.3 | -457 | -56.6 | - Major review and update to method used for estimating methane emissions from waste water treatment.<br>- New emission factors obtained from the water companies.<br>- New time series of activity data identified and used. |
| **EU-15** | **466** | **3.7** | **-141** | **-1.3** | |

$N_2O$ from 6B2 Domestic and Commercial wastewater accounts for 0.27 % of total EU-15 GHG emissions. Between 1990 and 2009 emissions increased by 5 % (Table 8.9). Comparably large decreases in absolute terms are only reported from France, whereas Italy and Spain had emission increases (Table 8.9). France increased the N efficiency of the waste-water plants since 1995, thus emissions decreased since that year and contribute with a share of 10.7 % to the EU-15 emissions in 2009, whereas this share in EU-15 emissions amount to 13.4% in 1990.

Emissions are mainly driven by the daily per capita protein consumption, being one relevant component for the calculation of nitrous oxide emissions from household wastewater according to the IPCC method. Germany was responsible for 23 %, Italy for 19 % and Spain for 13 % of the emissions from this source in 2009. Table 8.9 also suggests that 15 % of the EU-15 emissions are estimated using higher tier methodologies.

**Table 8.9** **6B2 Domestic and Commercial Wastewater: Member States' contributions to $N_2O$ emissions and information on method applied and emission factor**

| Member State | $N_2O$ emissions (Gg $CO_2$ | | | Share in EU15 emissions in 2009 | Change 2008- | | Change 1990- | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg CO2 equivalents) | (%) | (Gg CO2 equivalents) | (%) | | |
| Austria | 106 | 204 | 205 | 2.0% | 1 | 0% | 99 | 94% | D,CS | CS,D |
| Belgium | 294 | 293 | 294 | 2.9% | 1 | 0% | 0 | 0% | D | D |
| Denmark | 109 | 111 | 81 | 0.8% | -31 | -27% | -29 | -26% | D,CS | D,CS |
| Finland | 105 | 80 | 73 | 0.7% | -7 | -8% | -32 | -30% | D,CS | D |
| France | 1,285 | 1,084 | 1,074 | 10.7% | -10 | -1% | -211 | -16% | CR,T2 | CS |
| Germany | 2,224 | 2,310 | 2,304 | 23.0% | -6 | 0% | 80 | 4% | D | D |
| Greece | 325 | 378 | 380 | 3.8% | 1 | 0% | 55 | 17% | D | D |
| Ireland | 114 | 144 | 145 | 1.4% | 1 | 1% | 31 | 27% | T1 | D |
| Italy | 1,761 | 1,902 | 1,904 | 19.0% | 2 | 0% | 142 | 8% | D | D |
| Luxembourg | 9 | 11 | 11 | 0.1% | 0 | 1% | 2 | 21% | T1 | D |
| Netherlands | 466 | 460 | 438 | 4.4% | -22 | -5% | -28 | -6% | T2 | D |
| Portugal | 299 | 355 | 354 | 3.5% | 0 | 0% | 55 | 18% | D | D |
| Spain | 1,072 | 1,248 | 1,265 | 12.6% | 17 | 1% | 193 | 18% | D | D |
| Sweden | 173 | 136 | 136 | 1.4% | 0 | 0% | -37 | -21% | CS | D |
| United Kingdom | 1,246 | 1,363 | 1,372 | 13.7% | 9 | 1% | 127 | 10% | T1 | D |
| **EU-15** | **9,589** | **10,080** | **10,038** | **100.0%** | **-42** | **0%** | **449** | **5%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

Table 8.10 provides information on the contribution of Member States to EU recalculations in $N_2O$ from 6B Wastewater Handling for 1990 and 2008.

**Table 8.10** **6B Wastewater Handling: Contribution of MS to EU recalculations in $N_2O$ for 1990 and 2007 (difference between latest submission and previous submission in Gg of $CO_2$ equivalents and percent)**

| | 1990 | | 2008 | | Main explanations |
|---|---|---|---|---|---|
| | Gg CO2 equiv. | Percent | Gg CO2 equiv. | Percent | |
| Austria | 1 | 1.0 | 0 | 0.0 | update protein intake, connection rate |
| Belgium | 1 | 0.3 | 19 | 7.0 | The emissions of N2O from human sewage (6B) are revised during the 2011 submission for the complete time series in the three regions due to new protein consumption factors from FAO that became available. |
| Denmark | 3 | 3.1 | 7 | 6.6 | |
| Finland | 0 | 0.0 | 0 | -0.2 | Improved activity data between rural and densely populated areas. Improved activity data in Vahti database. |
| France | 203 | 17.2 | 193 | 20.0 | - Mise a jour de l'activité sur toute la série (azote rejeté par les industriels)<br>- Modification de la consommation de protéines + du taux de connexion |
| Germany | 0 | 0.0 | 0 | 0.0 | |
| Greece | 3 | 1.0 | 4 | 1.0 | CS method was used. Updated AD. |
| Ireland | 0 | 0.0 | 0 | 0.0 | |
| Italy | -32 | -1.7 | -70 | -3.4 | Nitrogen content in sludge used in agriculture (emissions accounted in 4.D.1.6) has been subtracted from total nitrogen content in human sewage. Protein consupmtion 2008 value changed due to has been assumed equal to 2007, consequently is changed as it has been assumed equal to 2007. Update of activity data (Industrial wastewater - beer). |
| Luxembourg | 0 | 0.0 | 0 | 2.5 | 2003-2008: population firgures were streamlined with the data as published by Statec. |
| Netherlands | 0 | 0.0 | 1 | 0.2 | error correction |
| Portugal | 19 | 4.2 | -14 | -2.5 | 1) Industrial WWH: Changes refer to revision of Industrial organic load and treatment on the basis of the revision of activity data on industrial production (1990 and 2008) and revision of treatment types. 2) Domestic sewage: change in protein intake data source data (from FAO data to National Statistical Office data) |
| Spain | 0 | 0.0 | 0 | 0.0 | |
| Sweden | 7 | 3.7 | 13 | 8.7 | New activity data. New value on organic product. |
| UK | 218 | 21.2 | 126 | 10.2 | Consistent time series of protein consumption data identified and used. |
| **EU-15** | **424** | **4.4** | **279** | **2.7** | |

### *8.2.3 Waste incineration (CRF Source Category 6C) (EU-15)*

Source category 6C Waste incineration includes one key category: $CO_2$ from 6C Waste Incineration. This category includes incineration of waste, not including waste-to-energy facilities. Emissions from waste burnt for energy are reported under 1A Fuel combustion activities. Emissions from burning of agricultural wastes should be reported under 4 Agriculture.

Table 8.11 and Table 8.12 summarize greenhouse gas emission trends by Member State. $CO_2$ emissions from waste incineration account for 0.07 % of total EU-15 GHG emissions and decreased by 35 % between 1990 and 2009. All MS decreased their $CO_2$ emissions from waste incineration during 1990 and 2009, except for France, Greece, and Sweden. The UK, Italy and Belgium had the largest decreases in absolute terms; these MS account for 24 % of the emissions from this source in 2009.

**Table 8.11 6C Waste Incineration: Member States' contributions to total GHG and $CO_2$ emissions**

| Member State | GHG emissions in 1990 (Gg $CO_2$ equivalents) | GHG emissions in 2009 (Gg $CO_2$ equivalents) | $CO_2$ emissions in 1990 (Gg) | CO2 emissions in 2009 (Gg) |
|---|---|---|---|---|
| Austria | 27 | 12 | 27 | 12 |
| Belgium | 253 | 77 | 253 | 77 |
| Denmark | 0.21 | 0.30 | IE | IE |
| Finland | 0.00 | 0.00 | IE | IE |
| France | 2,036 | 2,090 | 1,737 | 1,797 |
| Germany | 0.00 | 0.00 | NO | NO |
| Greece | 0.16 | 4 | 0.15 | 4 |
| Ireland | 0.00 | 0.00 | NE | NO |
| Italy | 785 | 661 | 537 | 250 |
| Luxembourg | 0.00 | 0.00 | IE | IE |
| Netherlands | 0.00 | 0.00 | IE | IE |
| Portugal | 11 | 2 | 10 | 1 |
| Spain | 88 | 12 | 78 | 4 |
| Sweden | 45 | 114 | 44 | 108 |
| United Kingdom | 1,395 | 325 | 1,212 | 280 |
| **EU-15** | **4,641** | **3,297** | **3,898** | **2,531** |

*Emissions of Denmark and Finland are included in the Energy sector.*
*Emissions of Luxembourg and the Netherlands are included in 1A1a*
*Emissions of Ireland are not reported because data for whole time series are not available.*
*Emissions of Germany are not reported because all waste incineration in Germany is carried out with energy recovery; for this reason, and in order to avoid double counting, the resulting emissions are reported in the energy section and $CO_2$ emissions from 6.C are not occurring.*
*Abbreviations explained in the Chapter 'Units and abbreviations'.*

**Table 8.12** **6C Waste incineration: Member States' contributions to $CO_2$ emissions and information on method applied and emission factor**

| Member State | $CO_2$ emissions in Gg | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg CO2 equivalents) | (%) | (Gg CO2 equivalents) | (%) | | |
| Austria | 27 | 12 | 12 | 0.5% | 0 | 0% | -15 | -54% | D | CS,D |
| Belgium | 253 | 91 | 77 | 3.0% | -14 | -15% | -176 | -70% | T1 | PS |
| Denmark | IE | IE | IE | - | - | - | - | - | NA | NA |
| Finland | IE | IE | IE | - | - | - | - | - | NA | NA |
| France | 1,737 | 1,463 | 1,797 | 71.0% | 334 | 23% | 60 | 3% | CR | CS,PS |
| Germany | NO | NO | NO | - | - | - | - | - | NA | NA |
| Greece | 0.15 | 4 | 4 | 0.1% | 0 | -2% | 3 | - | D | D |
| Ireland | NE | NO | NO | - | - | - | - | - | NA | NA |
| Italy | 537 | 250 | 250 | 9.9% | 0 | 0% | -287 | -53% | D | CS |
| Luxembourg | IE | IE | IE | - | - | - | - | - | NA | NA |
| Netherlands | IE | IE | IE | - | - | - | - | - | NA | NA |
| Portugal | 10 | 1 | 1 | 0.0% | 0 | 0% | -10 | -94% | D | CS,D |
| Spain | 78 | 4 | 4 | 0.2% | 0 | 0% | -74 | -95% | CR | CR,CS |
| Sweden | 44 | 123 | 108 | 4.3% | -14 | -12% | 65 | 147% | M | PS |
| United Kingdom | 1,212 | 281 | 280 | 11.0% | -1 | 0% | -933 | -77% | T2 | CS |
| **EU-15** | **3,898** | **2,227** | **2,531** | **100.0%** | **305** | **14%** | **-1,367** | **-35%** | | |

*Emissions of Denmark and Finland are included in the Energy sector.*
*Emissions of Luxembourg and the Netherlands are included in 1A1a.*
*Emissions of Ireland are not reported because data for whole time series are not available.*
*Emissions of Germany are not reported because all waste incineration in Germany is carried out with energy recovery; for this reason, and in order to avoid double counting, the resulting emissions are reported in the energy section and $CO_2$ emissions from 6.C are not occurring.*

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

## 8.3 Methodological issues and uncertainties (EU-15)

The following considerations address national methods and circumstances which are available in the Member States' national inventory reports. The focus is laid on the reporting categories 6A1 $CH_4$ emissions from managed solid waste disposal sites and 6A2 $CH_4$ emissions from unmanaged solid waste disposal sites since they are EU-15 key categories and contribute 1.8 % and 0.16 % of total GHG emissions, respectively. The reporting category 6B2 $CH_4$ emissions from domestic and commercial wastewater is a key source in the EU-15 as well and is also comprehensively analysed. Source categories 6B1, 6C and 6D are only briefly discussed.

### *8.3.1 Managed Solid Waste Disposal (CRF Source Category 6A1) (EU-15)*

$CH_4$ emissions from managed solid waste disposal are key sources in all Member States, with the exception of Luxembourg. For key sources in the source category, 6A it is good practice to use the First Order Decay (FOD) method (Tier 2) to calculate the emissions and to display emissions trends over time. All EU-15 Member States applied – in line with the IPCC Good Practice Guidance – Tier 2 methodologies in order to estimate $CH_4$ emissions from managed solid waste disposal sites, which means that 100 % of all EU-15 emissions are calculated using higher tier methods, see Table 8.2. Two Member States used a country-specific emission model in accordance with the Tier 2 methodology (Denmark and Belgium). The remaining Member States applied the Tier 2 methodology proposed by the IPCC Good Practice Guidance and the IPCC Guidelines. Table 8.13 summarizes the characteristics of the national methodologies for estimating $CH_4$ emissions from managed solid waste disposal sites.

**Table 8.13 6A1 Managed Waste Disposal: Description of national methods used for estimating $CH_4$ emissions**

| Member State | Description of methods |
|---|---|
| **Austria** | For the calculation of emissions of solid waste disposal on land, IPCC Tier 2 method is applied. Where available, country-specific factors are used. If these were not available, IPCC default values are taken. [NIR 2011] |
| **Belgium** | The methodology used to calculate the emissions from solid waste disposal on land differs between the two regions in Belgium where these sites are located (Flanders and Wallonia).<br>In the Flemish region, a combination of two models is used: a multiphase model for the estimation of emissions of the sites which are permitted and a first order decay model for all other, old waste disposal sites which are no longer permitted to dispose, but where still emissions occur after the ban of disposal on these sites (these are the solid waste disposal sites in after-care).<br>Walloon region: The $CO_2$ and $CH_4$ emissions from solid waste disposal on land are calculated with a first order decay model that considers separately the emissions of industrial and municipal waste until 2007. This was due mainly because it was separated in the Walloon waste statistics. In 2010, Walloon waste figures have been given under another format which doesn't consider separately the amounts of industrial and municipal waste anymore. The overall methodology follows the Tier 2 IPCC methodology.<br>No waste disposal sites are located in the Brussels region. [NIR 2011] |
| **Denmark** | The $CH_4$ emission at the Danish SWDSs is based on a First Order Decay (FOD) model according to an IPCC tier 2 approach (IPCC 1997, 2000 and 2006). The model calculations are performed using national statistics on landfill site characteristics and amounts of waste fractions deposited each year.[NIR 2011] |
| **Finland** | Finland uses the IPCC Tier 2 method as a basis for the estimation of $CH_4$ emissions. However Equation 5.1 from the GPG (2000) has been slightly modified, so that the term MCF (t) has been substituted by the term MCF (x) in the calculation of the methane generation potential L0(x). Calculations are not made separately for each landfill but the total waste amount and the average common MCF value for each year have been used. It has been thought that the situation in year t defines the MCF to be used for the emissions caused by waste amounts landfilled in the previous years (and degraded later in year t) as well.[NIR 2011] |
| **France** | $CH_4$ emissions are determined by using the first order decay method consistent with IPCC Tier 2 by integrating data on the effectiveness of capture from biogas flared or recovered. Country-specific parameters are based on measurements. Quantities of waste landfilled are known from 1960 onwards and based on surveys from ITOMA of ADEME [NIR 2011] |
| **Germany** | IPCC Tier 2 Method used partly with IPCC default parameters, partly with CS parameters where available. [NIR 2011] |
| **Greece** | IPCC Tier 2 Method used. The estimation of methane emissions from solid waste disposal on land is based on the application of the FOD method. The method was applied separately for the managed and unmanaged waste disposal, taking account of the different conditions in those sites and the detailed information available regarding the opening and closure years of the operation of the managed sites. [NIR 2011] |
| **Ireland** | The methodology for estimating $CH_4$ production given in the 2006 IPCC Guidelines has been applied for use in the 2010 and subsequent submissions. In the present model analyses undertaken for both individual sites and groups of landfills, annual MCF values show an increase over time to reflect the change from generally shallow, poorly-managed landfills before 1998 (and therefore pre landfill licensing) to well controlled and engineered landfills in subsequent years. The model was applied for the five largest landfills individually and to all other landfills by assigning them to seven separate groups according to annual waste amount and life cycle. Two additional runs were used to account for sewage sludge and street cleanings. [NIR 2011] |
| **Italy** | Emission estimates from solid waste disposal on land have been carried out using the IPCC Tier 2 methodology, through the application of the First Order Decay Model (FOD). The assumption that all the landfills, both managed and unmanaged, started operation in the same year, and have the same parameters, has been considered, although characteristics of individual sites can vary substantially. [NIR 2011] |
| **Luxembourg** | The spreadsheet implementing the Tier 1 methodology from the 2006 IPCC Guidelines for national greenhouse gas inventories has been used. Following the recommendations of the in-country review of 2008 and the centralized review of 2009169, the calculation was made since 1950 and also taking into account the pre-treatment of waste before being landfilled. In 2009, the Environment Agency conducted two studies: 1) Composition of the high caloric fraction from SIDEC and 2) Emissions of the waste deposited at the MSW landfills. In 2011 the study "Emissions of the waste deposited at the MSW landfills" was refined for the period 2004-2007, calculated for the years 2008 and 2009 and extrapolated for the years 2010 to 2030. [NIR 2011] |
| **Netherlands** | In order to calculate the $CH_4$ emissions from all the landfill sites in the Netherlands, the simplifying assumption was made that all the wastes are assumed to be landfilled on one landfill site, an action that started in 1945. However, characteristics of individual sites vary substantially. $CH_4$ emissions from this 'national landfill' are then calculated using a first-order decomposition model (first-order decay function) with an annual input of the total amounts deposited and the characteristics of the land-filled waste and the amount of landfill gas extracted. This is equivalent to the IPCC Tier 2 methodology. Since the $CH_4$ emissions from landfills are a key source, the present methodology is in line with the IPCC Good Practice Guidance. [NIR 2011] |
| **Portugal** | To better take into account to the fact that $CH_4$ emissions from SWDS occur over a long period of time and not immediately after disposal of waste on land, the methodological approach considered was the First Order Decay Method (Tier 2). [NIR 2011] |
| **Spain** | IPCC Tier 2 Method is used. Estimation parameters are partly taken from country-specific data as provided by landfill operators as well as from IPCC default parameters. [NIR 2011] |
| **Sweden** | Methane emissions have been calculated by using the IPCC default model and the IPCC First Order Decay (FOD) model respectively. The two methods are not really comparable. The FOD model, on the other hand, uses a time factor representing the delay in methane production, which results in a slower decrease of emitted methane. The estimates of the FOD model are used in the Swedish National GHG Inventory. [NIR 2011] |

| | |
|---|---|
| **United Kingdom** | The UK approach to calculating emissions of methane from landfills uses a “Tier 2” methodology based national data on waste quantities, composition, properties and disposal practices over several decades. The equations for calculating methane generation use a first-order decay (FOD) methodology.The The UK revised the model used to estimate emissions from the managed waste disposal on land in 2008. The new model (MELMod-UK) offers considerable advantages to the user in terms of transparency of approach, utility and ease of use. [NIR 2011] |

*Source: NIR 2011*

The Tier 2 FOD method requires data on current as well as historic waste quantities, composition and disposal practices for several decades. In the following section a detailed overview of the most important parameters and methodological aspects of the FOD method applied by the Member States are presented. The main factors influencing the quantity of $CH_4$ produced are the amount of waste disposed of on land and the concentration of biodegradable C in that waste.

Amount of waste disposed on SWDS: The FOD method requires historic data on waste generation over decades but it is difficult to achieve consistent time series for the activity data over such long periods. The data sources used for generating time series of activity data by the Member States are summarized in Table 8.14.

**Table 8.14 6A1 Managed Solid Waste Disposal: Data sources used for generating time series of activity data**

| Member State | Data sources used for generating time series (6A1) |
|---|---|
| **Austria** | Data for 2008 was (for the first time) taken from the EDM (Electronic Data Management), administered by the BMLFUW. This is due to the fact that since the beginning of 2009 landfill operators are obliged to register their data (waste input-output report) directly and electronically (per upload) at the portal of **http://edm.gv.at**. For 2009 no data has been reported any more.<br>From 1998 to 2007 data were taken from the database for solid waste disposals “Deponiedatenbank” (“Austrian landfill database”) – a database, administered and maintained by the Umweltbundesamt until the end of 2008.<br>From 1950 to 1997 the amounts of deposited residual waste were taken from national studies (HACKL & MAUSCHITZ 1999, UMWELTBUNDESAMT 2001c) and the respective Federal Waste Management Plans (BUNDESABFALLWIRTSCHAFTPLAN 1995, 2001).<br>However, the amount of waste from administrative facilities of industry is not considered (data from 1950 to 1999), whereas it is included in the Deponiedatenbank (“Austrian landfill database”), which is used for the activity data from 1998 onwards.<br>The quantities of “non residual waste” from 1998 to 2007 were taken from the database for solid waste disposals “Deponiedatenbank” (“Austrian landfill database”). For the years 2008 and 2009 the quantities were taken from the EDM (Electronic Data Management). Only the amounts of waste with biodegradable lots were considered. There are no data available for the years before 1998. Thus extrapolation was done using the Austrian GDP (gross domestic product) per inhabitant as indicator. [NIR 2011] |
| **Belgium** | In the Walloon region the quantity of waste disposed comes from the statistics of OWD (Walloon Waste Office). Until 2009, it published each year the industrial and municipal waste disposed, based on the taxes declaration forms covering 50 solid waste disposal sites of various sizes. For 2009 data, industrial and municipal waste was gathered and there was only 33 SWDS in activity. Those statistics are available on a yearly basis since 1994. For the years before, the amounts have been estimated using available data and OWD expert judgement assumptions. In the Flemish region input data of waste disposal sites are available since 1990. The main source of data collection and information is originating from the public Flemish institute for waste management (OVAM). There is no waste disposal site in the Brussels region. [NIR 2011] |
| **Denmark** | The data used for the amounts of municipal solid waste deposited at managed solid waste disposal sites are (according to the official registration) worked out by the Danish Environmental Protection Agency (DEPA) in the so-called ISAG database. [NIR 2011] |
| **Finland** | Activity data for the time series is taken from different sources: The VAHTI database contains data on the total amounts of waste taken to landfills from 1997 onwards. Corresponding data for the years 1992-1996 were collected to the Landfill Registry of the Finish Environment Institute. The activity data for municipal waste for the year 1990 is based on the estimates of the Advisory Board for Waste Management (1992) for municipal solid waste generation and treatment in Finland in 1989. The disposal data (amount and composition) at the beginning of 1990s for industrial, construction and demolition waste are based on surveys and research by Statistics Finland, VTT Technical Research Centre of Finland and National Board of Waters and the Environment. Estimated data on waste amounts before the year 1990 is based on a report by VTT. [NIR 2011] |
| **France** | Quantities of waste landfilled are known from 1960 onwards and based on surveys called ‘ITOMA’ made by ADEME. [NIR 2011] |
| **Germany** | The amount of landfilled municipal waste is taken from the Federal Statistics Office (1975 – 2004). The surveys of waste quantities commenced in 1975 on the basis of the Environmental Statistics Act in 1974. Waste quantities for the period from 1950 to 1975 were extrapolated on the basis of population data. Landfilled wastes after 1 June 2005 must not, according to the legislation, contain biodegradable components and do not, therefore, contribute to the generation of landfill gas. Data for landfilled waste in the former GDR in the 1980ies were provided by a national study. According to that study the amount of landfilled waste per capita was significantly lower than in the old German |

| Member State | Data sources used for generating time series (6A1) |
|---|---|
| | Länder (190 kg/capita versus 330 kg/capita). For the years 1990 and 1993 for the new German Länder detailed data about landfilled municipal solid waste is available. Since 1996, differentiated data is available on landfilled quantities of individual fractions of industrial waste. The amount of landfilled industrial waste between 1975 and 1996 was derived on the basis of the overall amount of landfilled waste. The amount of landfilled industrial waste is kept constant between 1950 and 1975. Data on landfilled sludges from municipal and industrial wastewater treatment is available since 1975 for the Old German Länder and was extrapolated for the time period before 1975 based on population data as well as on the assumption that the amount of sludges from industrial wastewater remained constant. [NIR 2011] |
| **Greece** | Estimates on solid waste quantities generated are included in various reports from research programmes and studies, but refer to specific points in time rather than to a whole period, while different assumptions have been applied in each case for the estimation of quantities generated. Therefore, data for some years are either missing or are unreliable. The quantities of municipal solid wastes for the period 1960-2000 was estimated on the basis of population figures and coherent assumptions regarding generation rates per capita and day, in order to derive complete time series for waste quantities generated. For the rest of the period 2001-2009 more accurate data for the quantities of municipal solid wastes was used as they were provided by the waste management sector of the Ministry of Environment, Energy and Climate Change (MEECC).<br>For the estimation of the quantities of municipal solid wastes the method was used in previous submission were based on the assumption that MSW generation rates was in the order of 0.8 – 1.1 kg/ capita and day, depending on the type of region (rural, semi-urban, urban, large urban regions) in 1997. According to the Ministry of Environment, Energy and Climate Change (MEECC) the MSW generation rate was assumed to change annually by 0.028 kg/ capita and day, while a higher figure (annual increase by 0.035 kg/capita and day) was assumed for the regions of Athens, Central Macedonia, Crete and the islands of South Aegean. A higher figure for MSW generation rate (2.1 kg/ capita and day) was considered for foreign visitors. For the period 1960 – 1990 the rates of annual per capita waste increase are lower (0.8% - 1.5% depending on the region). [NIR 2011] |
| **Ireland** | The EPA commenced the development of the National Waste Database (NWD) in the early 1990s to address a severe lack of information on waste production and waste management practices in Ireland. The database was needed to support radical reform of national policy and legislation on waste pursuant to the Waste Management Act of 1996 and subsequent Government strategies on sustainable development (DELG, 1997) and waste management (DELG, 1998). National statistics generated from this database published on a three-year cycle, and interim reports published on a yearly basis since 2001 by the EPA are the primary basis for establishing the historical time-series of municipal solid waste (MSW) placed in landfills from 1995 onwards. Identification and risk assessment of historical landfills under S.I. No. 524 of 2008 (DEHLG, 2008) serves as the main source of information on landfilling of waste prior to 1995. The results of other surveys undertaken in previous years (Boyle, 1987, ERL, 1993, MCOS, 1994 and DOE, 1994) have also been used to some extent in compiling the MSW time-series. [NIR 2011] |
| **Italy** | Basic data on waste production and landfills system used for the emission inventory are those provided by the Waste Cadastre. The Waste Cadastre is formed by a national branch, hosted by ISPRA, and by regional and provincial branches. The basic information for the Cadastre is mainly represented by the data reported through the Uniform Statement Format (MUD), complemented by those provided by regional permits, provincial communications and by registrations in the national register of companies involved in waste management activities. Since 1999, ISPRA yearly publishes a report, in which waste production data, as well as data concerning landfilling, incineration, composting and generally waste life-cycle data, are reported. It has been assumed that waste landfilling started in 1950. The complete database from 1975 of waste production, waste disposal in managed and unmanaged landfills and sludge disposal in landfills is reconstructed on the basis of different sources, national legislation and regression models based on population. Since waste production data are not available before 1975, they have been reconstructed on the basis of proxy variables. Gross Domestic Product data have been collected from 1950 and a correlation function between GDP and waste production has been derived from 1975; thus, the exponential equation has been applied from 1975 back to 1950. Consequently the amount of waste disposed into landfills has been estimated, assuming that from 1975 backwards the percentage of waste landfilled is constant and equal to 80%. Apart from municipal solid waste, sludge from urban wastewater handling plants has also been considered. Sludge disposed in landfill sites has been estimated from the equivalent inhabitants treated in wastewater treatment plants, distinguished in primary and secondary plants, applying the specific per capita sludge production. The total amount of sludge per year can be treated by incineration or composting, or once digested disposed to soil for agricultural purpose or to landfills. As for the waste production, also sludge landfilled has been reconstructed from 1950. Starting from the number of wastewater treatment plants in Italy in 1950, 1960, 1970 and 1980, the equivalent inhabitants have been derived and consequently the amount of sludge disposed in landfill sites, assuming 80 kg $inhab.^{-1}$ $yr^{-1}$ sludge production. The fraction of sludge disposed in landfill sites has been estimated to be 75% in 1990, decreasing to 9,7% in 2009. A new waste category disposed into non hazardous landfills has been added in 2009: industrial waste with composition comparable to MSW. [NIR 2011] |
| **Luxembourg** | Activity data were calculated in accordance to the MSW produced per capita/year. Data on the population are from STATEC. No national data on municipal waste production from 1950 to 1989 were available. Data from Germany for the years 1950 and 1975 were used. Data in-between were interpolated. Data for Luxembourg for the year 1990 were available (581 kg) which were nearly identical to the IPPC default values (560 kg). Data up to the year 2009 were from the Environment Agency taking into account the effect of aerobic decomposition at SIGRE since 1993 and at SIDEC since 2007. [NIR 2011] |
| **Netherlands** | The amount of waste disposed on landfill sites are mainly based on the annual survey performed by the Working Group on Waste Registration at all the landfill sites in the Netherlands. The data can be found in the Internet; a corresponding documentation is also available, which contains the amount of methane recovered from landfill sites yearly. [NIR 2011] |

| Member State | Data sources used for generating time series (6A1) |
|---|---|
| **Portugal** | Since 1999, data on MSW is available, including production amounts, final disposal and, to a less extent, waste composition. For previous years information was available from the Strategic Plan on Municipal Solid Waste which was approved by the Government in 1997. This plan includes data from annual municipal registries. Another source of information is a research study performed by Quercus. The data was based on a survey performed in 1994, which enabled the calculation of per capita generation rates for 1994, based on the amounts of waste collected and the population served by waste collection. Before 1994, data on landfill wastes had to be estimated based on expert judgment for waste generation growth rates. For the period 1960-1980 it was considered a per capita waste generation growth rate of 2.5% per year; for the following years (1980-1994) 3% per year. To take into account the fact that part of the population (rural areas) was not served by an organised waste collection and waste disposal system, values of annual production were multiplied by the percentage of population served by waste collection in each municipality. After 2000, it was assumed that all the population of the country is served by waste collecting systems. The total amount of waste disposed to SWDS was then calculated based on this estimated value minus the amounts of waste incinerated and composted. [NIR 2011] |
| **Spain** | From 1990 onwards, the information is provided directly by the Ministry of the Environment (MMA) in the publication, “The Environment in Spain”. For large SWDS and those with biogas recovery, the AD is derived from questionnaires provided by each landfill. For the calculation of emissions, the MSW quantities to consider are those deposited since 1970. In the period from 1970 to 1990, the calculation of the waste deposited at managed SWDS without biogas capture and unmanaged SWDS has been estimated by multiplying the coefficient of MSW generation per inhabitant and day, by the population, the number of days in the year and the fraction of MSW generated that is deposited in each type of landfill. For the inventory 2009, new disposal sites with combustion of recovered methane have been identified. Though, only for one of the sites data could be obtained. [NIR 2011] |
| **Sweden** | Household waste: A first national survey was elaborated by EPA in 1980, similar data in 1985 and 1990 and 1994 were provided by Statistics Sweden, since 1994 an annual survey on landfilled waste is carried out by Avfall Sverige – Swedish Waste Management. Figures on sludge from wastewater treatment and garden waste are available since 1990. Industrial waste: Studies on quantities and treatment of organic waste from industry in 1993 and 1996 were carried out by the Swedish EPA. Landfilled wastewater sludge from the pulp industry (important waste fraction) was yearly documented until 2000 by the Swedish EPA. Today the sludge from the pulp industry is incinerated and composted. Since 2006 waste statistics are reported to the EU. The treatment of waste is to be reported by treatment method for the different types of waste according to EWC-Stat. The method of treatment relates to various recovery and disposal operations (“R and D codes”) are compiled into 5 different groups. Group 4, ”Disposal operations: Land filling, deep injection, sur-face impoundment, permanent storage and others”, is relevant for “Solid waste disposal on land, CRF 6A”. So far, waste data has been reported for the reference years 2004, 2006 and 2008. No waste statistics on landfilling are compiled for the intermediate years by SEPA. In 2010, a study was carried out in order to analyze possibilities to use the reported waste data to WStatR for the calculations of $CH_4$ from solid waste land-fills. The study recommended implementation of WStatR-data from reference year 2006 and onwards. [NIR 2011] |
| **United Kingdom** | Estimates of the quantities of waste sent to landfill over the past 10-15 years have been extensively revised and quantities reduced in the light of published data on both local-authority (LA) controlled wastes and, especially, commercial & industrial (C&I) waste, and on government receipts of revenues derived from the Landfill Tax. The revised data were used for LA-controlled and C&I waste from 1995 and 1997, respectively, retaining previous data as already described in the 2008 NIR for earlier years. In order to eliminate discontinuities in the time series of waste to landfill amounts, the new data were spliced into the previous from 1975, using linear interpolation between the previous 1975 data and the revised data for C&I beginning in 1997. It is recognised that considerable uncertainties exist in relation to the amount and composition of waste landfilled, especially prior to 1990, before reliable weighing and waste analysis were widely employed. [NIR 2011] |

*Source: NIR 2011*

Some Member States explicitly describe the consistency of their time series (compare Table 8.15).

**Table 8.15 6A1 Managed Solid Waste Disposal: Consistency of time series of activity data**

| Member State | Consistency of time series |
|---|---|
| **Austria** | In the national study (HACKL & MAUSCHITZ 1999) as well as in the Federal Waste Management Plans the amounts of residual waste from administrative facilities of businesses and industries were not considered and therefore originally not included in the data of the years 1950 to 1999. Waste from these sources is however deposited and hence reported by the operators of landfill sites (therefore included in the Austrian landfill database) and thus considered in the time series from 1998 onwards. To achieve a consistent time series, data of the two overlapping years (1998 and 1999) were examined and the difference – which represents the residual waste from administrative facilities of industries and businesses – was calculated. This difference, relative to the change of residual waste from households, was then applied to the years 1950 to 1997 accordingly. There is no explicit description of time series consistency for non-residual waste. [NIR 2011] |
| **Belgium** | No detailed description of time series consistency. [NIR 2011] |
| **Denmark** | Registration of the amount of waste has been carried out since the beginning of the 1990s in order to measure the effects of |

| Member State | Consistency of time series |
|---|---|
| | action plans. The activity data is, therefore, considered to be consistently long enough to make the activity data input to the FOD model reliable. [NIR 2011] |
| **Finland** | In Finland, the historical waste amount is assessed starting from the year 1900. The uncertainties in historical activity data (estimated on the basis of different weighting of the population and GDP that are assumed to be good indicators of the amount of waste) are large but the amount of waste produced at the beginning of the 1900's was fairly small, thus reducing the significance of large uncertainties. The uncertainty estimates of the current amounts of waste are based on differences between different statistics and complemented with expert judgement. In the case of municipal sludge, the uncertainties in both historical and current activity data are quite large. On the other hand, the amount of industrial waste can be fairly accurately estimated based on industrial production, and therefore these uncertainties are the smallest in historical years. In Finland, the amount of landfill gas recovered is obtained from the Finnish Biogas Plant Register, and this figure is considered accurate. An interesting note is that methane recovery describes the reduction of emissions compared with the situation where gas is emitted. In this case, the emission reduction is accurately known, though total emissions contain higher uncertainties. [NIR 2011] |
| **France** | Since 1985, ADEME ensures completeness of the surveys by providing adjustments if necessary. Surveys are not available for each year, so interpolations are made. The CITEPA also conducts internal audits on the series consistency over time. [NIR 2011] |
| **Germany** | Over the long activity-data period involved, thirty years, time series inconsistencies are inevitable. In Germany, such inconsistencies are primarily a result of German reunification and the fusion of two different economic and statistical systems. Further aspects are changes of legislation and statistics in the waste sector. [NIR 2011] |
| **Greece** | The time-series consistency of emissions is controlled by applying consistent methodologies and verified activity data in line with IPCC guidelines. In case of changes or refinements in methodologies and EFs based on plant-specific data time-series consistency is ensured by performing recalculations according to the IPCC good practice guidance. [NIR 2011] |
| **Ireland** | The methodologies used in the derivation of emissions estimates from the waste sector are consistent over the time-series. In the case of category 6.A, this consistency applies to all three components that determine the ultimate emissions, i.e. $CH_4$ generation, $CH_4$ flared and $CH_4$ utilized. Adoption of the model in the 2006 IPCC Guidelines is justified by the information available for its detailed application and brings Ireland into line with other Parties using this methodology well in advance of the expected mandatory use of these guidelines for inventory reporting post-2012. [NIR 2011] |
| **Italy** | No detailed description of time series consistency. [NIR 2011] |
| **Luxembourg** | No information available. [NIR 2011] |
| **Netherlands** | The time-series consistency of the activity data is very good due to the continuity in data provided. [NIR 2011] |
| **Portugal** | No detailed description of time series consistency. [NIR 2011] |
| **Spain** | Approaches in line with IPCC Good Practice Guidance are used for the activity data. Detailed descriptions are provided how some of the estimation parameters such as DOC have been extrapolated. [NIR 2011] |
| **Sweden** | The times series in the waste sector are calculated consistently, and when statistics are not produced annually, interpolation and extrapolation have been necessary tools for imputation. [NIR 2011]. |
| **United Kingdom** | The estimates for all years have been calculated from the MELmod model and thus the methodology is consistent throughout the time series. Estimates of waste composition and quantities have been taken from different sources – prior to 1995 they are from Brown et al. (1999), prior to 2000 they are based on the LQM (2003) study and from 1995 they are based on new information compiled by Eunomia (Eunomia, 2011). The new waste to landfill data indicates a significant decrease in the amount of LA-controlled and C&I waste sent to landfill since about 2002 and 2003. [NIR 2011] |

*Source: NIR 2011*

The amount of waste disposed on SWDS depends on the one hand on the total amount of waste generated and on the per capita waste generation rate, respectively. However, solid waste disposal in EU Member States is not estimated based on the per capita waste generation rate; the waste generation rate is not a parameter used in the higher tier emission estimation. All Member States are using higher tier methods for the estimation of emissions from solid waste disposal, based on national statistics of solid waste disposal on waste disposal sites (see Table 8.2).

In the additional information box of the CRF tables, the waste generation rate is not very well defined. No clear definition is available on which waste fractions should be included for comparability; neither the UNFCCC reporting guidelines, nor the CRF, nor the IPCC Guidelines provide an exact definition which waste types and waste streams should be included in the estimation of the waste generation rate.

In the case of Austria considerable amounts of composting is reported under 6D (other), which means that the composted waste amounts are excluded from 6A. Compared to last year's inventory, the waste generation rate in Austria as reported in CRF table 6A,C decreased from 0.15 kg/capita/day to 0.08 kg/capita/day. This decline is due to a drop in the amount of annual municipal waste at the solid waste disposal site of 43 % in 2008-2009 while the population remained at the same level than reported for the year before. Since 2009, no further deposition of waste directly without any pretreatment occurred any more in four of the nine Austrian provinces where this was still allowed until the end of 2008. For Spain large number of tourists increase the waste amounts, but are not reflected in the population numbers.

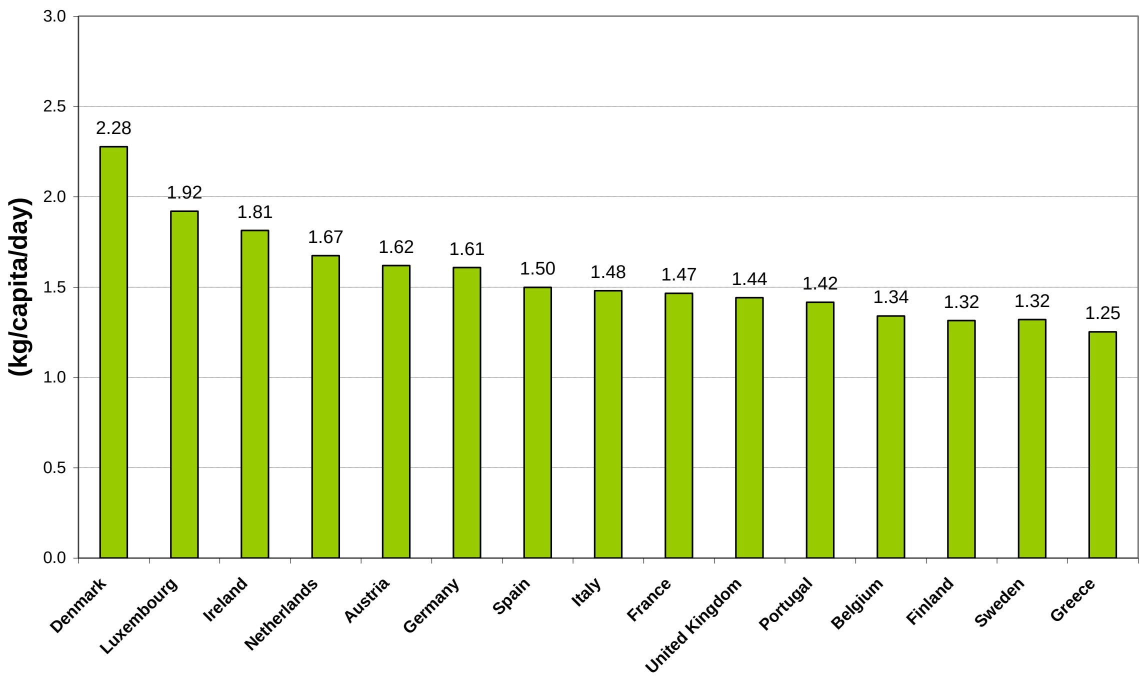
It is difficult, though, to explain the differences for all Member States from the information available in the NIR. Because of the different coverage of wastes included, the waste generation rate reported does not reflect policies and measures to reduce waste generation.

To understand the background of the differences in the MS a decomposition analysis of this parameter would be necessary, but some explanation for the differences are poorly monitored, such as the links between the waste generation and public awareness on waste or the quantified share of waste generated by tourists in tourist destination.

Therefore, Figure 8.3 shows the waste generation rate for EU-15 MS based on the homogenous data source EUROSTAT: On the basis of the Regulation on waste statistics (EC) No. 2150/2002, amended by Commission Regulation (EU) No. 849/2010, data on the generation and treatment of waste is collected from the Member States. The information on waste generation has a breakdown in sources (several business activities according to the NACE classification and household activities) and in waste categories (according to the European Waste Classification for statistical purposes). The information on waste treatment is broken down to five treatment types (recovery, incineration with energy recovery, other incineration, disposal on land and land treatment) and in waste categories.

The waste generation rate per capita varies only slightly among the EU-15 Member States, from 12.5 kg/capita/day for Greece to 2.28 kg/capita/day for Denmark.

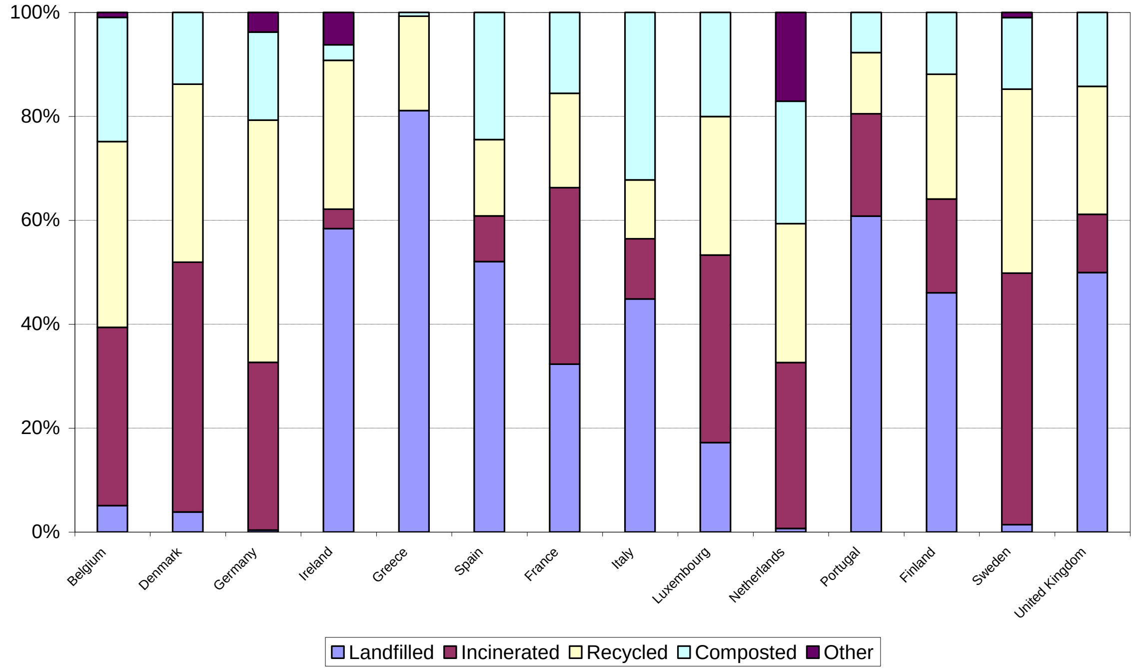
**Figure 8.3 6A1 Managed Waste Disposal: Waste Generation Rate**




*Source: EUROSTAT 2011*

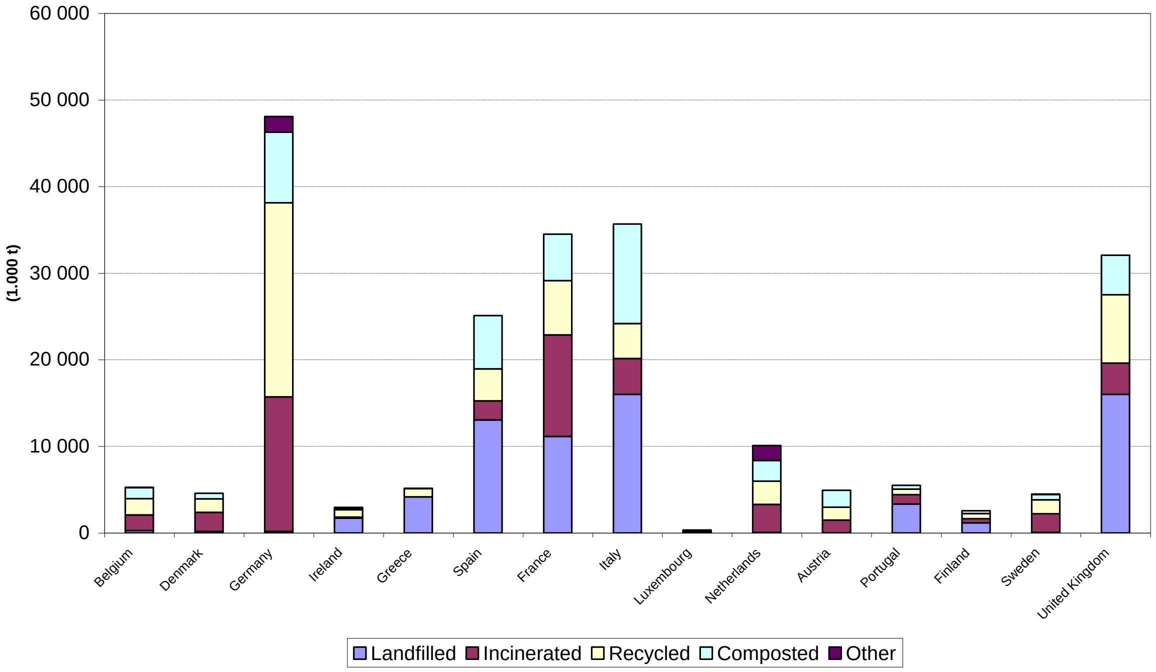
On the other hand the amount of waste generated on SWDS is strongly influenced by the waste management practices of the individual Member States: by the share of waste incinerated, recycled and composted, compare Figure 8.4 and Figure 8.5.

**Figure 8.4** **6A1 Managed Waste Disposal: Waste management practices in the EU-15 (shares) in 2009**




*Source: EUROSTAT 2011*

**Figure 8.5** **6A1 Managed Waste Disposal: Waste management practices in the EU-15 (absolute values) in 2009**




*Source: EUROSTAT 2011*

Many Member States experienced a reduction of waste landfilled and an increase of amounts of waste recycled, composted and increased recovery of landfill gas. Both trends have already taken place before the Landfill Directive and the Directive on packaging waste, but are further supported by these directives.

The waste management practices and policies which determine the fraction of MSW disposed to SWDS, the fraction of waste incinerated and the fraction of waste recycled differ significantly among the Member States. For example, disposing waste on SWDS is the predominant waste disposal route in Greece and Ireland with correspondingly few quantities of waste incinerated and recycled in these countries. The low share for incineration in the EU-15 especially in Greece is alsoe due to considerable public concern over the use of large-scale waste incineration. In Germany, Denmark and the Netherlands it is vice versa. Since 2005, landfills in Germany remaining in operation may only store waste that conforms to strict categorization criteria. Landfills also must reduce landfill-gas formation from such waste by more than 90 % with respect to gas from untreated waste. In the Netherlands, waste policy also has the aim of reducing landfilling by introducing bans for the landfilling of certain categories of waste, e.g. the organic fraction of household waste (in the early 1990s) and by raising the landfill tariff to comply with the incineration of waste.

The amount of methane generated on SWDS depends on the Methane Correction Factor, the fraction of dissolved organic carbon (DOC) dissimilated, the fraction by volume of $CH_4$ in landfill gas and the waste composition, more precisely the fraction of DOC in waste. While the first three parameters do not vary strongly among the Member States, more information is provided on the DOC (Figure 8.6 and

Table 8.17) as well on waste composition of land filled waste (Table 8.16). The latter parameters are again strongly influenced by waste management practices and policies.

**Table 8.16 6A1 Managed Solid Waste Disposal: Waste composition of landfilled waste**

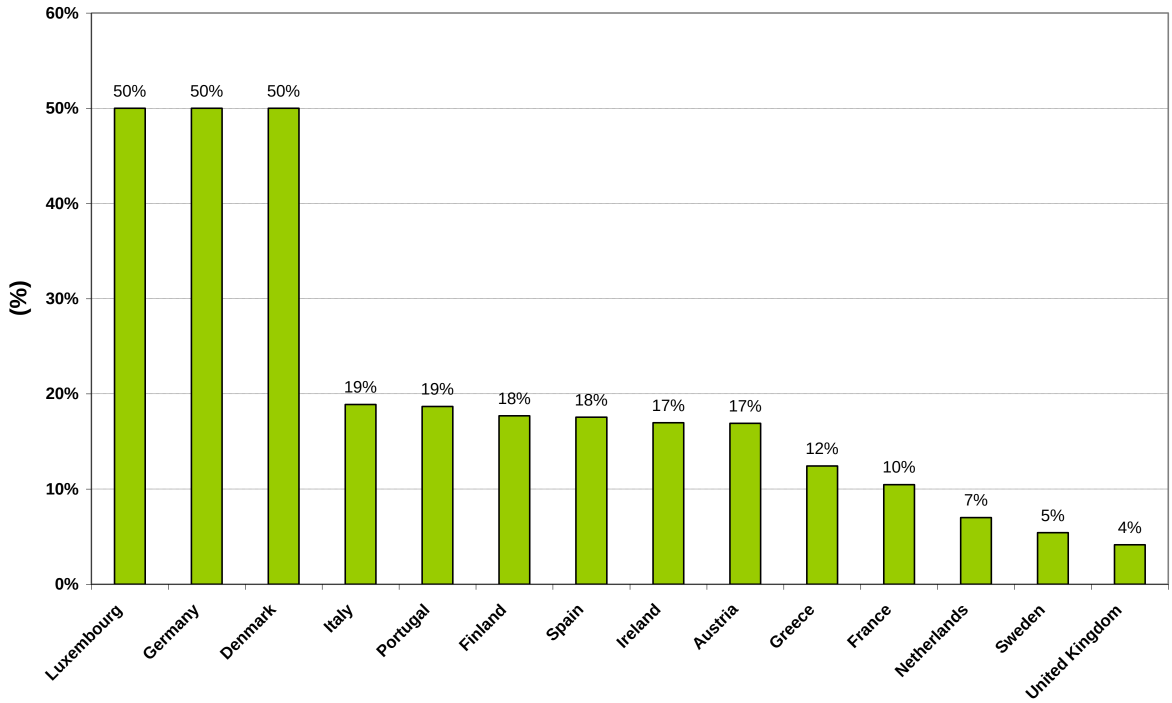
| Member State | Composition of landfilled waste |
|---|---|
| **Austria** | Landfilled waste is differentiated in "residual waste" and ""non residual waste" (bulky waste, construction, mixed industrial waste, road sweeping, sewage sludge, rakings, residual matter from waste treatment). Detailed values such as for the half life period, DOC, and DOCF are available for these waste types. The composition of residual waste is specified according to different waste fractions (such as paper, glass, or plastics). [NIR 2011] |
| **Belgium** | Waste types are differentiated into municipal and industrial categories as well as into several sub categories. Several values for DOC, DOCF and k are given. [NIR 2011] |
| **Denmark** | The following waste types are taken into consideration: Domestic waste, bulky waste, garden waste, commercial & office waste, industrial waste, building & construction waste, sludge, ash & slag. As material fraction the following types are differentiated: Waste food, cardboard, paper, wet cardboard and paper, plastics, other combustibles, glass and other non-combustibles. [NIR 2011] |
| **Finland** | Solid municipal waste, municipal sludge, industrial sludge, solid industrial waste, construction and demolition waste, industrial and municipal inert waste, and other inert waste are considered as waste groups. These groups are further split into several subgroups. Detailed DOC values are provided in the NIR. [NIR 2010] |
| **France** | Composition of landfilled waste is not mentioned explicitly in the NIR 2010. The method used differentiated between easily biodegradable, average degradable and weakly biodegradable waste. [NIR 2011] |
| **Germany** | Several studies on the waste composition were evaluated. The analysis for the Old German Länder was performed for different waste types: household waste (organic material, paper/cardboard, composites, textiles, diapers, and wood), commercial waste, and bulky waste (organic material, paper/cardboard, textiles, and wood). For the former GDR waste fractions were taken from a study. According to that study, household waste in the GDR was composed of vegetable waste, paper/cardboard, wood, rubber, composites as well as textiles. [NIR 2011] |
| **Greece** | The composition of generated MSW comprises the following fractions: Putrescibles, textiles, wood, paper, plastics, metals, glass, and rest. [NIR 2011] |
| **Ireland** | Waste constituents of MSW that contribute to DOC are food waste, paper, wood, textiles and disposable. Furthermore, street cleansings and sludge from municipal wastewater treatment are considered. [NIR 2011] |
| **Italy** | An in-depth survey has been carried out, in order to diversify waste composition over the years. Three slots (1950 – 1970; 1971 – 1990; 1991 – 2007) have been individuated to which different waste composition has been assigned. On the basis of data available on waste composition, the moisture content, the organic carbon content and the fraction of biodegradable organic carbon for each waste stream, the DOC contents and the methane generation potential values ($L_0$) have been generated. On the basis of the waste composition, waste stream have been categorized in three main types: rapidly biodegradable waste, moderately biodegradable waste and slowly biodegradable waste. The following waste fractions are considered: food waste, sewage sludge, garden and park waste, paper and paperboard, nappies, textiles and leather, and wood. [NIR 2011] |
| **Luxembourg** | Waste composition is exactly known since 1992. The data from the national waste composition analyse 1992/94 were used till 2003. For the years 2004 to 2009 the data from the 2011 study were used taking into account the aerobic pre-treatment before landfilling. Luxembourg oriented its values near the IPPC default values but some changes were made: 1950-1974 it is assumed that the fractions “food”, “paper” and “wood” landfilled were lower. The difference was allocated to the fraction “plastics, other inert” waste. For the years before 1992 no data are available. Waste composition are Food, Garden, Paper, Wood, Textile, Nappies and Plastics, other inert. [NIR 2011] |
| **Netherlands** | An average DOC value for waste as a whole is provided as a time series in the NIR. [NIR 2011] |
| **Portugal** | SWDS include solid municipal or urban waste (household, garden, commercial-services wastes) and industrial wastes. For the fermentable fractions of urban waste the following categories apply: paper and textiles, non-food fermentable materials, food waste, and wood or straw. For industrial waste several groups exist: paper and textiles, garden waste, park waste or other non-food organic putrescibles, food waste, wood or straw, fuels, plastics, sludge from natural origin, sludge from non-natural origin or hydrocarbons, synthetic fibres, and non-natural organic substances. [NIR 2011] |
| **Spain** | The composition of municipal solid waste comprises the following categories: organic matter, paper and cardboard, plastics, glass, ferrous metals, non-ferrous metals, wood, textiles, rubber and latex, disposable and rechargeable batteries, other. For waste from origins other than direct household collection, other categories apply: compost, waste water sludge and others. Specific information on the waste composition is provided based on questionnaires by plant operators. [NIR 2011] |
| **Sweden** | Landfilled waste includes includes household and similar waste, park and garden waste, industry- and non-industry specific waste (organic fractions), industry- and non-industry specific waste (organic and inorganic fractions), construction and demolition waste (organic and inorganic fractions) and sludge from wastewater handling and pulp industry.Deposited waste is further broken down into different waste fractions for household and industrial wastes. [NIR 2011] |
| **United Kingdom** | The UK method divides the waste stream into four categories of waste: rapidly degrading, moderately degrading, slowly degrading, and inert. As recommended in the Good Practice Guidance, the estimates of waste disposal quantities include commercial and industrial waste, demolition and construction waste, sewage sludge disposal to landfill as well as municipal waste. [NIR 2011] |

*Source: NIR 2011*

Fraction of Dissolved Organic Carbon (DOC) in MSW: The DOC content of landfill waste is based on the composition of waste and can be calculated from a weighted average of the carbon content of various components of the waste stream. Different countries are known to have MSW with widely differing waste compositions. While the average DOC value in MSW are illustrated in Figure 8.6,

Table 8.17 provides corresponding detailed information on the DOC values extracted from the NIR.

**Figure 8.6 6A1 Managed Solid Waste Disposal: Fraction of DOC in MSW**




*Source: CRF 2011 Table 6A,C Additional information.*

**Table 8.17 6A1 Managed Solid Waste Disposal: Further information on DOC values**

| Member State | Further information on DOC values |
|---|---|
| **Austria** | Detailed values for DOCF and DOC differentiated with respect to the waste type are available in the NIR. A time series of bio-degradable organic carbon content of directly deposited residual waste is indicated for the years 1950 to 2008. [NIR 2011] |
| **Belgium** | Municipal waste is divided into 10 main fractions during sorting analysis in the Flemish region. These analyses were carried out in 1985, 1993-1994, 1994-1995 and 1995-1996 by the Flemish institute OVAM. These fractions are connected to 1 of the 3 biodegradation rates (quick, average and slow). The biodegradable fractions of rough waste on the solid waste disposal sites are (analyses carried out in 1995): paper and carton: 3%, trim wood (from gardening): 10%, wood (construction & demolition, furniture): 20% textile: 6%.<br>For the Walloon Region the DOC value calculated for municipal waste lies in the default value range from IPCC revised 1996 Guidelines. The value for industrial waste was calculated using the detailed waste types from OWD and the IPCC Good Practice Guidance methodology. This detailed estimation led to a complete recalculation, as the new estimated DOC were much lower than the default value previously used. In 2008, municipal and industrial waste values have been gathered in the Walloon statistics. Linear interpolation is used to estimate the intermediate values of DOC. [NIR 2011] |
| **Denmark** | For the following categories, investigations of DOC content have been carried out for Danish conditions: waste food, cardboard, paper, wet cardboard and paper, plastics, other combustibles, glass, other non-combustible. [NIR 2011] |
| **Finland** | DOC fractions of different types of waste are based on the IPCC default values and national research data. DOC values of groups (solid municipal waste, municipal and industrial sludge (from dry matter), solid industrial waste, construction and demolition waste, industrial inert waste, and other inert waste) and of subgroups are provided in the NIR. [NIR 2011] |
| **France** | The OMINEA report (February 2008) fixes an average DOC of 150 kg/t for the easily degradable waste, 75 kg/ton is used for the average degradable waste and 0 for the weakly degradable wastes. The annual average DOC varies between 102 and 110 kg/ton. [NIR 2011] |
| **Germany** | For the DOC national and IPCC default factors were used. The following values were chosen: Organic material: 18%, garden and park waste: 20%, paper and cardboard: 40%, wood and straw: 43%, textiles: 24%, diapers: 24%, composites: 10%, sludges from wastewater treatment: 50%. [NIR 2011] |
| **Greece** | Time series of total amounts of DOC for waste on managed and unmanaged waste disposal sites as well as of sludge are provided. Degradable organic carbon (DOC): 0.4 for paper and textiles (default value), 0.3 for wood (default value), 0.15 for food waste (default value) and 0.4 for sewage sludge.[NIR 2011] |
| **Ireland** | The waste constituents of MSW that contribute to DOC are food waste, paper, wood, textiles and disposable nappies are identified in the available NWD breakdown for 1995, 1998, and 2001 through 2009. The IPCC default proportions of DOC content are used for all these constituents (Annex G). Street cleansing composition data is available, and the DOC content is therefore calculated from its constituent components. In addition, a DOC content of 5 percent has been assumed for sewage sludge. [NIR 2011] |
| **Italy** | On the basis of data available on waste composition, the moisture content, the organic carbon content and the fraction of biodegradable organic carbon for each waste stream, the DOC contents and the methane generation potential values ($L_0$) have been generated. [NIR 2011] |
| **Luxembourg** | Only default values were used, as no country specific values are available. [NIR 2011] |
| **Netherlands** | The change in DOC values over time is due to such factors as the prohibition of landfilling of combustible wastes. [NIR 2011] |
| **Portugal** | The estimation of DOC for urban waste is based on information on the waste composition from several sources. Figures are presented for IPCC categories A, B, C and D. Furthermore, DOC values are available for the different groups of industrial waste. These DOC values resulted from weighted averages based on the quantities reported for each EWC category considered and the respective assigned DOC, and refer to disposal on land. [NIR 2011] |
| **Spain** | The degradable organic carbon content in MSW is obtained by applying equation 5.4 of the IPCC Good Practice Guidance to the data on the standard composition information derived from the data evaluated in the corresponding questionnaires provided by landfills that perform biogas capture as well as the information on the national mean standard composition from the remaining landfills that is provided by the publication "The Environment in Spain". For waste from origins other than direct household collection, specific values based on tables 2.4 and 2.6 of 2006 IPCC Guidelines have been used for compost plants (0.2), waste water sludge (0.175) and others (0.04). [NIR 2011] |
| **Sweden** | IPCC values for gas potentials are used for the different fractions of household waste, as well as garden waste. Estimated DOC content for each waste category are provided. [NIR 2011] |
| **United Kingdom** | A detailed review of waste composition, in terms of materials, moisture content and dissimilable degradable organic carbon (DDOC) content has been undertaken and the results are described in Eunomia's report (Eunomia, 2011) and summarised in Annex 3. The previous methodology used for inventory reporting for this sector, in which only cellulose and hemicelluloses were considered to contribute to methane formation has been discontinued, since this approach underestimates the importance of other carbon sources, particularly for food wastes. The new methodology, which has been adopted following endorsement by the peer reviewers, calculates the DDOC content of various waste materials through reference to the lignin and non-lignin content. [NIR 2011] |

*Source: NIR 2011, CRF 2011 ,Table 6A,C Additional information*

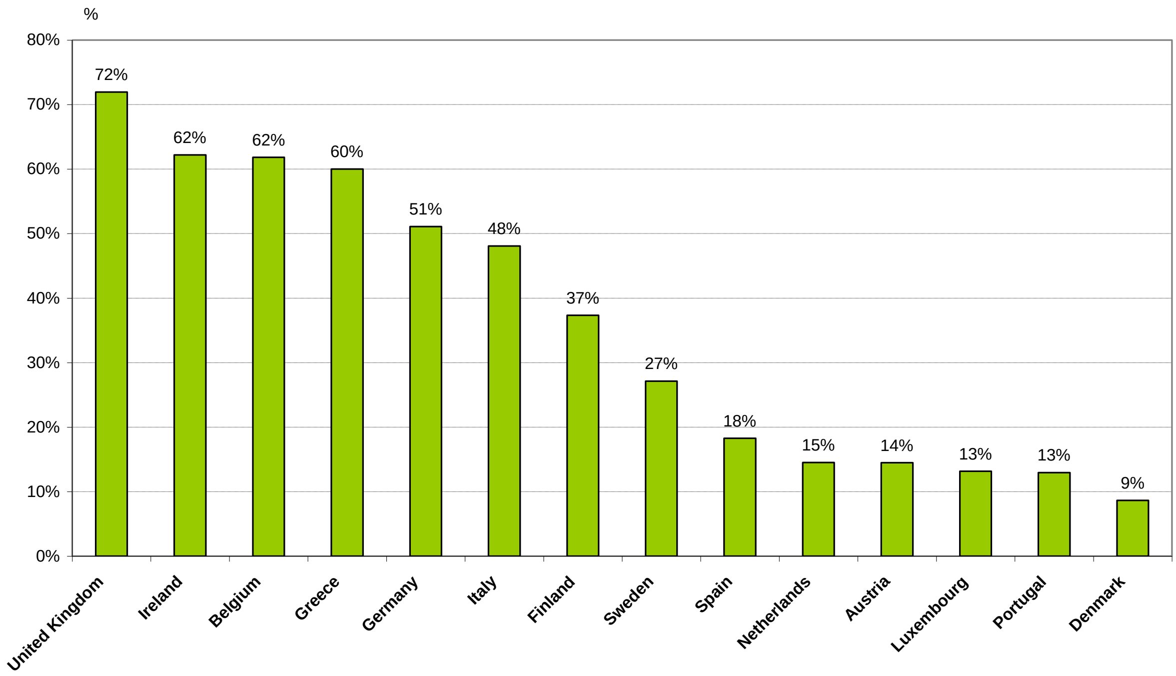
Figure 8.6 presents an average DOC, however usually different DOC values for individual waste fractions are used. In the case of the United Kingdom, a national model is based on a country-specific method, in which the DOC value is based on cellulose and hemi-cellulose content for each waste component and degradability. These values may lack comparability with other countries. For Austria composting of biodegradable waste is reported separately. Consequently considerable amounts of waste with high DOC are excluded from category 6A which results in a lower DOC for the remaining MSW. In Italy, DOC values are based on different national studies. In addition the DOC reflects the considerable reductions achieved in diverting biodegradable waste to other waste management methods such as composting or mechanical-biological treatment.

Besides lower quantities of organic carbon deposited into landfills, the major determining factor for the decrease in net $CH_4$ emissions are increasing methane recovery rates from landfills.

Methane recovery: The recovered $CH_4$ is the amount of $CH_4$ that is captured for flaring or energy use and is a country-specific value which has significant influence on the emission level. The percentage of $CH_4$ recovered, compare Figure 8.7, varies among the Member States between 9 % in Denmark and 72 % in the United Kingdom and depends on the share of solid waste disposal sites that are able to recover $CH_4$ (see

Table 8.18).

**Figure 8.7** **6A1 Managed Solid Waste Disposal: Methane recovery**




*$CH_4$ recovery in% = $CH_4$recovery in Gg/ ($CH_4$ recovery in Gg + $CH_4$ emissions in Gg)*100*
*Source: CRF 2011 Table 6A,C*

Compared to last year's information the methane recovery increased for two MS: Belgium: +1.5 % and Portugal: +0.2 % and decreased for all other MS: Germany: -8.4 %, Greece: -6.4 %, Ireland: -5.7 %, Austria: -2.8 %, Finland: -2.6 %, Italy: -2.2 %, the Netherlands: -1.4 %, Luxembourg: -1.2 % Sweden, Spain and the UK: -0.8 %, Denmark: -0.1 %.

France, due to findings in the in-country review in 2010 revised the capture rate of biogas. Currently the MS does not report any data for methane recovery.

As a result of the in country review in Germany in 2010, the time series for the period 1990 to 2008 was completely recalculated. In the recalculation, monitoring data were used for determination of the rates of landfill-gas collection. Since those data do not include the total collected quantities of landfill gas, the recalculation leads to considerably higher methane emissions and lower methane recovery.

The lower methane recovery in Greece is the result of the improvement of the methodology for estimation of biogas flared, from Tier 1 to Tier 2 (FOD), and of the revision of DOCF.

For Ireland, the revisions to the methodology for 6.A.1 are associated with decreasing the extent of landfill gas flaring. This results in an overall increase in the $CH_4$ emission. This revision has been possible because a full survey of landfill gas flaring was undertaken for estimates of 2008 and 2009 (previously the 2008 returns were not complete). The survey provided an improved understanding of the activities, and in particular it was noted that some flaring was not being operated on a continuous basis following consultation with individual landfill operators. The whole time series of emissions was revised accordingly.

In the case of Finland, the decrease in methane recovery was due to a revision of data based on findings during the Finish centralized review in 2010, where the ERT identified an overestimation of the recovery (FCCC/ARR/2010/FIN, para 95).

Until the compilation of the EU inventory report, review reports for ten out of fifteen Member States were available. For some MS recommendations with respect to the calculation of recovery could be found (Finland, Ireland, Luxembourg and the UK).

Recovery from UK landfills is financially driven, as the set minimum price given for the electricity generated in UK landfills results in a large financial incentive for recovery operators to collect all the gas produced. Furthermore, regulatory pressure exists to require a high level of gas collection in order to conform to the requirements of the 1993 Landfill Directive.

$CH_4$ recovery in EU-15 amounts to 47 % of generated $CH_4$. Methane recovery is further enhanced by the Landfill Directive, and monitoring programs will need to be established. The recovery potential depends on the waste management strategies, e.g. diverting organic fractions to composting leaves more inert materials on landfills and reduces the potentials to recover and use $CH_4$ (as in the case of the Netherlands, Austria or Denmark). Compared to last year's inventory report, $CH_4$ recovery for the EU-15 decreased by 11 %; this reduction was mainly caused by the revision of the French $CH_4$ recovery.

Moreover, Member States use different methods to determine $CH_4$ recovery. Belgium, Finland, Ireland, Luxembourg, the Netherlands and Spain use measured plant-specific data. In Austria, Ireland, Italy, Portugal and the United Kingdom surveys are carried out. Denmark and Sweden take the corresponding data from their energy statistics. France and Germany use general assumptions concerning the methane recovery.

**Table 8.18 6A1 Managed Solid Waste Disposal: Further information on methane recovery**

| Member State | Number of SWDS recovering $CH_4$ | Total number of SWDS | Further information on methane recovery |
|---|---|---|---|
| **Austria** | | Excavated-soil landfills: 475<br><br>Construction-waste landfills: 90<br><br>Residual waste/treated waste landfills: 39<br><br>Mass waste landfills: 46 | In 2004, the Umweltbundesamt investigated the amount of annual collected landfill gas by questionnaires sent to landfill operators showing that in 2001, the amount of collected landfill gas was more than 5 times higher than in 1990. In 1990 only 9 landfills were equipped with landfill gas wells. In 2001 at all operating mass landfills landfill gas was collected. In 2008 a further study was conducted (UMWELTBUNDESAMT 2008c) again sending questionnaires to landfill operators to get new data on collected landfill gas as well as information on its use. Results show, that from 2002 on the amount of landfill gas generated – and landfill gas recovered accordingly – decreased as a consequence of the reduced carbon content of deposited waste (despite a consistent recovery practice).<br>As no new information on the amount of landfill gas recovered became available for the years 2008 and 2009, the mean value of the recovery rate of the years 2002 to 2007 (ranging from 12 % to 14 %) was taken as a proxy (13.2 %) to calculate the actual amount of landfill gas recovered. In this years' submission, the decreasing methane concentration in recovered landfill gas – from 48 % (2002) to 45 % (2007) (UMWELTBUNDESAMT 2008c) – has been considered in the calculation, resulting in higher emissions accordingly. This is mainly due to the extensive capturing of landfill gas and the dilution of the landfill gas captured. [NIR 2011]. |
| **Belgium** | 14 (Wallonia, 2009) | | Methane recovery takes place in the Flemish region from 1994 on. Recovery data of the Flemish waste disposal sites are included for the first time in the 2009 submission. Consequently a complete dataset of recovery data became available in Belgium.<br>Methane is recovered in the Walloon region from 1993 on. Each year, all the landfills with $CH_4$ recovery (14 in 2009) are contacted to collect data on the amount and $CH_4$ content of the biogas recovered (flaring or energy purposes). The $CH_4$ content is measured by landfill owners as it determines the possible use of the biogas (only "rich" biogas" is used in engines, the rest is flared). [NIR 2011] |
| **Denmark** | 26 (2003) | 134 (2001) | Energy-producing installations at 26 sites (DEPA 2003) are registered. The Danish Energy Agency registers the gas amounts recovered at disposal sites in energy units (TJ) (DEA, 2010). Data for landfill gas plants are reported according to Energy Statistics from the Danish Energy Authority. [NIR 2011] |
| **Finland** | 35 | | Data on landfill gas recovery are obtained from Finnish Biogas Plant Register. [NIR 2011] |
| **France** | 97% | | 97% of the solid waste disposal is landfilled on SWDS with biogas capturing. 63% of the $CH_4$ generated is estimated to be recovered in 2009. Following the in-country review in September 2010, the capture rate of biogas has been revised, resulting in an increase in $CH_4$ emissions over the entire period. [NIR 2011] |
| **Germany** | | 150 (2005) | For the years 2000 – 2008 data on the estimation of $CH_4$ recovery from landfills is included. The amount of used methane has been recalculated from the known electricity output, whereas the amount of internal energy consumption on the landfill site is not included. The data does not include land fill gas recovery from closed landfills. [NIR 2011] |
| **Greece** | 4 | | According to data from the Ministry for Environment, recovery and flaring of biogas constitute management practices in the 4 major managed SWDS of Greece (in the cities of Athens, Patra, Thessalonica and Larissa). For 3 of these sites (in Patra, Thessalonica and Larissa) the collection of data on the amount of biogas flared has not been possible yet. The estimation of biogas recovered in these sites was based on the assumption that for technical reasons, 60% of biogas released is finally recovered and flared. Detailed measurements data have been collected only for the SWDS of Athens, in which almost 50% of total waste going to managed sites is disposed. The quantities of waste disposed in the 3 sites for which the $CH_4$ recovery is based on assumptions, the volume of biogas flared in the SWDS of Athens and methane that is totally recovered, are presented. For the estimation of methane recovered in the SWDS of Athens, the fraction of methane in landfill gas (F) was calculated at 0.5 and methane density at 0.7 kg $CH_4$/m3, based on the data collected. [NIR 2011] |
| **Ireland** | 8 | | In 2008 the EPA commissioned a detailed study. Information on the number of flares in use, together with data relating to flare capacity, run time and performance was used to estimate the volume of landfill gas flared at each site. The tonnage of $CH_4$ flared was calculated from landfill gas volume by accounting for gas temperature (assumed to be ambient air temperature) and pressure (provided in survey questionnaire returns) and by using methane destruction efficiencies of 50 percent for open flares and 98 percent for closed flares. The study found that there were six methane utilisation plants at landfills in Ireland in 2008 with a total of 24 engines operated by Bioverda Power Systems. The amount of methane input to landfill gas utilization plants is calculated from their known electricity outputs as obtained by SEI from EIRGRID (Electricity Transmission System Operator) using an overall efficiency of 36.6 percent for the engines, which is considered typical of the engine types in general use. [NIR 2011] |
| **Italy** | | | The amounts of methane recovered and flared have been estimated taking into account the amount of energy produced, the energy efficiency of the methane recovered, the caption efficiency and the efficiency in recovering methane for energy purposes assuming that the rest of methane captured is flared. The total $CH_4$ recovered is the sum of methane flared and methane used for energy purposes. The methane used for energy production is estimated starting from the electricity produced (GWh) annually by landfills (TERNA, several years) assuming an energy conversion efficiency equal to 0.3, typical efficiency value for engines that produce electricity from biogas (Colombo, 2001). The methane flared has been |

| Member State | Number of SWDS recovering $CH_4$ | Total number of SWDS | Further information on methane recovery |
|---|---|---|---|
| | | | estimated for the years 1990-1997 on the basis of information supplied by the plants (De Poli and Pasqualini, 1991); for the following years the methane flared has been estimated on the basis of information supplied by the main operators (Asja, 2003 and Acaia, 2004) regarding the efficiency in recovering methane for energy purposes with respect to the total methane collected. This value increased from 60% of the total, in 1998, to 70% since 2002. [NIR 2011] |
| **Luxembourg** | 1 | 2. | At the SIGRE site, a methane recovery system is operated since 2000, and, since 2002, at the SIDEC site. Recovery of landfill gas started in 2002 (flaring) and 2000 (electricity and heat plant), respectively. Recovered $CH_4$, as determined from monthly reports of the landfill operators (measured quantities) is subtracted from the estimated emissions. [NIR 2011] |
| **Netherlands** | 53 (2009) | | The amount of waste disposed on landfill sites are mainly based on the annual survey performed by the Working Group on Waste Registration at all the landfill sites in the Netherlands. The data can be found in the Internet; a corresponding documentation is also available, which contains the amount of methane recovered from landfill sites yearly. [NIR 2011] |
| **Portugal** | | | Data on landfill gas recovered refer to the amounts of biogas consumed in electrical production in landfill systems. This information is collected annually by DGEG (annual inquiry), together with data on electric energy produced and sold, typology of equipments, etc. The quantities of biogas that are reported in Nm3 where converted into $CH_4$ amounts, considering a density of 0.72 kg/m3 and a percentage of 60% of $CH_4$ in biogas. Concerning uncontrolled dumping sites, it was considered that there is gas burning when a dumping site has been closed and is associated with a managed landfill having recovery of $CH_4$. For industrial waste, data on quantities of $CH_4$ recovered and combusted were considered jointly with urban waste, as all industrial waste was considered to be disposed together with urban waste in SWDS. [NIR 2011] |
| **Spain** | 35 (2009) | | 35 landfills in Spain have landfill gas recovery systems. Landfill gas is partly flared, partly utilized for energy purposes. [NIR 2011] |
| **Sweden** | 58 (2008) | 85 (2009) | Information on recovered gas (in energy units) is provided by Avfall Sverige and converted to use quantities by Statistic Sweden. [NIR 2011] |
| **United Kingdom** | | | Reliable data on methane collected for power generation are available (which set a lower limit on the actual gas collection) but better data on landfill gas flaring is needed to determine overall amounts of methane collected. Overall, it is believed that a 75% collection efficiency for methane as an average over the gas-producing life of modern landfills is not excessive, given industry and regulator experience, but further measurements are being pursued to improve confidence in this key factor. Data on power generation from landfill gas is centrally collected and allows a good estimate to be made of methane recovered for this purpose. Some landfill gas is also flared, both at sites too small for commercial exploitation of gas as an energy source but also as backup and standby duty for gas disposal at large sites. Date on the amount of methane flared is much less reliable than that used for energy recovery as there is no reporting obligation on site operators in this respect. The overall landfill gas recovery rate (70% of methane produced) from 2005 onwards is based on industry estimates of gas collection efficiency at sites during the phase of maximal gas production, reduced to reflect estimated collection efficiency over the whole gassing life of a landfill. We have no evidence that gas collection efficiency has continued to increase since 2005, but further research is proposed to reduce this aspect of uncertainty. [NIR 2011] |

*Source: NIR 2011.*

Industrial waste: Data on industrial waste may be difficult to obtain in many countries. DOC default values for industrial waste are not provided by the IPCC.

Table 8.19 illustrates how industrial waste is considered in the individual Member States. Two Member States do not consider industrial waste in the NIR.

**Table 8.19 6A1 Managed Solid Waste Disposal: Methodological issues regarding industrial waste**

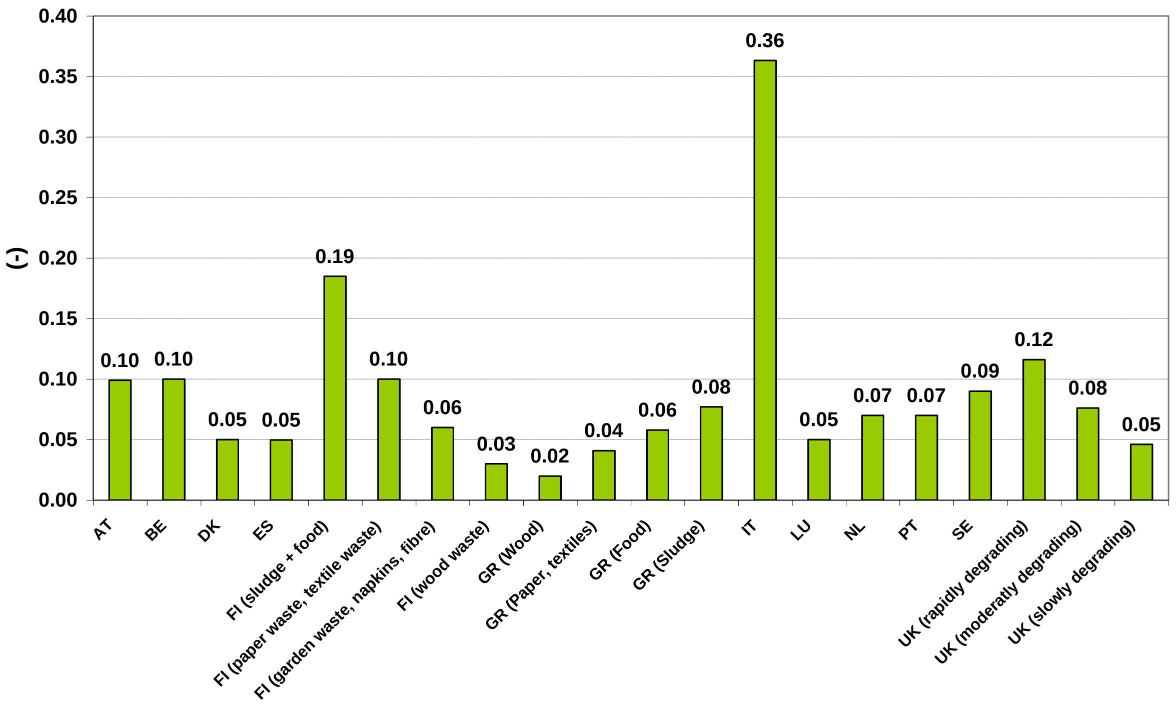
| Member State | Industrial waste |
|---|---|
| **Austria** | “Mixed industrial waste” is considered under "non residual waste". Several waste types with their respective waste identification numbers are described. These are not clearly referenced as industrial wastes, though. [NIR 2011] |
| **Belgium** | In the Walloon Region the $CO_2$ and $CH_4$ emissions from solid waste disposal on land are calculated with a first order decay model that considers separately the emissions of industrial and municipal waste until 2007. This was due mainly because it was separated in the Walloon waste statistics. In 2010, Walloon waste figures have been given under another format which doesn’t consider separately the amounts of industrial and municipal waste anymore.<br>Emissions from industrial waste are calculated with the same model as municipal waste. The DOC value for industrial waste was estimated calculated using the detailed waste types from OWD and the IPCC Good Practice Guidance methodology. This detailed estimation led to a complete recalculation, as the new estimated DOC values were much lower than the default value previously used. [NIR 2011] |
| **Denmark** | Industrial waste is considered and data on its composition and amount deposited are used in the emission model. [NIR 2011] |
| **Finland** | Industrial solid waste and industrial sludge as well as industrial inert waste are considered as waste types. Activity data and several DOC values are provided in the NIR. [NIR 2010] |
| **France** | Industrial waste is included in the estimation. [NIR 2011] |
| **Germany** | The Federal Statistical Office provides detailed data about landfilling of industrial waste since 1996. In the inventory, waste quantities from the following industry branches are considered: wastes from agriculture, horticulture, forestry, fishery and food processing, wastes from wood processing, wastes from the production of cellulose, paper and cardboard, wastes from the textiles industry, packaging wastes as well as the wood fraction from construction and demolition wastes. [NIR 2011] |
| **Greece** | Industrial waste is neither mentioned nor considered explicitly. [NIR 2011] |
| **Ireland** | Cleansing waste (street sweepings, municipal bins, parks and gardens waste) and other waste streams that occur in Ireland are construction and demolition waste.. [NIR 2011] |
| **Italy** | In non hazardous landfills industrial wastes assimilated to municipal solid waste (AMSW) could be disposed. Their composition must be comparable to municipal solid waste composition. From 2001, data on industrial waste disposed in municipal landfills are available from Waste Cadastre. For previous years, assimilated municipal solid waste production has been reconstructed, and the same percentage of MSW disposed in landfill has been applied also to AMSW. The complete database of AMSW production from 1975 to 2000 is reconstructed starting from data available for the years 1988 (ISTAT, 1991) and 1991 (MATTM, several years) with a linear interpolation, and with a regression model based on Gross Domestic Product (Colombari et al, 1998). From 1975 back to 1950 AMSW production has been derived as a percentage of MSW production; this percentage has set equal to 15%, which is approximately the value obtained from the only data available (MSW and AMSW production for the years 1988 and 1991). [NIR 2011] |
| **Luxembourg** | Today, there are no landfill sites for purely industrial waste in Luxembourg. However, one site existed in the past and it has been closed down in the early 1990s (Ronnebierg site). The emissions of the closed industrial waste disposal on land site (Ronnebierg) are estimated for the period 2000 to 2009. [NIR 2011] |
| **Netherlands** | Industrial waste is neither mentioned nor considered explicitly. [NIR 2011] |
| **Portugal** | The fermentable part of industrial waste is considered. Historical time series are based on 1999 data which refer to annual registries relating to industrial unit declarations sent to the regional environment directorates which have been estimated on expert judgment. For the period 1960-1990 it was considered a growth rate of 1.5% per year; for the following years (1990-1998) 2% per year. Data for the years 2000, 2002 and 2003 refer to annual registries. The year 2001 refer to estimates based on the average of 1999 and 2000 data. Data for period 2004 to 2006 are interpolated values based on the 2003 and 2007 figures. Data from 2007 onwards refer to data collected under the Waste Registry . All industrial waste generated was considered to be disposed in SWDS together with urban waste. However, as there is no available information concerning final industrial waste disposal, it was assumed that all estimated waste produced has followed the urban disposal pattern between uncontrolled and controlled SWDS. Except for DOC, the same parameters are used for industrial waste as for municipal waste. [NIR 2011] |
| **Spain** | For large SWDS and those with biogas recovery, the AD is derived from questionnaires provided by each landfill. Waste types whose information is requested in the questionnaire were classified in four categories: household waste, waste from composting rejections, residues (sludge) from wastewater treatment plants and urban other wastes not classified under the above categories (bulky waste, demolition, ash from combustion processes, industrial, etc.). Construction waste has been excluded from the total quantity of waste landfilled. [NIR 2011] |
| **Sweden** | Detailed description available in the NIR of how activity data and emissions of relevant industrial wastes and sludges are generated. [NIR 2011] |
| **United Kingdom** | The estimates of waste disposal quantities include industrial waste. Waste quantities are obtained from studies, surveys, and models. [NIR 2011] |

*Source: NIR 2011*

Methane generation rate constant: $CH_4$ is emitted on SWDS over a long period of time rather than instantaneously. The tier 2 FOD model can be used to model landfill gas generation rate curves for individual landfill over time. One important parameter is the methane generation rate constant. It is determined by a large number of factors associated with the composition of waste and the conditions at the site. Rapid rates which are associated with a high moisture content and rapidly degradable material can be found for example in part of the waste in Finland, Greece and the UK. Figure 8.8 provides some $CH_4$ generation rate constants as reported by the Member States in CRF table 6 A,C, while

Table 8.20 summarizes information on the applied country specific approach.

**Figure 8.8** **6A1 Managed Solid Waste Disposal: Methane generation rate constant**




*Source: CRF 2011 Table 6 A,C Additional information, NIR 2011*

**Table 8.20 6A1 Managed Solid Waste Disposal: Further information on the methane generation rate constant**

| Member State | Information on the half-time respectively the methane generation rate constant |
|---|---|
| **Austria** | Several values for the half life period of different waste types (residual waste, wood, paper, sludges, bulky waste and other waste, bio waste, textiles, construction waste and fats) are presented. [NIR 2011] |
| **Belgium** | Several values for the biodegradation rate are given. [NIR 2011] |
| **Denmark** | Assumption is that the half-life of the carbon in the waste is 14 years. [NIR 2011] |
| **Finland** | Methane generation rate constants are divided into four categories: k1= 0.185 for wastewater sludges and food waste, k2=0.03 for wood waste and de-inking sludge, k3=0.1 paper waste and textile waste, and k4=0.06 for garden waste, napkins, fibre and coating sludges. [NIR 2011] |
| **France** | NIR provides three values are provided: k1=0.5 for 15 % of the waste, k2=0.1 for 55 % of the waste and k3=0.04 for 30 % of the waste. [NIR 2011] |
| **Germany** | Several values for the half life are provided (years): food waste: 4, garden and park waste: 7, paper and cardboard: 12, wood: 23, textiles/diapers: 12, composites: 12, sludges from wastewater treatment: 4. [NIR 2011] |
| **Greece** | The estimation of k is determined by the conditions in the disposal sites (e.g. moisture content, temperature, soil type) and by the composition of waste landfilled. Considering the fact that climate in Greece is dry temperate (the ratio of mean annual precipitation to potential evapotranspiration is around 0.5), half life was estimated at 17 years for paper and textiles, 35 for wood, 12 years for food waste and 9 years for sewage sludge disposed on land. [NIR 2011] |
| **Ireland** | The 2006 IPCC Guidelines provide narrow ranges for the value of decay rate constant appropriate to the individual waste components under different climatic zones. Ireland has chosen the highest values given for the Western Europe wet temperate conditions for all waste constituents, as the value of the ratio MAP:PET (Mean Annual Precipitation: Potential Evapotranspiration) is greater than 2 in Ireland. [NIR 2011] |
| **Italy** | The methane generation rate constant k in the FOD method is related to the time taken for DOC in waste to decay to half its initial mass (the 'half life' or t½). The maximum value of k applicable to any single SWDS is determined by a large number of factors associated with the composition of the waste and the conditions at the site. The most rapid rates are associated with high moisture conditions and rapidly degradable material such as food waste. The slowest decay rates are associated with dry site conditions and slowly degradable waste such as wood or paper. Thus, for each rapidly, moderately and slowly biodegradable fraction, a different maximum methane generation rate constant has been assigned. National half-life values are suggested in a study. Accordingly, waste streams have been categorized in three main types: rapidly biodegradable waste (food waste, sewage sludge, k1=0.69), moderately biodegradable waste (garden and park waste, k2=0.14) and slowly biodegradable waste (paper and paperboard, textile and leather, wood and straw, k=0.05). [NIR 2011] |
| **Luxembourg** | Default values for the generation rate for types of waste, where no data are available (IPCC 2000 GPG, p.5.10) [NIR 2011] |
| **Netherlands** | Methane generation rate constant: 0.094 up to and including 1989, decreasing to 0.0693 in 1995 and constant thereafter, this corresponds to half-life times of 7.4 and 10 years, respectively. The change in k-values is caused by a sharp increase in the recycling of vegetable, fruit and garden waste in the early 1990s. [NIR 2011] |
| **Portugal** | The value of $CH_4$ generation rate constant (k) depends on several factors as the composition of the waste and the conditions of the SWDS. In the absence of national studies to determine this parameter, and following the recommendations of the in-depth review, the values used in the previous submissions were revised in order to apply the guidance from IPCC 2000. The k value considered was 0.07 (half life of about 10 years), which represents a higher decay rate compared to the k default value proposed by the IPCC 2000 (0.05 - half life of about 14 years). [NIR 2011] |
| **Spain** | The constant rate of methane generation takes the value recommended by the IPCC Good Practice Guidance (0.05) with the exception of three managed landfills for which k values of 0.035, 0.043 and 0.049 have been chosen. [NIR 2011] |
| **Sweden** | National value for half-life time of 7.5 years. The choice of the half-life factor has also been motivated by the rather wet climate conditions in Sweden (MAP/PET>1), and that the 2006 IPCC Guidelines recommends the default value of 7 for such climate conditions. [NIR 2011] |
| **United Kingdom** | MELMod uses waste to landfill data from 1945 to the present, a period equivalent to over four half lives for the slowly degrading waste (i.e. with a decay rate of 0.046 year-1, equivalent to a half life 15 years). This lies within the range of 3 to 5 half-lives recommended by the IPCC Good Practice Guidelines. [NIR 2011] |

*Source: NIR 2011, CRF 2011 Table 6 A,C Additional information*

Concerning the magnitude of the methane generation factor, Italy explains its high weighted average degradation rate with high moisture contents. The weighted averages of k should reflect the waste composition as well as the moisture content or average temperatures. In general, a comparison is difficult since many parameters have influence on the average value.

### 8.3.2 Unmanaged Solid Waste Disposal (CRF Source Category 6A2) (EU-15)

$CH_4$ emissions from unmanaged solid waste disposal were reported in only six Member States in 2009 (France, Greece, Ireland, Italy, Portugal and Spain). Two of these six Member States (Spain, Greece) still dispose MSW to unmanaged SWDS, compare column 'Annual MSW to unmanaged SWDS' in Table 8.21, while in France, Italy and Portugal waste disposals from the past still emits (see Table 8.4). 100% of all EU-15 emissions from this category are calculated using higher tier methods. The Methane Correction Factor (MCF) reflects the way in which MSW is managed and the effect of management practices on $CH_4$ generation. According to the Revised 1996 IPCC Guidelines, the MCF for unmanaged disposal of solid waste depends of the type of site – shallow, deep or uncategorized.

Table 8.22 gives an overview of the MCF applied the relevant Member States.

**Table 8.21 6A2 Unmanaged Solid Waste Disposal: Selected parameters for calculating emissions from source category 6A2**

| Member State | Emissions reported from unmanaged SWDS | Annual MSW to unmanaged SWDS (Gg) | MCF $CH_4$ | | |
|---|---|---|---|---|---|
| | | | Unmanaged SWDS | Deep | Shallow |
| **France** | X | 0.00 | 0.50 | NO | 0.50 |
| **Greece** | X | 26.6 | 0.80 | 0.80 | IE |
| **Ireland** | X | NO | NA | NA | NA |
| **Italy** | X | NO | 0.60 | NO | 0.60 |
| **Portugal** | X | NO | 0.60 | IE | 0.60 |
| **Spain** | X | 551.63 | 0.60 | 0.80 | 0.40 |

*Source: CRF 2011 table 6 and 6A,C*

**Table 8.22 6A2 Unmanaged Solid Waste Disposal: Further information**

| Member States | Unmanaged waste disposal on SWDS |
|---|---|
| **France** | The difference between managed and unmanaged MSWD is based on the degree of compaction of waste in MSWD. In recent years all waste generated is treated in managed MSWD sites. Uncompacted landfill gradually ceased in favor of compacted landfills. However, closed MSWD continue to be issued because of the kinetics of the reaction. [NIR 2011] |
| **Greece** | Unmanaged wastes are considered to be landfilled in sites of similar characteristics concerning their composition and management (depth of sites), while the starting year of disposal and degradation of total unmanaged waste is assumed to be 1960. According to the Ministry of Environment, Energy and Climate Change (MEECC), 2182 unmanaged SWDS were still operating in 2000 (MEECC 2001). Following the National and Regional Planning of Solid Waste Management (compiled in the end of 2003), the process of closure and rehabilitation of unmanaged sites is already in progress and is expected to be completed in the following years, along with the construction of managed SWDS, following to the standards set by the EU directives, in order to cover the needs of the country. Nowdays, there is a small number of Unmanaged waste disposal sites which is planned to be eliminated until the end of 2011. [NIR 2011] |
| **Ireland** | In the 2006 IPCC guidelines the MCF varies from 0.4 for shallow unmanaged landfills to 1.0 for fully anaerobic deep and managed landfills. In the present model analyses undertaken for both individual sites and groups of landfills, annual MCF values show an increase over time to reflect the change from generally shallow, poorly-managed landfills before 1998 to well controlled and engineered landfills in subsequent years. The larger landfills that were in existence prior to the introduction of waste licensing were subject to some level of management but not to the extent of fully managed licensed sites after 1998. These large sites are assigned to the IPCC category of unmanaged deep sites for the years up to 1998 with MCF of 0.8 and to the managed category with MCF of 1.0 for the remainder of their lifetime. The 250 sites that operated primarily as small open town dumps and shallow uncontrolled disposal sites with significant aerobic conditions up to the introduction of waste licensing are assigned to the IPCC category of unmanaged shallow sites up to 1998, for which the appropriate MCF is 0.4. A transition from unmanaged shallow classification in 1960 to one-third unmanaged shallow and two-thirds unmanaged deep sites in 1998 is applied to the remainder of sites, giving an increasing MCF from 0.4 to 0.67 over this period. [NIR 2010] |
| **Italy** | From 2000, municipal solid wastes are disposed only into managed landfills, due to the enforcement of regulations. The share of waste disposed of into uncontrolled landfills has gradually decreased thanks to the enforcement of new regulations, and in the year 2000 it has been assumed equal to 0; emissions still occur due to the waste disposed in the past years. The unmanaged sites have been considered shallow. The MCF value used for unmanaged landfill is the default IPCC value reported for uncategorised landfills: in fact, in Italy, before 2000 existing unmanaged landfills were mostly shallow, because they resulted in uncontrolled waste dumping instead of real deep unmanaged landfills. To be conservative, the default IPCC value reported for uncategorised landfills has been used. It is assumed that landfill gas composition is 50% carbon dioxide and 50% methane. [NIR 2011] |
| **Portugal** | The share of final disposal destiny (inter alia uncontrolled dumping sites) for the first years of the time series was calculated having as a basis the Quercus survey. Data for recent years (mainly since 1999) refer to data collected from management systems. There have been significant efforts at national level to deactivate and close all uncontrolled dumping sites. This effort was concluded in 2002 when all uncontrolled dumping sites had been closed. Concerning uncontrolled dumping sites, it was considered that there is gas burning when a dumping site has been closed and is associated with a managed landfill having recovery of $CH_4$. It was assumed that all estimated industrial waste produced have followed the urban disposal pattern between uncontrolled and controlled SWDS. [NIR 2011]. |
| **Spain** | No statistical information is available for unmanaged SWDS. It is assumed that 50% of unmanaged landfills are deep (depth > 5 m) and the remaining 50% are shallow (depth <5 m). For unmanaged SWDS it is also assumed that the waste is partly burned to reduce the volume. The burning fractions have been decreased during the inventory period. [NIR 2011] |

*Source: NIR 2011.*

### *8.3.3 Waste water handling (CRF Source Category 6B) (EU-15)*

$CH_4$ Emissions from domestic and commercial waste water handling (6B2) are a significant emission source in category 6B and key source in the EU. $CH_4$ emissions from waste water handling are calculated with the help of diverse methods (CR (CORINAIR), CS, D, M, T1 and T2). 25 % of all EU-15 $CH_4$ emissions from wastewater handling (6B) are calculated using higher tiers (i.e. all methods besides default and T1 methods).

Table 8.23 provides an overview of the $CH_4$ emission sources in wastewater handling which have been identified by the Member States. Furthermore methods applied to determine $CH_4$ emission from municipal wastewater and sludge handling are described in detail.

**Table 8.23** **6B2 Domestic and Commercial Waste Water Handling: $CH_4$ emission sources and methods for determining $CH_4$ emissions**

| Member State | $CH_4$ emission sources and description of methods (municipal wastewater and sludge) |
|---|---|
| **Austria** | Municipal wastewater treatment in Austria uses mainly aerobic procedures. As a result no or negligible methane emissions are produced since such emissions only occur under anaerobic conditions. In the year 2008 – the latest year for which data is currently available – 92.8% of the Austrian population was connected to municipal wastewater treatment plants. The remaining wastewater is treated either in septic tanks (4.4% of the Austrian population), domestic wastewater treatment plants (2.5%), or other disposal facilities, which are not further specified in the respective data sources ("unspecified disposal routes": 0.3%). Wastewater treatment plants are using aerobic procedures (resulting in $N_2O$ emissions), whereas septic tanks are characterised by anaerobic conditions (resulting in $CH_4$ emissions). As in there occur anaerobic processes, methane emissions are produced. $CH_4$ emissions from cesspools and septic tanks are calculated pursuant to the IPCC method. The following parameters were used: Average organic load: 60 g BOD5 per inhabitant and day, methane producing capacity Bo: 0,6 kg $CH_4$/ kg BoB5, methane conversion factor MCF: 0.27. The amount of inhabitants not connected to sewage systems and wastewater treatment plants was taken from the respective Austrian reports on water pollution control. Data for the years 1971, 1981, 1991, 1995 and 1998, 2001, 2003, 2006 and 2008 were available. The missing data were interpolated. The share of inhabitants connected to septic tanks has to be extrapolated from the year 2000 onwards. In Austria sewage sludge treatment is carried out on the one hand by aerobic stabilisation and on the other hand by anaerobic digestion. As sludge stabilisation is carried out aerobicly, the amount of methane emissions produced is negligible. Methane gas produced in the digestion processes is usually used for energy recovery or is flared. As the $CH_4$ emissions from both processes are negligible, they are not estimated. [NIR 2011] |
| **Belgium** | In this category, two sources of $CH_4$ emissions are taken into account, the municipal wastewater treatment plant and the sceptic tanks.<br>The methodology for the septic tanks is based on an article (Vasel, 1992) [32] which describes the characteristics and parameters of individual septic tanks. The IPCC default value of 0.6 kg $CH_4$/kg BOD is used. Each habitant produces 0.060kg BOD/day, whose 60 % eventually settles (IPCC fraction that readily settle). It is considered that only 25 % of the BOD loading is anaerobically degraded (0,060*0,6*0,25), because the septic tanks are regularly emptied and consequently the sludge is then treated aerobically. The annual emission factor becomes 1,971 kg $CH_4$/inhab*year (0,6*0,060*60%*25%*365 kg$CH_4$/kg BOD). The $CH_4$ emissions are estimated by multiplying these emission factors by the number of inhabitants not connected with a municipal wastewater treatment plant.<br>In the Walloon region, after discussion with the regional responsible for municipal wastewater treatment plants, it appears that most of the plants are conducted aerobically. Those who use anaerobical digestion of the sludge recover the $CH_4$ for energy purpose. Consequently, no $CH_4$ emissions are accounted in this subcategory. In the Brussels region, there are two municipal wastewater treatment plants. One is conducted aerobically and the other anaerobically. The $CH_4$ produced by the anaerobical digestion is recovered for energy purpose. No $CH_4$ emissions are consequently estimated for this subcategory.<br>In the Flemish region the emissions of $CH_4$ of the municipal waste water treatment plants are estimated by using the methodology as described in the EMEP/CORINAIR guidebook [3]. An emission factor of 0,3 kg $CH_4$/inhabitant*year is used to calculate these emissions. [NIR 2011] |
| **Denmark** | The methodology developed for this submission for estimating emission of methane and nitrous oxide from wastewater handling follows the IPCC Guidelines (IPCC, 1997) and IPCC Good Practice Guidance (IPCC, 2000). The unspecified fugitive methane emission has this year been specified according the following identified systems and processes contribution to the fugitive methane emission from waste water handling in Denmark. Fugitive methane releases from the municipal and private WWTPs have been divided into contributions from 1) the sewer system, primary settling tank and biological N and P removal processes, 2) from anaerobic treatment processes in closed systems with biogas extraction and combustion for energy production and 3) septic tanks. Monitoring data on the influent biological oxygen demand (BOD) are available for mixed industrial and household wastewater, which are used for calculating the total organic waste (TOW) in the influent wastewater. From 1990 to 1998, the IPPC default methodology for household wastewater has been applied by accounting and correcting for the industrial influent load (Thomsen & Lyck, 2005). For the years 1999 to 2009 monitoring data from the national monitoring program exists (cf. Table 8.3.9). For the year 2009 the national total TOW data are calculated based on monitoring data from approximately 1000 municipal WWTPs; each WWTP represented by an average of 12 measurements. Yearly BOD data are calculated from measured BOD per litre influent waste water multiplied by the influent amount of water. A country-specific emissions factor for calculating the amount of methane produced during anaerobic treatment processes, the gross methane emission (cf. Table 8.3.1), at the Danish WWTPs have been derived. [NIR 2011] |
| **Finland** | A national methodology that corresponds to the methodology given in the Revised 1996 Guidelines is used in the estimation of the $CH_4$ emissions. Emission sources cover municipal (domestic) and industrial wastewater handling plants and uncollected domestic waste water for $CH_4$ emissions. For uncollected domestic wastewaters the Check method with default parameters (IPCC Good Practice Guidance) has been used. [NIR 2011] |
| **France** | On the basis of the statistics of the wastewater treatment plants in France, the emissions are calculated according to the IPCC tier 2 method, distinguishing between natural lagoons and cesspools. Some assumptions are made: 1.Only 2.4% of the water of the residential/commercial sector collected in waste water treatment plants are treated in stabilization ponds, 2. this treatment corresponds to a conversion rate of 0.23. [NIR 2011] |
| **Germany** | Municipal wastewater treatment in Germany uses aerobic procedures (municipal wastewater-treatment facilities, small wastewater-treatment facilities), i.e. it produces no methane emissions, since such emissions occur only under anaerobic conditions. Treatment of human sewage from persons not connected to sewage networks or small wastewater treatment facilities represents an exception: in cesspools, uncontrolled processes (partly aerobic, partly anaerobic) may occur that lead to methane formation. Organic loads from cesspools are calculated pursuant to the IPCC method, in which the relevant population is multiplied by the average organic load per person. [NIR 2011] |

| Member State | $CH_4$ emission sources and description of methods (municipal wastewater and sludge) |
|---|---|
| **Greece** | $CH_4$ from waste water handling was estimated according to the default methodologies suggested by IPCC. Considering the fact that there are not sufficient data regarding all the wastewater handling facilities of the country and as a result methane emissions are calculated based on the total population served, emissions from wastewater treatment and the sewage sludge removed from wastewater are not considered separately. However, methane emissions from sewage sludge disposed in managed sites have been estimated. Therefore, in order to avoid double counting of emissions from sludge treatment, the organic load (in biochemical oxygen demand) of sludge that is actually disposed on land was subtracted by the organic load of wastewater treated. [NIR 2011] |
| **Ireland** | Approximately one-third of the population in Ireland is served by urban wastewater treatment plants, which are based on aerobic systems with no emissions of $CH_4$. The other one-third of the population uses septic tanks to treat wastewater mainly for individual houses in nonurban areas (Smith et al., 2004). The prevailing temperature in septic tanks is less than 15°C in Ireland, which is too low for the occurrence of methanogenesis and it is reasonable to assume that no appreciable emissions of $CH_4$ occur. Consequently the notation key “NO” is reported for $CH_4$ under wastewater in sub-categories 6.B.1 and 6.B.2 of the CRF tables. [NIR 2011] |
| **Italy** | In Italy wastewater handling is managed mainly using a secondary treatment, with aerobic biological units. The stabilization of sludge occurs in aerobic or anaerobic reactors; where anaerobic digestion is used, the reactors are covered and provided of gas recovery. It is assumed that domestic and commercial wastewaters are treated 95% aerobically and 5% anaerobically, whereas industrial wastewaters are treated 85% aerobically and 15% anaerobically. $CH_4$ emissions from sludge generated by domestic and commercial wastewater treatment have been calculated using the IPCC default method on the basis of national information on anaerobic sludge treatment system. Emissions from methane recovered, used for energy purposes, in wastewater treatment plants are estimated and reported under category 1A4a. A percentage of 1.8% of domestic and commercial wastewater is actually treated in Imhoff tanks, where the digestion of sludge occurs anaerobically without gas recovery. [NIR 2011] |
| **Luxembourg** | Municipal wastewater treatment in Luxembourg uses mainly aerobic processes such as activated sludge or biofiltration. As a result, no or negligible methane emissions are produced, since such emissions only occur under anaerobic conditions. In these plants, sludge stabilisation is carried out in order to prevent uncontrolled putrefaction. In facilities with a treatment capacity smaller than 30.000 population-equivalents (p.e.) the stabilisation is usually carried out aerobically, with oxygen and energy consumption, while for facilities with a treatment capacity larger than 30.000 p.e., the stabilisation is normally carried out anaerobically with production of methane gas. The gas produced is usually used for energy recovery in combined heat/power generating systems or may be flared. In this emission inventory, methane emissions from these small anaerobic sludge treatments have been taken into account as there is no gas reuse and therefore methane emissions have been assumed. The methodology for these septic tanks is based on the IPCC method in which the relevant population (individual septic tanks) or population equivalents (for the small mechanical treatment plants) is multiplied by the average organic load per person.The 2006 IPCC default value of 0,6 kg $CH_4$/kg BOD is used. Each habitant produces 60 g BOD/day, and a MCF of 0,27 is assumed (STEINLECHNER et al. 1994). According to the national expert judgment and based on the study of Steinlechner et al. (1994), the MCF has been adapted to the national situation in Austria which is also applicable for Luxembourg. [NIR 2011] |
| **Netherlands** | In general, the emissions are calculated according to the IPCC guidelines, with country-specific parameters and emission factors being used for $CH_4$ emissions from wastewater handling (including sludge). The calculation methods are equivalent to the IPCC Tier 2 methods. [NIR 2011] |
| **Portugal** | $CH_4$ emissions from domestic wastewater handling were estimated using a methodology adapted from IPCC 1996 Revised Guidelines and Good Practice Guidance, which follows three basic steps: 1. Determination of the total amount of organic material originated in each wastewater handling system, 2. Estimation of emission factors and 3. Calculation of emissions. [NIR 2011] |
| **Spain** | The methodology in Section 5.2 of the IPCC Good Practice Guidance has been applied. Computing the contributions of the water and sludge lines, the emissions are obtained as a product of the degradable organic load (water and sludge) and the methane emission factors, discounting from this product the amount of methane recovered. The methane emission factors are expressed as the product of the respective parameter B0 of maximum capacity for methane production times the weighted methane conversion factor, WMCF.<br>For domestic/commercial waste water, the organic load is the activity variable selected, expressed in mass of Biochemical Oxygen Demand (BOD5). For the calculation of this variable, the population data currently served by waste-water treatment stations has been used, as detailed in the publication “The Environment in Spain” from the Ministry of the Environment. For the degradable organic load, a value of 300 mg BOD5/litre of waste water and a flow of 200 litres/inhabitant equivalent per day, and 365 operating days per year, have been assumed. [NIR 2011] |
| **Sweden** | 6B2a has been divided into three sections: a) Large wastewater treatment plant (treatment capacity: more than 2 000 pe); b) Small wastewater treatment plants (treatment capacity: 25 -2000 pe); c) Population not connected to wastewater discharge system.<br>a) In Sweden, all large wastewater treatment plants are using aerobic wastewater treatment processes. No $CH_4$ is supposed to be generated because of the use of aeration in the wastewater treatment process.<br>b) For small wastewater treatment plants, the situation is at the moment not well enough investigated and therefore Sweden is using the IPCC Good Practice Guidance method (Page 5.15 Box 5.1 Check method). Activity data on population connected to small wastewater treatment plants (700 000 people) is derived from background data in a not yet published survey of treatment methods and sewage networks for Swedish municipal waste water treatment plants 2010.<br>c) For population not connected to wastewater discharge system, the following applies:<br>1.) The sludge in the wastewater is collected in sand filters or infiltration beds, collected and transported to anaerobic digestion plants located at larger wastewater treatment plants221. It is covered and reported in section CRF6B2b (sludge treatment).<br>2.) $CH_4$ emissions from the remaining waste water are likely to be NO (not occur-ring) or negligible. The waste water is rich in oxygen, and for biological processes to occur the water must not be too cold.222 Sweden has a rather cold climate with an average annual temperature of 4.8 (°C) 1991-2005. [NIR 2011] |

| Member State | $CH_4$ emission sources and description of methods (municipal wastewater and sludge) |
|---|---|
| **United Kingdom** | The methodology of the UK model differs in some respects from the IPCC default methodology. The main differences are that it considers wastewater and sewage together rather than separately. It also considers domestic, commercial and industrial wastewater together rather than separately. The inventory compilation method for methane estimates from water treatment and sewage sludge treatment and disposal is based on activity data from the water industry annual reporting system to UK industry regulators (for 2000 onwards) and an historic time series of sludge treatment data published by Defra (Defra EPSIM data, 2004). The UK Water Industry Research organisation has developed a spreadsheet emissions estimator tool, drawing upon available emission factors for sub-processes within the industry, and each UK water company uses this tool to estimate its annual emissions. From these reported emissions and activity data, implied emission factors for specific emission sub-sources can be derived.<br>Emissions data have only been made available for the year 2008, and hence the Implied Emission Factors from 2008 have been applied to the activity data across all years. The use of such a limited dataset is not ideal, and the uncertainties in the emission estimates, especially for earlier years in the time series, are regarded as high. [NIR 2011] |

*Source: NIR 2011; CRF 2011 Tables 6, 6Bs1 and 6Bs2*

$CH_4$ emissions from industrial wastewater and sludge handling are not key sources. Nevertheless, information about the methods applied for the estimation of $CH_4$ emissions from this source category is provided in Table 8.24.

Emissions of methane from industrial wastewater handling are reported by eight Member States (Finland, France, Greece, Italy, the Netherlands, Portugal, Spain and Sweden), but seven Member States indicate either that emissions are not estimated or not applicable or not occurring (Austria (NA), Belgium (NE), Germany (NO), Ireland (NO), Luxembourg (NO) or that emissions are reported elsewhere (Denmark and the United Kingdom).

The only MS that indicates $CH_4$ emissions from industrial wastewater as not estimated is Belgium which aims on collecting data from industrial wastewater plants the Flemish region, although the emissions originating from the industrial waste water plants are probably negligible.

Sweden, for the inventory submission in 2011, estimated $CH_4$ emissions from wastewater handling for the first time. To also correspond to the recommendation from the ERT (FCCC/ARR/2009/EC, para 85), these emissions have been considered for the EU inventory, thus increasing its completeness.

Emissions from sludge handling are reported by four Member States (France, Greece, Ireland and Spain), other Member States either reported emissions as not estimated (Belgium and the Netherlands) or not occurring (Germany, Luxembourg and Sweden,) or not applicable (Austria) or reported the emissions elsewhere (five Member States: Denmark, Finland, Italy, Portugal and the United Kingdom).

An overview of methodological issues regarding $CH_4$ emissions from industrial wastewater and sludge handling is provided in Table 8.24.

**Table 8.24 6B1 Industrial Waste Water Handling: $CH_4$ emissions and methods applied**

| Member State | $CH_4$ emissions from industrial wastewater | | Methods for determining $CH_4$ emissions from industrial wastewater and sludge handling |
|---|---|---|---|
| | Waste water | Sludge | |
| **Austria** | NA | NA | Industrial wastewater treatment and sewage sludge treatment is carried out under aerobic as well as anaerobic conditions. As $CH_4$ gas is usually used for energy recovery or is flared, the amount of $CH_4$ emissions from industrial wastewater treatment and sewage sludge treatment is negligible and therefore reported as "not applicable". In the energy sector sewage gas is considered as an energy source. [NIR 2011] |
| **Belgium** | NE | NE | Emissions originating from the anaerobical treatment of industrial wastewater (category 6B1) are not estimated in Belgium. The plants that apply this treatment in the Walloon region also recover the $CH_4$ for energy purposes. Consequently, as for the anaerobical municipal wastewater treatment plants, no $CH_4$ emissions are accounted in this subcategory. Although, like mentioned above, the emissions originating from the industrial waste water plants are probably negligible, attempts are going on in the Flemish region to collect data for this sector. So far, necessary data needed to make a |

| Member State | $CH_4$ emissions from industrial wastewater | | Methods for determining $CH_4$ emissions from industrial wastewater and sludge handling |
|---|---|---|---|
| | Waste water | Sludge | |
| | | | rough estimation, are still missing. [NIR 2011] |
| **Denmark** | IE | IE | No distinction between emissions from industrial and municipal WWTPs is made, as Danish industries to a great extent are coupled to the municipal sewer system and waste water streams from households and industries therefore mixed in the sewer system prior to further treatment at centralised WWTPs. The contribution from the industry to the influent waste water at the centralised WWTPs has increased from zero to around 40% from 1987 to 2010 with the highest influent contribution occurring at the biggest and most advanced technological WWTPs in Denmark (Thomsen & Lyck, 2005; ASEP 2010). Monitoring data on the mixed household and industrial influent biological oxygen demand (BOD) are available for all WWTPs with a capacity above 30 PE treating more than 90 % of the Danish waste water. Monitoring data on the influent biological oxygen demand (BOD) are available for mixed industrial and household wastewater, which are used for calculating the total organic waste (TOW) in the influent wastewater. From 1990 to 1998, the IPPC default methodology for household wastewater has been applied by accounting and correcting for the industrial influent load (Thomsen & Lyck, 2005). For the years 1999 to 2009 monitoring data from the national monitoring program exists (cf. Table 8.3.9). For the year 2009 the national total TOW data are calculated based on monitoring data from approximately 1000 municipal WWTPs; each WWTP represented by an average of 12 measurements. Yearly BOD data are calculated from measured BOD per litre influent waste water multiplied by the influent amount of water. [NIR 2011] |
| **Finland** | X | IE | A national methodology that corresponds to the methodology given in the Revised (1996) Guidelines is used in estimation of the $CH_4$ emissions. The emissions from industrial wastewater treatment are based on the COD load. These DC (Degradable Organic Component) values of wastewaters with shared methane conversion factors have been used for both wastewater and sludge handling. The emissions from sludge disposal on land are, however, estimated and reported in the Solid waste disposal on land (landfills) subsector. These DC (Degradable Organic Component) values of wastewaters with shared methane conversion factors have been used for both wastewater and sludge handling. The emissions from sludge disposal on land are, however, estimated and reported in the Solid waste disposal on land (landfills) subsector. [NIR 2011] |
| **France** | X | X | For the estimation of $CH_4$, it is considered that the industrial effluent received at the waste water treatment plants are treated completely under aerobic conditions, unlike the effluent from the residential and commercial sector. However, some agro-food processing industries treating their waste water in situ are likely to use the natural lagoon. The IPCC equation for industrial water (according to the Chemical Oxygen Demand - COD) is then applied with Bo = 0.25 kg / kg COD. |
| **Germany** | NO | NO | The composition of industrial wastewater, in contrast to that of household wastewater, varies greatly by industrial sector. In Germany, the biological stage of industrial wastewater treatment is partly aerobic and partly anaerobic. Anaerobic wastewater treatment is especially useful for industries whose wastewater has high levels of organic loads. This treatment method has the advantages that it does not require large amounts of oxygen, produces considerably smaller amounts of sludge requiring disposal and generates methane that can be used for energy recovery. As in treatment of municipal wastewater, treatment of industrial wastewater releases no methane emissions into the environment. The processes include aerobic treatment and anaerobic digestion; gas formed in the latter is either used for energy recovery or is flared. [NIR 2011] |
| **Greece** | X | X | The methodology for calculating methane emissions from industrial wastewater is similar to the one used for domestic wastewater. In order to estimate the total organic waste produced through anaerobic treatment, the following basic steps were followed: Collection of data regarding industrial production of approximately 25 industrial sectors / sub-sectors for the period 1990 – 2009. Calculation of wastewater generated, by using the default factors per industrial sector (m3 of wastewater/t product) as suggested by the IPCC Good Practice Guidance. Calculation of degradable organic fraction of waste, by using the default factors (kg COD/m3 wastewater) suggested by the IPCC Good Practice Guidance for each sector / sub-sector. The distribution between aerobic and anaerobic treatment of industrial wastewater for each industrial sector was estimated on the basis of data derived from a relevant project. The maximum methane production potential factors and the methane conversion factors for aerobic and anaerobic treatment, which were used for the final estimation of methane emissions, are similar to those used for domestic wastewater handling. [NIR 2011] |
| **Ireland** | NO | X | The anaerobic stabilisation of sludge is a source of $CH_4$ in Ireland. The amounts of industrial wastewater sludge produced are available from biennial reports on urban wastewater treatment and approximately three percent of this sludge is treated anaerobically. The average BOD of industrial wastewater sludge is 60 kg/t (40 percent of the typical BOD content of treated industrial wastewater) and DOC is estimated as the product of average BOD content and tonnes of dry solids of sludge. The emission factor for $CH_4$ is derived from equation 11 on page 6.21 of the Revised 1996 IPCC Guidelines using the IPCC default value of 0.6 for BO, 0.3 for the fraction of sludge treated and 1.0 for MCF. [NIR 2011] |

| Member State | $CH_4$ emissions from industrial wastewater | | Methods for determining $CH_4$ emissions from industrial wastewater and sludge handling |
|---|---|---|---|
| | Waste water | Sludge | |
| **Italy** | X | IE | In Italy wastewater handling is managed mainly using a secondary treatment, with aerobic biological units. It is assumed that domestic and commercial wastewaters are treated 95% aerobically and 5% anaerobically, whereas industrial wastewaters are treated 85% aerobically and 15% anaerobically. The methane estimation concerning industrial wastewaters makes use of the IPCC method based on wastewater output and the respective Degradable Organic Carbon for each major industrial wastewater source. No country-specific emission factors of methane per Chemical Oxygen Demand are available so the default value of 0.25 kg $CH_4$ $kg^{-1}$ DC, suggested in the IPCC Good Practice Guidance, has been used for the whole time series. As recommended by the Good Practice Guidance for key source categories, data have been collected for several industrial sectors (iron and steel, refineries, organic chemicals, food and beverage, paper and pulp, textiles and leather industry). The total amount of organic material for each industry selected has been calculated multiplying the annual production by the amount of wastewater consumption per unit of product and by the degradable organic component. Moreover, the fraction of industrial degradable organic component removed as sludge has been assumed equal to zero. The yearly industrial productions are reported in the national statistics, whereas the wastewater consumption factors and the degradable organic component are either from Good Practice Guidance or from national references. National data have been used in the calculation of the total amount of both COD produced and wastewater output for refineries, organic chemicals, beer production, wine, milk and sugar sectors, the pulp and paper sector, and the leather sector. [NIR 2011] |
| **Luxembourg** | NO | NO | Industrial wastewater treatment and sewage sludge treatment is carried out under aerobic conditions (activated sludge process). As for the municipal facilities there are no methane emissions. [NIR 2011] |
| **Netherlands** | X | NE | The source category „wastewater handling” also includes the $CH_4$ emissions from anaerobic industrial wastewater treatment plants (WWTP), but these are small compared to urban wastewater treatment plants (WWTP). For anaerobic industrial WWTPs, the $CH_4$ emission factor is expressed as 0.056 t/t DOC design capacity, assuming a utilization rate of 80%, a $CH_4$-producing potential (Bo) of 0.22 t/t DOC and a methane recovery (MR) of 99%. [NIR 2011] |
| **Portugal** | X | IE | Methane emissions from industrial wastewater handling also follow the default methodology proposed in the 1996 IPCC Guidelines and the Good Practice Guidance. The organic wastewater load (TOW) is estimated using statistical production data on industries (ton product/yr) multiplied by pollution coefficients (kg O2/ton product). These coefficients were developed from field monitoring data at installations in Portugal. (NIR 2010) |
| **Spain** | X | X | For industrial point sources, the emissions are based on data obtained from individualized questionnaires sent to each plant. The point source activity data comprise oil refineries and paper pulp manufacturing plants. Wastewater from food industry and chemical industry was estimates as area source based on the organic load. The methane emission factor selected, with regard to the volume of waste water treated, is derived from the EMEP/CORINAIR Guidebook. For the period 1990-2000 no data is available for the wastewater volume treated and the amount is derived by an extrapolation based on the driver production data. [NIR 2011] |
| **Sweden** | X | NO | The majority of the facilities in Sweden are using aerobic processes, where no $CH_4$ is supposed to be generated because of the use of aeration in the wastewater treatment process. In 2009, there were only four (4) facilities using anaerobic waste-water treatment processes in Sweden. These facilities were in the pulp industry and food industry. For methane emissions from industries with internal wastewater treatment, Sweden has chosen a national method to estimate the emissions based on data availability. According to wastewater treatment expertise, the loss of $CH_4$ in the energy recovery process should be within the range of 2 - 5 %. This factor can be combined with data on energy recovery from the anaerobic processes.[NIR 2011] |
| **United Kingdom** | IE | IE | Industrial waste water is considered together with commercial and domestic wastewater. [NIR 2011] |

*Source: NIR 2011, CRF 2011 Tables 6, 6.Bs1 and 6.Bs2*
*According to table 6.Bs1in CRF 2011; X= emissions are reported; NA=not applicable; NE= not estimated; IE= included elsewhere; NO=not occurring*

According to the IPCC Good Practice Guidance, the emission factor for determining $CH_4$ emissions from wastewater and sludge handling is composed of the maximum methane producing potential (B0) and the methane conversion factor (MCF). There is an IPCC default value available for the maximum methane producing potential which is applied in most of the Member States. In contrast, the MCF has to be determined country specifically and varies strongly among the Member States depending on wastewater and sludge treatment systems used;

Table 8.25 provides an overview of the MCF applied by the Member States.

**Table 8.25 6B Waste Water Handling: Methane Conversion Factors**

| Member State | MCF | Specification of MCF | Further information on MCF |
|---|---|---|---|
| **Austria** | 0.27 | Cesspools and septic tanks | Value is taken from a national study. [NIR 2011] |
| **Belgium** | - | - | No information provided. [NIR 2011] |
| **Denmark** | - | Anaerobic treatment processes in closed systems with biogas extraction for energy production | Methane conversion factor depends on the extent to which BOD settles in the septic tanks. has been set equal to 0.5 (IPCC, 2006) assuming that degradation for the settles DOC occurs under 100% anaerobic conditions. The methane recovery, MRinlet, for the anaerobic wastewater treatment with biogas production has been set to 99% according to expert knowledge (personal communication, Professor Jes Vollertsen, Aalborg University and ASEP, 2010). [NIR 2011] |
| **Finland** | 0.01<br>0.005 | Municipal (domestic) wastewaters<br>Industrial wastewaters | The estimated methane conversion factors for collected wastewater handling systems (industrial and domestic) are low in Finland because the handling systems included in the inventory are either aerobic or anaerobic with complete methane recovery. The emission factors mainly illustrate exceptional operation conditions. The MCF is based on expert knowledge. [NIR 2011] |
| **France** | 0.23 | | Only for natural lagoons $CH_4$ emissions occur. [NIR 2011] |
| **Germany** | 0<br>0.5 | Municipal wastewater treatment<br>Cesspools | Aerobic conditions. The MCF for cesspools has been estimated on the basis of experience gained in other countries (septic tanks in the U.S., anaerobically treated municipal wastewater in the Czech Republic). [NIR 2011] |
| **Greece** | - | - | The default values for these factors are 0 for aerobic conditions and 1 for anaerobic conditions (and these values were applied in the calculations). [NIR 2011] |
| **Ireland** | 1 | Industrial Wastewater Sludge | The amounts of industrial wastewater sludge produced are available from biennial reports on urban wastewater treatment and approximately three percent of this sludge is treated anaerobically (O‟ Leary et al. 1997, 2000; O‟Leary and Carty, 1998; Smith et al. 2003; 2004, 2007; Monaghan et al. 2009). The average BOD of industrial wastewater sludge is 60 kg/t (40 percent of the typical BOD content of treated industrial wastewater) and DOC is estimated as the product of average BOD content and tonnes of dry solids of sludge. The emission factor for $CH_4$ is derived from equation 11 on page 6.21 of the Revised 1996 IPCC Guidelines using the IPCC default value of 0.6 for Bo, 0.3 for the fraction of sludge treated and 1.0 for MCF. [NIR 2011] |
| **Italy** | 0.25 | Industrial wasterwater | $CH_4$ emissions from sludge generated by domestic and commercial wastewater treatment have been calculated; the stabilization of sludge occurs in aerobic or anaerobic reactors; where anaerobic digestion is used, the reactors are covered and provided of gas recovery.<br><br>For industrial wastewaters, no country-specific emission factors of methane per Chemical Oxygen Demand are available, so the default value of 0.25 kg $CH_4$ $kg^{-1}$ DC, suggested in the IPCC Good Practice Guidance, has been used for the whole time series. [NIR 2011] |
| **Luxembourg** | 0.27 | Septic tank | The 2006 IPCC default value of 0,6 kg $CH_4$/kg BOD is used. Each habitant produces 60 g BOD/day, and a MCF of 0,27 is assumed (STEINLECHNER et al. 1994). According to the national expert judgment and based on the study of Steinlechner et al. (1994), the MCF has been adapted to the national situation in Austria which is also applicable for Luxembourg. The MCF defines the portion of methane producing capacity (B0) that degrades anaerobically and may vary between 0,0 (completely aerobic) to 1,0 (completely anaerobic) according to the IPCC 2006 Guidelines. [NIR 2011] |
| **Netherlands** | 0.5 | Septic tank | (NIR 2010) |
| **Portugal** | 0.1<br>0<br>0<br>0.3<br>0.5 | No treatment<br>Primary<br>Secondary (well managed)<br>Secondary (not well managed)<br>Septic tanks | The new guidelines from IPCC that were recently published (IPCC 2006) present more detailed values, now specific of treatment systems and management conditions, and they were used to establish the new MCF values. In the case where the industrial effluent was discharged into the unitary municipal treatment system, the MCF was determined from the average situation in Portugal for the domestic wastewater system when there is any form of treatment, either primary, secondary or tertiary. [NIR 2011] |
| **Spain** | 0.15<br>0.3<br>0.005<br>0.3 | industrial wastewater<br>industrial sludge<br>domestic wastewater<br>domestic wastewater sludge | The Weighted Methane Conversion Factor, WMCF, is calculated in accordance with Equation 5.8 in the IPCC Good Practice Guidance. [NIR 2011] |
| **Sweden** | - | - | No information available. [NIR 2011] |
| **United Kingdom** | - | - | No information available. [NIR 2011] |

*Source: NIR 2011*

Most Member States report $N_2O$ emissions from waste water handling. Different methods are applied (CR, CS, D, T1 and T2). 15% of $N_2O$ emissions from domestic wastewater handling are estimated by higher tier methods (Tier 2, CORINAIR (CR)). In Table 8.26 the methods for determining $N_2O$ emissions from wastewater handling applied by the Member States are described in detail.

**Table 8.26 6B Waste Water Handling: Methods for determining $N_2O$ emissions**

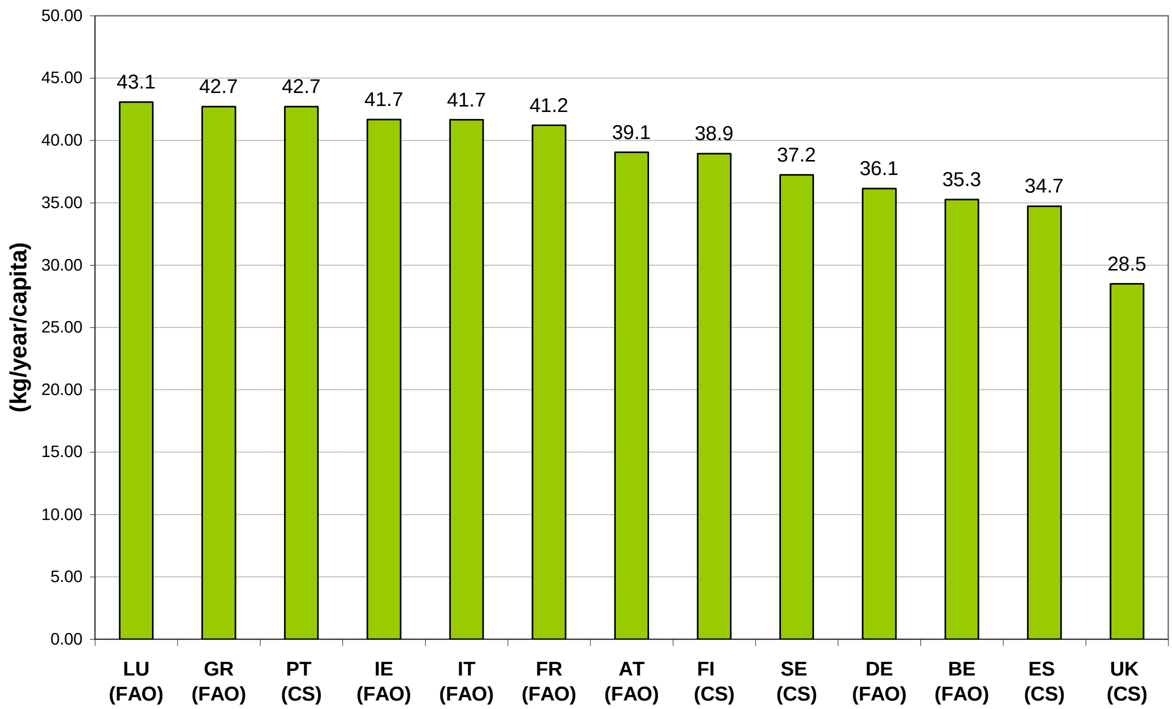
| Member State | $N_2O$ emissions from wastewater 1) | | Description of methods used ($N_2O$) |
|---|---|---|---|
| | Industrial | Domestic | |
| **Austria** | X | X | $N_2O$ emissions from domestic and commercial wastewater handling are calculated by differing between wastewater arising from households connected and from households not connected to the municipal sewage system. $N_2O$ emissions resulting from households not connected to the public sewage system were calculated according to the IPCC default method, as described in revised 1996 IPCC Guidelines. The data for the daily protein intake per person are taken from FAO statistics. The number of inhabitants is provided by Austria Statistics. Emission factor (0.01) and fraction of nitrogen in protein (0.16) are IPCC default values.<br>$N_2O$ emissions arising in waste water treatment plants are calculated by using a country-specific method based on IPCC. According to a national study, the amount of wastewater that is treated in sewage plants and the amount of nitrogen that is denitrificated should be considered. Finally the $N_2O$ emissions arising from waste water treatment plants and other treatment are summed up.<br>It is assumed that industrial wastewater handling additionally contributes 30% of $N_2O$ emissions from municipal wastewater treatment plants. As this share represents only the situation in the 1990ies, the ERT recommended a survey to verify this share. In this survey, several methods and different international approaches were compared and a literature review was undertaken. It resulted in the conclusion that the consideration of industrial $N_2O$ with 30% of $N_2O$ emissions from domestic wastewater treatment plants, is still justified. Data for the amount of wastewater that is treated in sewage plants as well as on the denitrification rate were taken from the Austrian reports on water pollution control and and situation reports on the disposal of urban wastewater and sludge; missing data in between were interpolated. [NIR 2011] |
| **Belgium** | NE | X | The $N_2O$ emissions from human sewage are estimated by using the methodology described in the IPCC 1996 Guidelines by multiplying the protein consumption per capita with the population, the N fraction in the protein and the default EF. The default values for N fraction in protein (kg N / kg protein) and $N_2O$ emission factor are 16 % and 0.01 kg $N_2O$-N / kg sewage-N produced. The figure of protein consumption originates from the FAO statistics. The population figures come from the National Institute of Statistics. A revision of the protein consumption/capita took place from 2003 on, based on a revision of the FAO statistics. During the 2011 submission the FAO-values are revised for the complete time series. [NIR 2011] |
| **Denmark** | IE | X | The emission of $N_2O$ from wastewater handling is calculated as the sum of contributions from wastewater treatment processes at the WWTPs and from sewage effluents. The emission from effluent wastewater, i.e. indirect emissions, includes separate industrial discharges, rainwater conditioned effluents, effluents from scattered houses, from mariculture and fish farming. [NIR 2011] |
| **Finland** | NE | X | In Finland, the N input from fish farming and from municipal and industrial wastewaters into the waterways is collected into the VAHTI database. For municipal wastewaters the measured values have been considered more reliable than the N input according to population data. In addition to the IPCC approach, also nitrogen load from industry and fish farming were taken into account. For uncollected wastewaters the nitrogen load is based on population data and protein consumption. The assessed $N_2O$ emissions cover only the emissions caused by the nitrogen load to waterways. In addition to the emissions caused by nitrogen load of domestic and industrial wastewaters also the emissions caused by the nitrogen load of fish farming have been estimated. $N_2O$ emission calculations are consistent with the IPCC method for discharge of sewage nitrogen to waterways. [NIR 2011] |
| **France** | X | X | IPCC method is used for domestic wastewater. The final EF 43 g $N_2O$/inhabitant/year. The wastewater treatment plants have been eliminating N and therefore the EF decreased between 1990 and 2008. For industrial waste the $N_2O$ EF is 16 g/hab/year. [NIR 2011] |
| **Germany** | NA | X | IPCC Default Method applied. For the amount of Protein per person and day FAO data is used. [NIR 2011] |
| **Greece** | X | X | $N_2O$ from waste water handling were estimated according to the default methodology suggested by IPCC. $N_2O$ emissions from domestic wastewater handling are estimated as the indirect nitrous oxide emissions from human consumption of food and their subsequent treatment through wastewater handling systems. Data on protein consumption (Protein) are provided by FAO.$N_2O$ emissions from industrial wastewater have been estimated for the first time in the current submission on the basis of the |

| Member State | $N_2O$ emissions from wastewater 1) | | Description of methods used ($N_2O$) |
|---|---|---|---|
| | Industrial | Domestic | |
| | | | emission factors equal to 0.25 g $N_2O$/m3 of wastewater production (EMEP/CORINAIR, 2007). The waste water production is resulting from the model for the estimation of methane emissions from industrial waste water. [NIR 2011] |
| **Ireland** | NA, NE | X | Human consumption of food results in the production of sewage, which is processed in septic tanks or in wastewater treatment facilities and is then disposed of directly onto land, into the soil through percolation areas or discharged to a water body. $N_2O$ emissions are estimated by taking the IPCC default value of 0.16 for the nitrogen content in protein and applying the default emission factor of 0.01 (kg $N_2O$-N/ kg sewage produced) to obtain the quantity of nitrogen in sewage ultimately entering the atmosphere as $N_2O$. [NIR 2011] |
| **Italy** | X | X | $N_2O$ emissions from domestic and commercial wastewater treatment are reported in human sewage. The default approach suggested by the IPCC Guidelines and updated in the Good Practice Guidance, based on population and per capita intake protein has been followed. Fraction of nitrogen protein of 0.16 kg N $kg^{-1}$ protein and an emission factor of 0.01 kg N-$N_2O$ $kg^{-1}$ N produced have been used, whereas the time series of the protein intake is from the yearly FAO Food Balance. $N_2O$ emissions from industrial wastewater have been estimated on the basis of the emission factors equal to 0.25 g $N_2O$/m3 of wastewater production (EMEP/CORINAIR, 2007). The waste water production is resulting from the model for the estimation of methane emissions from industrial waste water. [NIR 2011] |
| **Luxembourg** | X | X | Pursuant to the 2006 IPCC Guidelines, nitrous oxide emissions from household waste-water can be evaluated by taking into account the average per-capita protein intake. The IPCC default values are used in each case for the nitrous oxide emission factor per kg of nitrogen in wastewater and for the nitrogen fraction in protein. The number of in-habitants and the commuters are provided by the STATEC.<br>$N_2O$ emissions from industrial wastewater handling are issued from only one chemical plant that produces plastics and which releases N to aquatic environments. This industrial wastewater treatment plant (WWTP) is equipped with a biological treatment with denitrification. $N_2O$ emissions are based on the measured inflow data in the WWTP. The data available since the year 2002 are the flow as well as the mean annual nitrogen concentration in the WWTP. [NIR 2011] |
| **Netherlands** | NE | X | $N_2O$ emissions from the biological N-removal processes in urban WWTP as well as indirect $N_2O$ emission from effluents are calculated using the IPCC default emission factor of 0.01 tons $N_2O$-N per ton N removed or discharged. Since $N_2O$ emissions from wastewater handling was identified in previous NIRs as a key source, the present Tier 2 methodology complies with the IPCC Good Practice Guidance. Because of their insignificance compared to $N_2O$ from domestic wastewater treatment, no $N_2O$ emissions were estimated for industrial wastewater treatment and from septic tanks. [NIR 2011] |
| **Portugal** | X | X | Emissions of $N_2O$ from domestic wastewater were estimated following the proposal of IPCC 1996 Revised Guidelines. Activity data results of protein intake, according to FAO database, multiplied by total population. For industrial wastewater, the methodology proposed in the CORINAIR/EMEP Handbook, based on the knowledge of total production of wastewater, expressed in equivalent inhabitants, and the use of a simple and unspecific emission factor, was chosen. [NIR 2011] |
| **Spain** | NE | X | The methodology used to calculate nitrous oxide emissions from human sewage is proposed in the 2006 IPCC Guidelines. Protein intake was updated in previous edition for the 1990-2008 time series with the new information provided by the Directorate General of Industry and Food Markets, Ministry of Environment and Rural and Marine Affairs. The new information consists of human consumption of food protein, for a reference population study of the diet in Spain. On the basis of that information, total protein has been scaled by multiplying in each year the total consumption of protein diet study in Spain with the ratio between the Inventory reference population and reference population study of diet food in Spain. Used parameters were the fraction of nitrogen in the protein (0.16 kg N / kg protein) and the emission factor (0.01 kg $N_2O$-N/kg N in sanitation waters). For the population data from the National Statistics Institute, estimated at 1 January has been used. [NIR 2011] |
| **Sweden** | X | X | National activity data on nitrogen in discharged wastewater from municipal wastewater treatment plants and industries are used, in combination with a model estimating nitrogen in human sewage from people not connected to municipal wastewater treatment plants. [NIR 2011] |
| **United Kingdom** | IE | X | Nitrous oxide emissions from the treatment of human sewage are based on the IPCC default methodology. The most recent average protein consumption per person is based on the Expenditure and Food Survey (Defra, 2009). For the purposes of the 2009 estimates within the inventory, the Expenditure and Food Survey 2009 was not available in time, and therefore the data for 2008 has been used as a best estimate. [NIR 2011] |

*Source: NIR 2011, CRF 2011 Tables 6, 6.Bs1 and 6.Bs2*
*According to table 6.Bs1in CRF 2011; X= emissions are reported; NA=not applicable; NE= not estimated; IE= included elsewhere; NO=not occuring*

One important parameter for the determination of $N_2O$ emissions from wastewater handling, the daily per capita protein consumption is country-specific and applied by almost all Member States; an overview of the values is given in Figure 8.9. The Netherlands, however, does not determine $N_2O$ emissions from wastewater handling via the average per-capita protein intake – as many countries do – but on basis of data on the total Nitrogen loads removed in Urban Waste Water treatment plants. Similarly, Denmark reports the indirect emissions from wastewater effluents under human sewage. The effluent considers discharged sewage nitrogen load consisting of contributions from municipal wastewater treatment plants, the separate industry, effluent from mariculture and fish farming, rainwater conditioned effluents and scattered houses not connected to the sewerage system.

**Figure 8.9 6B Waste Water Handling: Protein consumption**




*Source: CRF 2011, Table 6 B; NIR 2011*
*CS= Country-specific value; FAO = FAO data basis*
*CS ES: Publication "Nutrition in Spain" by the Ministry of Agriculture, Food and Fisheries" (MAPA); CS FI: Tike, 2010; CS PT: National Statistical Office (INE); CS SE: National value: The Swedish yearbook of agricultural statistics 2007; CS GB: DEFRA, 2009: The Expenditure and Food Survey.*

### 8.3.4 Waste Incineration (CRF Source Category 6C) (EU-15)

Emissions from waste incineration are reported by nine Member States in 2009 (Austria, Belgium, France, Greece, Sweden, United Kingdom, Italy, Spain and Portugal). 15 % of EU-15 $CO_2$ emissions are calculated using higher tier methods. In

Table 8.27 an overview of category descriptions and methodological issues is provided.

**Table 8.27 6C Waste Incineration: Emissions reported and methodological issues**

| Member State | Emissions reported in CRF | Type of waste incinerated and methods applied |
|---|---|---|
| **Austria** | X | In this category, emissions from incineration of waste oil are included as well as emissions from municipal waste incineration without energy recovery. In Austria waste oil is incinerated in especially designed so called “USK-facilities”. The emissions of waste oil combustion for energy recovery (e.g. in cement industry) are reported under fuel combustion. In general, municipal, industrial and hazardous waste are combusted for energy recovery in district heating plants or in industrial sites and therefore the emissions are reported under fuel combustion. There is only one waste incineration plant without energy recovery which has been operated until 1991 with a capacity of 22 000 tons of municipal waste per year. This plant has been rebuilt as a district heating plant starting operation in 1996. Therefore the emissions since the re-opening of this plant are reported under fuel combustion from 1996 onwards. CORINAIR methodology is applied: the quantity of waste is multiplied by an emission factor for $CO_2$, $CH_4$ and $N_2O$. National emission factors for $CH_4$ are derived from residual fuel oil VOC emission factors (BMWA-EB 1990, BMWA-EB 1996, UMWELTBUNDESAMT 2001a). $N_2O$ emission factors are taken from a national study (ORTHOFER et al. 1995). For waste oil, the same $CO_2$ emission factor as for 1 A 1 a heavy oil ($CO_2$: 80 [t/TJ]) is used and a heating value of 40.3 GJ/Mg waste oil (source: Energy balance-residual fuel oil) is used to convert the emission factors from [kg/TJ] to [kg/Mg]. For municipal solid waste and clinical waste the $CO_2$ emission factor is calculated by means of default assumptions from (IPCC-GPG 2000). [NIR 2011] |
| **Belgium** | X | $N_2O$ emissions from domestic waste incineration are calculated using activity data known from the individual companies involved combined with the emission factor of CITEPA [2], which is 60 g $N_2O$/ton waste. Since 2008, one of the plants in Wallonia provided plant specific data, consequently the average EF slightly decreased.<br>In Flanders, only the fraction of organic-synthetic waste is taken into consideration (assuming that organic waste does not give any net $CO_2$ emissions). For the municipal waste, the institute responsible for waste management in Flanders (OVAM) is given the analysis of the different fractions in the waste. Based on this information, the amount of non-biogenic waste (excluding the inert fraction) is determined. The carbon emission factor is based on data from literature for the different fractions involved. For industrial waste, the amount of biogenic waste is considered to be the same as in municipal waste. The remaining amount is considered to be the non-biogenic part in which no inert fraction is present. For industrial waste, it is more difficult to determine the content of C and therefore the results of a study carried out by the VITO ‘Debruyn en Van Rensbergen ‘Greenhouse gas emissions from municipal and industrial wastes of October 1994’ are used. This study gives a content of C of the industrial waste of 65,5 %.<br>In Wallonia, following a legal decree in 2000, the air emissions from municipal waste incineration are measured by ISSEP and the results are validated by a Steering Committee. These results allow a crosscheck with the results of measurements directly transmitted by the incinerators to the environmental administration. From 1990 to 2000 $CO_2$ emissions of municipal waste incineration are reported assuming that 68 % of the waste is composed of organic material. This is based on the average garbage composition in Wallonia and the use of IPCC equation on organic content of the various materials. Since 2000, more precise data are reported by the waste incineration plants in the context of their environmental reporting. In 2005, the average organic content is 31 %. These emissions are now reported in the energy sector under 1A1a (biomass and other fuels, for the two respective fractions), according to IPCC guidelines.<br>The emission factors for the incineration of hospital and municipal waste and corpses are estimated by measurements in situ in connection with EPA and EMEP/CORINAIR emission factors. [NIR 2011] |
| **Denmark** | IE | Incineration of municipal, industrial, clinical and hazardous waste takes place with energy recovery, therefore the emissions are included in the relevant subsectors under CRF sector 1A. [NIR 2011] |
| **Finland** | IE | Emissions of greenhouse gases $CO_2$, $N_2O$ and $CH_4$ from Waste Incineration (CRF 6C) are reported in the energy sector (CRF 1A) in the Finnish inventory. There is no waste incineration on landfills in Finland and waste incineration for energy production is included in the energy sector. Waste incineration without energy recovery is nearly zero in combustion plants and it is also included in the energy sector. Waste incineration in households is quite small. In annual reporting of the recycling of wastepaper, the incineration of wastepaper is estimated to be only 23,000 tons. The incineration of paper and paperboard in households is estimated to be 31,000 tons together. [NIR 2011] |
| **France** | X | Emissions from waste incineration are reported for four categories: dangerous industrial waste incineration, municipal waste incineration without energy recovery, incineration of residues from agricultural production (cereals, oilseeds, pulses, leguminous vegetables and pulses), agricultural plastic film burning, incineration of sludge and other non-specified wastes. Furthermore, non-$CO_2$ emissions of incineration of biogenic waste are reported. [NIR 2011] |
| **Germany** | NO | Reported in the energy sector (CRF 1). [NIR 2011] |
| **Greece** | X | Carbon dioxide, Methane and Nitrous oxide emissions from the incineration of clinical waste produced in the Attica region have been estimated. Incineration of clinical waste in a central plant is still limited, despite the fact that the facilities existed are planned to cover the total daily needs of hospitals in Athens. For the estimation of $CO_2$ emissions, the default method suggested by the IPCC Good Practice Guidance was used. $CH_4$ and $N_2O$ emissions were estimated using default methodology and country specific emission factors. Data related to the amount of clinical waste incinerated derive from the ACMAR, which is operating the incinerator. The relevant parameters and emission factor used are the ones suggested in the IPCC Good Practice Guidance. [NIR 2011] |
| **Ireland** | NO | Incineration of clinical waste is no longer carried out in Ireland. Recently, health care waste and other non-renewable wastes were used in co-firing of cement kilns in 2009. Detailed information on the biomass and non-biomass fractions of all wastes co-fired in cement kilns is known, and this is taken into account under 1.A.2.f [NIR 2011] |
| **Italy** | X | Existing incinerators in Italy are used for the disposal of municipal waste, together with some industrial waste, sanitary waste and sewage sludge for which the incineration plant has been authorized from the com- |

| Member State | Emissions reported in CRF | Type of waste incinerated and methods applied |
|---|---|---|
| | | petent authority. Other incineration plants are used exclusively for industrial and sanitary waste, both hazardous and not, and for the combustion waste oils, whereas there are few plants that treat residual waste from waste treatments, as well as sewage sludge.<br><br>Emissions from waste incineration facilities with energy recovery are reported under category 1A4a, whereas emissions from other types of waste incineration facilities are reported under category 6C. For 2009, nearly 95% of the total amount of waste incinerated is treated in plants with energy recovery system. $CH_4$ emissions from biogenic, plastic and other non-biogenic wastes have been calculated. Regarding GHG emissions from incinerators, the methodology reported in the IPCC Good Practice Guidance has been applied, combined with that reported in the CORINAIR Guidebook. A single emission factor for each pollutant has been used combined with plant-specific waste activity data. Emissions have been calculated for each type of waste: municipal, industrial, hospital, sewage sludge and waste oils.<br><br>A complete data base of these plants has been built, on the basis of various sources available for the period of the entire time series, extrapolating data for the years for which there was no information. For each plant a lot of information is reported, among which the year of the construction and possible upgrade, the typology of combustion chamber and gas treatment section, if it is provided of energy recovery (thermal or electric), and the type and amount of waste incinerated (municipal, industrial, etc.).<br><br>Different procedures were used to estimate emission factors, according to the data available for each type of waste. As regards municipal waste, a distinction was made between $CO_2$ from fossil fuels (generally plastics) and $CO_2$ from renewable organic sources (paper, wood, other organic materials). Only emissions from fossil fuels, which are equivalent to 35% of the total, were included in the inventory. On the other hand, $CO_2$ emissions from the incineration of sewage sludge were not included at all, while all emissions relating to the incineration of hospital and industrial waste were considered.<br>$CH_4$ and $N_2O$ emissions from agriculture residues removed, collected and burnt 'off-site', are reported in the waste incineration sub-sector. Removable residues from agriculture production are estimated for each crop type taking into account the amount of crop produced, the ratio of removable residue in the crop, the dry matter content of removable residue, the ratio of removable residue burned, the fraction of residues oxidised in burning, the carbon and nitrogen content of the residues. $CO_2$ emissions have been calculated but not included in the inventory as biomass. All these parameters refer both to the IPCC Guidelines and country-specific values. [NIR 2011] |
| **Luxembourg** | IE | This category is presented under IPCC Sub-category 1A1a – Fuel Combustion Activities – Energy Industries – Public Electricity and Heat Production (see Section 3.2.6 in Chapter 3) because in the sole incinerator of the country (SIDOR site), energy from waste burning is recovered and injected in the electric public network. [NIR 2011] |
| **Netherlands** | IE | The source category Waste incineration is included in source category 1A1 Energy industries since all waste incineration facilities also produce electricity or heat used for energetic purposes.<br>Total $CO_2$ emissions – i.e. the sum of organic and fossil carbon – from waste incineration are reported per facility in the annual environmental reports. The fossil-based and organic $CO_2$ emissions from waste incineration (e.g. plastics) are calculated from the total amount of waste incinerated. Per waste stream (residential and several others) the composition of the waste is determined. For each of these types a specific carbon content and fossil carbon fractions are assumed, which will yield the $CO_2$ emissions. The method is described in detail in a national study and in a monitoring protocol. [NIR 2011] |
| **Portugal** | X | $CO_2$ emissions from incineration are calculated according to IPCC Guidelines, for each waste type (e.g. municipal solid waste (MSW), hazardous waste, clinical waste, and sewage sludge). Until 1999, incineration of solid wastes refers exclusively to incineration of hospital hazardous wastes. The figure for 1995 was used as an estimated for the former years. In 1999, two new incineration units started to operate in an experimental regime. Their industrial exploration started at the end of the same year or early January 2000. More recently another unit started operating. These units are dedicated to the combustion of MSW which is composed of domestic/commercial waste.<br>Emissions associated with the components of fossil origin – plastics, synthetic fibres, and synthetic rubber – are accounted for in the net emissions, which include also the non-$CO_2$ emissions from the combustion of organic materials (e.g. food waste, paper). $CO_2$ emissions from the biogenic component are only reported as a memo item.<br>Data on clinical waste incinerated refers only to Mainland Portugal and corresponds to data declared in registry maps of public hospital units (there is no incineration in private units). The quantities of clinical waste incinerated decreased strongly in recent years. 25 incinerators were closed in recent years in Mainland Portugal, only remaining at present one hospital incinerator. Other clinical wastes receive alternative treatment or are treated abroad. The non-biogenic components fractions are considered to be different for MSW, and clinical waste.<br>Data refer to combustion of industrial solid waste in industrial units which were collected from INR. Data for the years 2000, 2002 and 2003 refer to industrial units declarations. The figure for 2001 is interpolated, and 2004-07 refer to latest available data (2003). Data for the period 1990-98 are based on the same assumptions used for Industrial Solid Waste Disposed on Land: a per year growth rate of 2%.<br>$CH_4$, $N_2O$ and other emissions were estimated as the product of the mass of total waste combusted, and an emission factor for the pollutant emitted per unit mass of waste incinerated. Emission factors applied are either country-specific, being obtained from monitoring data in incineration units, or obtained from other references (US data, EMEP/CORINAIR). [NIR 2011] |
| **Spain** | X | Within this category, the emissions produced by the following activities have been estimated: incineration of corpses and clinical waste, municipal solid waste incineration without energy recovery, wastewater sludge incineration and industrial waste. For the incineration of human corpses in crematories, the combustion of a supporting fuel and some other material elements incinerated during the process also account for emissions. |

| Member State | Emissions reported in CRF | Type of waste incinerated and methods applied |
|---|---|---|
| | | Emission factors are derived from data of the crematories of the Municipality of Madrid. The clinical waste streams suitable for treatment by incineration are those with a low infection potential and those named "cytotoxic waste" which present a high infection potential. The estimation of the amount of this type of waste produced is calculated by considering the number of hospital beds and a waste production factor per bed and day. Activity data derive from the Statistical Yearbook of Spain published by INE and the Statistics Health Establishments Internship Institute. Since 2004, all municipal waste incinerators are equipped with energy recovery. Sludge incineration includes sludges from urban and industrial wastewater treatment. The main source of emission factors is the EMEP/CORINAIR Guidebook. [NIR 2011] |
| **Sweden** | X | Emissions from incineration of hazardous waste, and in later years also MSW and industrial waste, from one large plant are reported in CRF 6C. Reported emissions are for the whole time series obtained from the facility's Environmental report or directly from the facility on request. $CO_2$, SO2 and NOx are measured continuously in the fumes at the plant. In 2003 capacity was increased substantially at the plant by taking one new incinerator into operation. The new incinerator incinerates a mixture of MSW, industrial waste and hazardous waste. Only a minor part (less than 0.5%) of the total amount of MSW incinerated for energy purposes in Sweden are incinerated in the facility included in 6C. All other emissions from incineration of MSW are reported in CRF 1.Emissions reported are $CO_2$, NOx, SO2 and NMVOC. The $CO_2$ emission of biogenic origin of the MSW fraction of the waste, has since 2003 (when the incineration capacity increased dramatically, in order to treat MSW) been estimated using published information. According to information from the facility, occasional measurements concerning $CH_4$ and $N_2O$ have been performed. The $CH_4$ measurement showed very low or non-detectable amounts. $CH_4$ is therefore reported as NE in the CRF tables. In submission 2010 also $N_2O$ from waste incineration is reported for the whole time series 1990 – 2008. The estimates are based on occasional measurements of the $N_2O$ concentrations in the flue gas made by the company together with information on yearly flue gas volumes 2003 - 2009. [NIR 2011] |
| **United Kingdom** | X | Incineration of chemical wastes, clinical wastes, sewage sludge and animal carcasses is included here. There are approximately 70 plants incinerating chemical or clinical waste or sewage sludge and approximately 2600 animal carcass incinerators. Animal carcass incinerators are, typically, much smaller than the incinerators used to burn other forms of waste. This source category also includes emissions from crematoria. Emissions are taken from research studies or are estimated on literature-based emission factors, IPCC default values, or data reported by the Environment Agency's Pollution Inventory. [NIR 2011] |

*X = Emissions are reported in source category 6C, IE = included elsewhere, NE=not estimated, NO=not occurring*
*Source: NIR 2011, CRF 2011.*

### 8.3.5 Waste – Other (CRF Source Category 6D) (EU-15)

Under CRF source category 6D ten Member States report emissions for 2009. Emissions from composting have been reported by ten Member States (Austria, Belgium, Denmark, Finland, France, Germany, Italy, Luxembourg, the Netherlands and Spain). Denmark (until 2005) and France determine emissions from biogas production, Spain and Italy indicate emissions from sludge spreading, Germany from mechanical-biological waste treatment plants. In addition Denmark reports emissions of $CO_2$, $CH_4$ and NOx from accidental building and vehicle fires; compare Table 8.28.

**Table 8.28 6D Other: Reported emissions**

| Member State | Specification of "other waste" | 6 D $CO_2$ | 6 D $CH_4$ | 6 D $N_2O$ | 6 D NOx |
|---|---|---|---|---|---|
| Austria | Compost production | NA | 2.61 | 0.36 | NA |
| Belgium | Compost production | NA | 2.91 | NA | 0.12 |
| Denmark | Gasification of biogas | NO | NO | NO | NO |
| Denmark | Accidental fires | 27.67 | 0.16 | NE | 0.07 |
| Denmark | Compost production | NA | 3.70 | 0.13 | NA |
| Finland | Compost production | NO | 3.00 | 0.20 | NO |
| France | Compost production | NA | 5.55 | 1.10 | NA |
| France | Biogas production | NA | 0.65 | NA | NA |
| Germany | Compost production | NO | 26.13 | 0.66 | NO |
| Germany | Mechanical-biological waste treatment | NO | 0.27 | 0.49 | NO |
| Italy | Compost production | NA | 0.21 | NA | NA |
| Italy | Sludge spreading | NA | NA | NA | 1.49 |
| Luxembourg | Compost production | NO | 0.35 | 0.03 | NE |
| Netherlands | Compost production | NA | 0.97 | 0.12 | 0.01 |
| Spain | Sludge spreading | NE | 34.95 | NE | NE |

*Source: CRF 2011 Table 6*

In Table 8.29 the source category is described further in detail.

**Table 8.29 6D Other: Description and methodological issues**

| Member State | Waste – Other |
|---|---|
| **Austria** | Emissions were estimated using a country-specific methodology. To estimate the amount of composted waste it was split up into two fractions of "other waste": 1) residual waste treated in mechanical-biological treatment plants, 2) composted waste: bio waste collected separately, loppings, home composting. Emissions were calculated by multiplying the quantity of waste with the corresponding emission factor ($CH_4$ and $N_2O$) based on national references. [NIR 2011] |
| **Belgium** | $CH_4$ emissions from compost production are estimated using regional activity data combined with a default emission factor of 2.4 kg $CH_4$/ton waste entering in the compost centres. The emission factor of 2,4 kg $CH_4$/ton waste composted is used after consultation with colleagues in the Netherlands who use this factor as a result of measurements carried out. In Wallonia, new figures are available for the activity data of the years 2006 to 2009. The activity data figures are based on the quantities of waste coming out of the compost centers. According to expert judgement, the rate between the output of the compost centers (i.e. the amount of compost production) and the input (i.e. the amount of fresh organic waste that are composted) is around 35 %. Then, by dividing the output by 0.35, we obtain the amount of waste that will be composted. This methodology is deemed more adequate and more reliable for the calculation of the $CH_4$ emissions coming from composting. [NIR 2011] |
| **Denmark** | Emissions in this category could stem from accidental fires, sludge spreading, compost production, biogas production and other combustion. Other combustion sources include open burning of yard waste and wild fires. $CO_2$ emissions from compost production are considered to be biogenic. Buildings have a high content of wood both in the structure and in the interior; this leads to 83 % of the $CO_2$ emission from accidental building fires to be biogenic. Emissions from accidental fires have been slowly increasing from both building and vehicle fires. [NIR 2011] |
| **Finland** | Emissions from composting have been calculated using the methods given in the 2006 IPPC Guidelines for Greenhouse Gas Inventories. Activity data are based on VAHTI database and the Water and Sewage Works Register. The activity data for composted municipal biowaste for the year 1990 are based on the estimates of the Advisory Board for Waste Management for municipal solid waste generation and treatment in Finland in 1989. Data on 1997, 2004 and 2005 are from the VAHTI database and the intermediate years have been interpolated. In addition, composted solid biowaste in the years 1991-1996 has been interpolated using auxiliary information from the National Waste Plan until 2005. The new composting treatment code and composting plant code in Vahti registry have been used in the calculation of the years 2006-2009. [NIR 2011] |
| **France** | $CH_4$ and $N_2O$ emissions from composting as well as $CH_4$ emissions from biogas production are considered. Emissions are estimated by multiplying emission factors with the amount of waste composted and the amount of waste used for the production of biogas, respectively. Activity data for composting is derived from periodic surveys ITOMA performed by ADEME. For $CH_4$ emission a single emission factor of 952 g/t compost is used for all categories of waste. For $N_2O$ emissions a single emission factor per waste type (green waste, mixed organic household waste, sludge and other) is applied. Activity data for the estimation of $CH_4$ emissions from biogas production is also derived from periodic surveys ITOMA from ADAME; an emission factor of 2678 g/t waste is used. [NIR 2011] |
| **Germany** | In Germany, yearly increasing amounts of organic waste are composted. For this purpose, $CH_4$ and $N_2O$ emissions from composting of municipal solid waste are estimated using a national method. Acitivity data is provided by the National Statistical Agency. Emission factors stem from a national study. Composting of garden and organic waste in individual households is not considered in this category.<br>Since 1 June 2005, landfilling of biologically degradable waste is not permitted in Germany anymore. MSW has to be treated, therefore, prior to landfilling. Mechanical-biological treatment of waste is one of the options. A national method has been developed for the calculation of $CH_4$ and $N_2O$ emissions in which the amount of waste treated in mechanical-biological treatment plants is multiplied with emission factors from a national study. Acitivity data is provided by the National Statistical Agency. [NIR 2011] |
| **Italy** | Under this source category $CH_4$ emissions from compost production have been reported. The composting plants are classified in plants that treat selected waste (food, market, garden waste, sewage sludge and other organic waste, mainly from the agro-food industry) and the mechanical-biological treatment plants, that treat the unselected waste to produce compost, refuse derived fuel (RDF), and a waste with selected characteristics for landfilling or incinerating system. It is assumed that 100% of the input waste to the composting plants from selected waste is treated as compost, while in mechanical-biological treatment plants 30% of the input waste is treated as compost on the basis of national studies and references. Information on input waste to composting plants are published yearly by ISPRA since 1996, including data for 1993 and 1994, while for 1987 and 1995 only data on compost production are available; on the basis of this information the whole time series has been reconstructed. Since no methodology is provided by the IPCC for these emissions, literature data have been used for the emission factor, 0.029 g $CH_4$ $kg^{-1}$ treated waste, equivalent to compost production. [NIR 2011] |
| **Luxembourg** | Compost production sites generate $CO_2$ and $CH_4$ emissions. The IPCC Tier 1 method has been applied to estimate both methane and nitrous oxide emissions from compost production. Default EFs have been used. The mass of dry compost is 33.3% of the mass of humid sludge. $CO_2$ emissions are accounted for, but composting is biological decomposition of organic material, so it's biogenic. $CH_4$ emissions for composting are missing. Activity data is taken from STATEC Statistical Yearbook, Table A.3312 (these data are actually prepared by the Waste Division of the Environment Agency); and from Soil-Concept annual reports transmitted to the Waste Division of the Environment Agency. [NIR 2011] |
| **Netherlands** | This source category consists of the $CH_4$ and $N_2O$ emissions from composting separately collected organic waste from households. A country-specific methodology for this source category is used with activity data based on the annual survey performed by the Working Group on Waste Registration at all the industrial composting sites in the Netherlands and emission factors based on the average emissions (per ton of composted organic waste) of some facilities in the late 1990s (measured during a large-scale monitoring programme in the Netherlands). Emissions from small-scale composting of garden waste and food waste by households are not estimated as these are assumed to be negligible. Since this source is not considered as a key source, the present methodology level complies with the IPCC Good Practice Guidance. [NIR 2011] |

| Member State | Waste – Other |
|---|---|
| Spain | This category includes emissions from the spreading of sludge from waste water treatment plants. It was assumed that all sludge from wastewater treatments plants are dried by sludge spreading. $CH_4$ emissions are estimated by applying an emission factor of 29 kg per tonne of dried mud as derived from the "Report on Complementary Information in the Frame of the Assistance provided for CORINAIR 90 Inventory, CITEPA". [NIR 2011] |

*Source: NIR 2011*

## 8.4 EU-15 uncertainty estimates (EU-15)

Table 8.30 shows the total EU-15 uncertainty estimates for the sector Waste and the uncertainty estimates for the relevant gases of each source category. The highest level uncertainty was estimated for $N_2O$ from 6B3 and the lowest for $CO_2$ from 6C. With regard to trend $CH_4$ from 6D shows the highest uncertainty estimates, $CO_2$ from 6C the lowest. For a description of the Tier 1 uncertainty analysis carried out for the EU-15 see Chapter 1.7.

**Table 8.30 Sector 6 -Waste: EU-15 uncertainty estimates**

| Source category | Gas | Emissions 1990 | Emissions 2008 | Emission trends 1990-2008 | Level uncertainty estimates based on MS uncertainty estimates | Trend uncertainty estimates based on MS uncertainty estimates |
|---|---|---|---|---|---|---|
| 6.A.1 Managed Waste Disposal on Land | $CO_2$ | 0 | 0 | - | - | - |
| 6.A.2 Unmanaged Waste Disposal Sites | $CO_2$ | 0 | 0 | - | - | - |
| 6.A.3 Other | $CO_2$ | 218 | 12 | -94% | - | - |
| 6.C Waste Incineration | $CO_2$ | 4,140 | 2,495 | -40% | 21.3% | 5 |
| 6.D Other | $CO_2$ | 0 | 0 | - | - | - |
| 6.A.1 Managed Waste Disposal on Land | $CH_4$ | 127,492 | 66,749 | -48% | 24.3% | 13 |
| 6.A.2 Unmanaged Waste Disposal Sites | $CH_4$ | 12,819 | 6,019 | -53% | 54.4% | 19 |
| 6.A.3 Other | $CH_4$ | 3,162 | 2,559 | -19% | 43.0% | 22 |
| 6.B.1 Industrial Waste Water | $CH_4$ | 3,328 | 3,645 | 10% | 116.8% | 15 |
| 6.B.2 Domestic and Commercial Waste Water | $CH_4$ | 9,145 | 6,958 | -24% | 89.1% | 38 |
| 6.B.3 Other | $CH_4$ | 99 | 26 | -74% | 80.2% | 25 |
| 6.C Waste Incineration | $CH_4$ | 480 | 468 | -2% | 27.2% | 23 |
| 6.D Other | $CH_4$ | 378 | 1,606 | 325% | 34.9% | 293 |
| 6.B.1 Industrial Waste Water | $N_2O$ | 352 | 433 | 23% | 57.1% | 27 |
| 6.B.2 Domestic and Commercial Waste Water | $N_2O$ | 9,193 | 9,783 | 6% | 96.5% | 12 |
| 6.B.3 Other | $N_2O$ | 38 | 23 | -41% | 379.8% | 110 |
| 6.C Waste Incineration | $N_2O$ | 266 | 263 | -1% | 57.1% | 27 |
| 6.D Other | $N_2O$ | 133 | 915 | 590% | 96.5% | 12 |
| Total Waste | all | 171,257 | 103,923 | -39% | 20.7% | 11 |

***Note:*** *Emissions are in Gg $CO_2$ equivalents; trend uncertainty is presented as percentage points; the sum of the source category emissions may not be the total sector emissions because uncertainty estimates are not available for all source categories; uncertainty estimates for Portugal are not included.*

## 8.5 Sector-specific quality assurance and quality control (EU-15)

Under the Climate Change Committee a workshop was conducted in Spring 2005 on inventories and projections of greenhouse gas emissions from waste. The main objectives of the workshop were: (1) to provide an opportunity to learn about the methods used for inventories and projections in the different Member States, to share information, experience and best practice; (2) to compare the parameters chosen in the estimation methodologies across EU-15 Member States; (3) to compare emissions and methods used for GHG inventories with data and methods for EPER; and (4) to strengthen links between assessment of air pollution under the IPPC and emissions under the UNFCCC. In addition, the workshop provided an opportunity to discuss potential methodological changes or improvements of the draft 2006 IPCC inventory guidelines. The recommendations and presentations of this workshop can be downloaded from the Internet under the following link: **http://air-climate.eionet.eu.int/docs/meetings/050502_GHGEm_Waste_WS/meeting050502.html**. Clarifications from discussions of individual parameters used in the estimation of emissions from waste were incorporated in this report.

A second expert meeting under the Climate Change Committee on the estimation of $CH_4$ emissions from solid waste disposed to landfills was conducted in March 2006. This meeting was targeting in particular those EU Member States that do not yet use the IPCC FOD methods for their inventories (mostly new EU Member States). The objective of the expert meeting was to use the new default model provided by draft 2006 IPCC Guidelines for national GHG inventories in order to calculate $CH_4$ emissions for the participants' countries. 11 Member States, 2 EEA Member countries, and one accession country participated. 9 of the 14 countries had previously not estimated $CH_4$ emissions with a FOD method. The meeting enabled those Member States that still used Tier 1 method to use the FOD model with national/default data as available. Other Member States used the IPCC FOD model as quality check and for comparison with the results of the country-specific model with usually minor differences compared to the national model. The meeting also contributed to the exchange of experiences of specific circumstances regarding waste generation, composition and solid waste disposal in new Member States and on the estimation of $CH_4$ recovery in the absence of monitored data. In addition, the meeting provided recommendations to IPCC for further improvement and corrections of the draft default model.

## 8.6 Sector-specific recalculations (EU-15)

Table 8.31 shows that in the waste sector the largest recalculations in 1990 and 2008 were made for $CH_4$.

**Table 8.31 Sector 6 Waste: Recalculations of total GHG and recalculations of GHG emissions for 1990 and 2008 by gas (Gg $CO_2$ equivalents and percentage)**

| 1990 | $CO_2$ | | $CH_4$ | | $N_2O$ | | HFCs | | PFCs | | $SF_6$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Gg | percent | Gg | percent | Gg | percent | Gg | percent | Gg | percent | Gg | percent |
| Total emissions and removals | -17,295 | -0.6% | 13,980 | 3.2% | 8,543 | 2.2% | 47 | 0.2% | 6 | 0.0% | 11 | 0.1% |
| Waste | -219 | -5.0% | 12,198 | 7.8% | 435 | 4.4% | NO | NO | NO | NO | NO | NO |
| **2008** | | | | | | | | | | | | |
| Total emissions and removals | -21,852 | -0.7% | 14,673 | 4.9% | 9,128 | 3.2% | 660 | 1.1% | 77 | 2.7% | -2,603 | -29.0% |
| Waste | -240 | -9.6% | 12,761 | 14.5% | 301 | 2.6% | NO | NO | NO | NO | NO | NO |

*NO: not occurring*

Table 8.32 provides an overview of Member States' contributions to EU-15 recalculations.

**Table 8.32 Sector 6 Waste: Contribution of Member States to EU-15 recalculations for 1990 and 2008 by gas (difference between latest submission and previous submission Gg of $CO_2$ equivalents)**

| | 1990 | | | | | | 2008 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $CO_2$ | $CH_4$ | $N_2O$ | HFCs | PFCs | $SF_6$ | $CO_2$ | $CH_4$ | $N_2O$ | HFCs | PFCs | $SF_6$ |
| Austria | 0 | 0 | 1 | NO | NO | NO | 0 | 14 | 0 | NO | NO | NO |
| Belgium | 0 | 0 | 1 | NO | NO | NO | 0 | 15 | 19 | NO | NO | NO |
| Denmark | 1 | 63 | 14 | NO | NO | NO | 0 | 97 | 43 | NO | NO | NO |
| Finland | IE,NO | 0 | 0 | NO | NO | NO | IE,NO | 71 | 3 | NO | NO | NO |
| France | -226 | 626 | 203 | NO | NO | NO | -119 | 11,131 | 180 | NO | NO | NO |
| Germany | NO | 2,688 | 0 | NO | NO | NO | NO | 2,329 | -6 | NO | NO | NO |
| Greece | 0 | 576 | 3 | NO | NO | NO | 0 | 745 | 4 | NO | NO | NO |
| Ireland | NA,NE,NO | 0 | 0 | NO | NO | NO | NA,NO | 191 | 0 | NO | NO | NO |
| Italy | 0 | 1,960 | -32 | NO | NO | NO | 0 | 2,168 | -69 | NO | NO | NO |
| Luxembourg | IE,NA,NO | 0 | 0 | NO | NO | NO | IE,NA,NO | 1 | 0 | NO | NO | NO |
| Netherlands | IE,NA,NO | 0 | 0 | NO | NO | NO | IE,NA,NO | 19 | 1 | NO | NO | NO |
| Portugal | 0 | 39 | 19 | NO | NO | NO | 0 | -196 | -14 | NO | NO | NO |
| Spain | 0 | 0 | 0 | NO | NO | NO | 0 | 112 | 6 | NO | NO | NO |
| Sweden | 0 | 292 | 7 | NO | NO | NO | 0 | 305 | 13 | NO | NO | NO |
| UK | 6 | 5,954 | 218 | NO | NO | NO | -121 | -4,241 | 121 | NO | NO | NO |
| **EU-15** | **-219** | **12,198** | **435** | **NO** | **NO** | **NO** | **-240** | **12,761** | **301** | **NO** | **NO** | **NO** |

*NO: not occurring; NE: not estimated; NA: not applicable; IE: included elsewhere*

# 9 OTHER (CRF SECTOR 7)

This sector does not include any emissions.

# 10 RECALCULATIONS AND IMPROVEMENTS

## 10.1 Explanations and justifications for recalculations

Table 10.1 to Table 10.2 provide an overview of the main reasons for recalculating emissions in the year 1990 and 2008 for each EU-15 Member State, which provided the relevant information, and by source categories, for the largest recalculations (>+/- 500 Gg $CO_2$ equiv.). For more details see the information provided by the Member States' submissions in Annex 1.12.

**Table 10.1 Main recalculations by source category for 1990 and Member States' explanations for recalculations given in the CRF or in the NIR**

| | | 1990 | | Main explanations |
|---|---|---|---|---|
| | | Gg $CO_2$ equiv. | Percent | |
| 1A2_Manufacturing Industries and Construction $CO_2$ | Germany | 21,152 | 13.7 | - Reallocation of $CO_2$ emissions from blast furnace gas combustion in sinter plants and rolling mills from source catagory 2C1 to source catagory 1A2a.<br>- new available data from national statistics |
| 1A1_Energy Industries $CO_2$ | Germany | 8,564 | 2.1 | - Reallocation of $CO_2$ emissions from blast furnace gas combustion in cokeries from source catagory 2C1 to source catagory 1A1<br>- new available data from national statistics |
| 4D_Agricultural soils $N_2O$ | Germany | 7,343 | 17.2 | - Estimation procedure has been corrected in accordance with IPCC (1996b) procedure. Correction of error in the estimation of TAN-immobilization in solid manure systems.<br>- Correction of emission factors (1996 GL instead of 2006 GL).<br>- Revision of method that considers N-losses due to emissions from N-species. |
| 6A_Solid waste disposal on land $CH_4$ | UK | 6,377 | 12.8 | - Major review and update to the model used to estimate emissions from landfilled waste.<br>- A new time series of waste sent to landfill and waste composition has been identified and is now used. |
| 2E_Production of halocarbons HFC | Germany | 4,329 | 100.0 | From the submission 2011 the so far confidential emissions of the production can be reported in 2E. But the producer requested to report the HFCs as unspecified mix. |
| 6A_Solid waste disposal on land $CH_4$ | Germany | 2,688 | 7.5 | Revision of methane recovery from landfills |
| 6A_Solid waste disposal on land $CH_4$ | Italy | 1,960 | 14.7 | - Industrial wastes disposed into MSW landfills have been added and revision of rapidly biodegradable fractions<br>- Revision of sludge time series and addition of industrial wastes. New waste composition from 2006 and revision of previous waste compositions |
| 4D_Agricultural soils $N_2O$ | UK | 1,685 | 5.5 | - Correction to method for nitrogen leaching and run-off to remove correction for N volatilisation<br>- New source - application of sewage sludge to agricultural land |
| 2B_Chemical industries $CO_2$ | Germany | 1,471 | 12.7 | - For the $CO_2$-Emissions from methanol production the default emission factor of the IPCC GL 2006 is used, because the old emissions could not be explained.<br>- Inclusion of $CO_2$ recovery from amonia production |
| 1A2_Manufacturing Industries and Construction $CO_2$ | Luxembourg | 1,115 | 21.6 | - An electicity producing plant (autoproducer) of the iron and steel industry allocated to 1A1a was reallocated to 1A2a, as recommended in ARR 2009 59. This plant used liquid, solid and gaseous fuels and operated from 1990-1997. From 1990-1995, there were no other plants producing electricity and using liquid fuels.<br>- Activity data was revised due to new energy statistics from National Statistics (STATEC), and due to the application of national densities and NCVs, which are now streamlined with STATEC. |
| 4A_Enteric fermentation $CH_4$ | France | 1,107 | 3.6 | Correction du FE $CH_4$ sur toute la série |
| 4A_Enteric fermentation $CH_4$ | Germany | 1,100 | 4.2 | - Change of methan conversion factor. |

| | | 1990 | | Main explanations |
|---|---|---|---|---|
| | | Gg $CO_2$ equiv. | Percent | |
| | | | | - Change in estimating eneryg intake. |
| 1A2_Manufacturing Industries and Construction $CO_2$ | UK | 1,050 | 1.1 | - Method of calculating activity data in lime production reviewed and improved. Also causes reallocation of petcoke and gas and coal and coke in other industry. Method improvement in cement industry affects activity data of lubricants<br>- National energy stats changes affected EFs for coal coke coke over gas and BF gas as based on reported emissions. EU ETS EFs now used from 2005 for Colliery methane and from 2008 for OPG and pet coke. Earlier years interpolated.<br>- Other industry timeseries affected by reallocation of burning oil and fuel oil and gas oil to the crown dependancies. Other activity data affected from 2005 onwards by changes to national energy statistics. |
| 1A4_Other sectors $CO_2$ | France | 882 | 0.9 | Data consumption has been reviwed and increased in 1A4 due to reallocation of auto-production from district heating plant and energy balance consideration. |
| 2C_Metal production $CO_2$ | France | 692 | 18.8 | Ajout de sites qui n'étaient pas encore pris en compte |
| 6A_Solid waste disposal on land $CH_4$ | France | 620 | 7.5 | Mise a jour taux de captage du biogaz suite à la revue CCNUCC |
| 6B_Waste water handling $CH_4$ | Greece | 516 | 22.3 | Updated data for the fractions of industrial degradable organic component removed as sludge |
| 1A3_Transport $N_2O$ | France | 501 | 100.4 | Révisions des équations COPERT |
| 1A3_Transport $CO_2$ | Germany | -695 | -0.4 | AD corrected within Energy Balance; EF corrected within TREMOD v5.11; for civil aviaition new specific EFs due change from tier 2 to tier3 |
| 4D_Agricultural soils $N_2O$ | Denmark | -757 | -9.1 | Change in the calculation of leaching and run-off |
| 1A2_Manufacturing Industries and Construction $CO_2$ | Belgium | -787 | -2.4 | new methodology used for the calculation of emissions of $CO_2$ in the iron and steel sector in the Flemish region. In the sector 1A2a emissions of cokesgrit are added for the complete timeseries and emissions of anthracite from 2005 on. |
| 1B2_Oil and natural gas $CH_4$ | France | -1,234 | -44.3 | Mise a jour de la méthodologie d'estimation des émissions par GDF |
| 1A1_Energy Industries $CO_2$ | Luxembourg | -1,266 | -97.4 | - An electicity producing plant (autoproducer) of the iron and steel industry allocated to 1A1a was reallocated to 1A2a, as recommended in ARR 2009 59. This plant used liquid, solid and gaseous fuels and operated from 1990-1997. From 1990-1995, there were no other plants producing electricity and using liquid fuels.<br>- Activity data was revised due to new energy statistics from National Statistics (STATEC), and due to the application of national densities and NCVs, which are now streamlined with STATEC. |
| 1A1_Energy Industries $CO_2$ | UK | -1,881 | -0.8 | - Emission factor revised for colliery methane (based on time series average for natural gas) and for OPG (based on EU ETS data and used across the time series).<br>- Power stations database reviewed to improve transparency and traceability of data. Updates made to oil use in coal fired and oil fired power stations. |
| 1A3_Transport $CO_2$ | Spain | -2,223 | -3.9 | New methodology following application of the national MECETA model for aviation. The revision has effect in the fuel consumption as well as in the emission factors. |

| | | 1990 | | Main explanations |
|---|---|---|---|---|
| | | Gg $CO_2$ equiv. | Percent | |
| 1A3_Transport $CO_2$ | UK | -2,639 | -2.3 | - Road transport - updated distribution of vkm data between road types and between buses and coaches. Update to vkm data for motorcycles.<br>- Revised activity data for freight railways from the ORR for all years. Revised data for passenger rail from 2005 onwards.<br>- Reallocation of flights between UK and OTs/CDs between domestic and international as appropriate. Reallocation of shipping emissions between international and domestic based on port movement data. Coal use in rail reported from 2005. |
| 1A2_Manufacturing Industries and Construction $CO_2$ | France | -3,083 | -3.6 | Data consumption for the auto-production in industry have been corrected since 1990 due to a revision of data by SOes (french energy statistics) has been made. |
| 2C_Metal production $CO_2$ | Germany | -25,614 | -51.5 | Recalculation of $CO_2$ emissions from blast furnace gas combustion in industrial power plants from source category 2C1 to 1A2f and 1A1 |

**Table 10.2 Main recalculations by source category for 2008 and Member States' explanations for recalculations given in the CRF or in the NIR**

| | | 2008 | | Main explanations |
|---|---|---|---|---|
| | | Gg $CO_2$ equiv. | Percent | |
| 1A2_Manufacturing Industries and Construction $CO_2$ | Germany | 23,011 | 24.3 | - Reallocation of $CO_2$ emissions from blast furnace gas combustion in sinter plants and rolling mills from source catagory 2C1 to source catagory 1A2a.<br>- new available data from national statistics |
| 6A_Solid waste disposal on land $CH_4$ | France | 11,230 | 193.5 | Mise a jour taux de captage du biogaz suite à la revue CCNUCC |
| 1A1_Energy Industries $CO_2$ | Germany | 10,296 | 2.9 | - Reallocation of $CO_2$ emissions from blast furnace gas combustion in cokeries from source catagory 2C1 to source catagory 1A1<br>- new available data from national statistics |
| 4D_Agricultural soils $N_2O$ | Germany | 6,663 | 17.2 | - Estimation procedure has been corrected in accordance with IPCC (1996b) procedure. Correction of error in the estimation of TAN-immobilization in solid manure systems.<br>- Correction of emission factors (1996 GL instead of 2006 GL).<br>- Revision of method that considers N-losses due to emissions from N-species. |
| 1A4_Other sectors $CO_2$ | Germany | 3,168 | 2.1 | New available data from national statistics. |
| 1A2_Manufacturing Industries and Construction $CO_2$ | UK | 2,818 | 3.7 | - Method of calculating activity data in lime production reviewed and improved. Also causes reallocation of petcoke and gas and coal and coke in other industry. Method improvement in cement industry affects activity data of lubricants<br>- National energy stats changes affected EFs for coal coke coke over gas and BF gas as based on reported emissions. EU ETS EFs now used from 2005 for Colliery methane and from 2008 for OPG and pet coke. Earlier years interpolated.<br>- Other industry timeseries affected by reallocation of burning oil and fuel oil and gas oil to the crown dependancies. Other activity data affected from 2005 onwards by changes to national energy statistics. |
| 6A_Solid waste disposal on land $CH_4$ | Germany | 2,352 | 31.3 | Revision of methane recovery from landfills |
| 6A_Solid waste disposal on land $CH_4$ | Italy | 2,288 | 20.7 | - Industrial wastes disposed into MSW landfills have been added and revision of rapidly biodegradable fractions<br>- Revision of sludge time series and addition of industrial wastes. New waste composition from 2006 and revision of previous waste compositions |
| 2B_Chemical industries $CO_2$ | Germany | 2,080 | 14.4 | - For the $CO_2$-Emissions from methanol production the default emission factor of the IPCC GL 2006 is used, because the old emissions could not be explained.<br>- Inclusion of $CO_2$ recovery from amonia production |
| 4D_Agricultural soils $N_2O$ | UK | 1,716 | 7.4 | - Correction to method for nitrogen leaching and run-off to remove correction for N volatilisation<br>- New source - application of sewage sludge to agricultural land |
| 1A4_Other sectors $CO_2$ | France | 1,523 | 1.5 | Data consumption has been reviwed and increased in 1A4 due to reallocation of auto-production from district heating plant and energy balance consideration. |
| 4A_Enteric fermentation $CH_4$ | Germany | 1,440 | 7.4 | - Change of methan conversion factor.<br>- Change in estimating eneryg intake. |

| | | 2008 | | Main explanations |
|---|---|---|---|---|
| | | Gg $CO_2$ equiv. | Percent | |
| 2B_Chemical industries $N_2O$ | Germany | 1,363 | 16.3 | Correction of emission factor |
| 4A_Enteric fermentation $CH_4$ | France | 1,280 | 4.5 | Correction du FE $CH_4$ sur toute la série |
| 1A3_Transport $N_2O$ | France | 1,104 | 159.0 | Révisions des équations COPERT |
| 1A2_Manufacturing Industries and Construction $CO_2$ | Belgium | 980 | 3.7 | new methodology used for the calculation of emissions of $CO_2$ in the iron and steel sector in the Flemish region. In the sector 1A2a emissions of cokesgrit are added for the complete timeseries and emissions of anthracite from 2005 on. |
| 2F_Consumption of halocarbons HFC | Spain | 825 | 14.8 | Revision of the activity data according to new information provided by one of the main fire extinction operating plants. Additionally, the activity data for other fire extinction operating plant has been revised after detecting an error in the estimates of the fluorinated gases consumed |
| 1A1_Energy Industries $CO_2$ | Belgium | 695 | 2.8 | New methodology applied for the calculation of emissions of $CO_2$ in cokesmanufacturing industry in the Flemish region. In the 2011 submission emissions are calculated based on the fuel consumption instead of on the C-balance in the 2010 submission. |
| 1A1_Energy Industries $CO_2$ | Portugal | 580 | 3.0 | - New fuel consumption data was made available from Autonomous Region.<br>- Further analysis into EU-ETS showed need for activity data corrections.<br>- Fuel consumption double counting was identified in sectors with emissions estimated with energy balance data. |
| 6B_Waste water handling $CH_4$ | Greece | 532 | 160.7 | Updated data for the fractions of industrial degradable organic component removed as sludge |
| 2C_Metal production $CO_2$ | Belgium | 510 | 34.0 | Process emissions in the iron and steel sector (2C1) are revised for the complete time series in the 2011 submission in the Flemish region. A.o. the emissions of $CO_2$ from the addition of lime are newly added. |
| 1A4_Other sectors $CO_2$ | Netherlands | -515 | -1.3 | reallocation from 1.A.4 to 1A2 for non-road |
| 1B2_Oil and natural gas $CH_4$ | France | -729 | -38.0 | Mise a jour de la méthodologie d'estimation des émissions par GDF |
| 1A1_Energy Industries $CO_2$ | Italy | -1,867 | -1.2 | steam coal and natural gas emission factor update |
| 4D_Agricultural soils $N_2O$ | Netherlands | -1,906 | -22.5 | New model for calculating Nitrogen flows in agriculture |
| 1A3_Transport $CO_2$ | Spain | -2,135 | -2.1 | New methodology following application of the national MECETA model for aviation. The revision has effect in the fuel consumption as well as in the emission factors. |
| 1A2_Manufacturing Industries and Construction $CO_2$ | France | -2,394 | -3.3 | Data consumption for the auto-production in industry have been corrected since 1990 due to a revision of data by SOes (french energy statistics) has been made. |
| 1A4_Other sectors $CO_2$ | UK | -2,699 | -2.6 | - New EF based on carbon content measurements for domestic pet coke. GCV revised for coal for 2006 onwards. Revision to national energy statistics for coke for 2007 onwards.<br>- Northern Ireland domestic peat use data for all years. Revised national energy stats 2005 onward. Updates to CDs caused reallocation of LPG fuel oil and gas oil for all years. New AD for domestic petcoke. Improvements to offroad model 2004 onwards.<br>- Addition of fishing vessels in 1A4c |
| 6A_Solid waste disposal on land $CH_4$ | UK | -3,784 | -18.8 | - Major review and update to the model used to estimate emissions from landfilled waste. |

| | | 2008 | | Main explanations |
|---|---|---|---|---|
| | | Gg $CO_2$ equiv. | Percent | |
| | | | | - A new time series of waste sent to landfill and waste composition has been identified and is now used. |
| 1A3_Transport $CO_2$ | UK | -4,167 | -3.3 | - Road transport - updated distribution of vkm data between road types and between buses and coaches. Update to vkm data for motorcycles.<br>- Revised activity data for freight railways from the ORR for all years. Revised data for passenger rail from 2005 on-wards.<br>- Reallocation of flights between UK and OTs/CDs between domestic and international as appropriate. Reallocation of shipping emissions between international and domestic based on port movement data. Coal use in rail reported from 2005. |
| 2C_Metal production $CO_2$ | Germany | -24,087 | -54.7 | Recalculation of $CO_2$ emissions from blast furnace gas combustion in industrial power plants from source category 2C1 to 1A2f and 1A1 |

## 10.2 Implications for emission levels

Table 10.3 provides the differences in total EU-15 GHG emissions between the latest submission and the previous submission in absolute and relative terms. The table shows that due to recalculations, total EU-15 1990 GHG emissions excluding LULUCF have increased in the latest submission compared to the previous submission by 20260 Gg (+0.5 %). EU-15 GHG emissions for 2008 increased by 27526 Gg (+0.7 %) due to recalculations.

**Table 10.3 Overview of recalculations of EU-15 total GHG emissions (difference between latest submission and previous submission in Gg $CO_2$ equivalents)**

| | 1990 | 1995 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Total $CO_2$ equivalent emissions including LULUCF (absolute) | 5,292 | 7,803 | 19,661 | 10,133 | 21,150 | 16,406 | 28,106 | 25,476 | -5,408 | -16,240 | 82 |
| Total $CO_2$ equivalent emissions including LULUCF (percent) | 0.1% | 0.2% | 0.5% | 0.3% | 0.5% | 0.4% | 0.7% | 0.7% | -0.1% | -0.4% | 0.0% |
| Total $CO_2$ equivalent emissions excluding LULUCF (absolute) | 20,260 | 18,755 | 25,289 | 26,251 | 30,959 | 26,864 | 34,234 | 32,863 | 28,872 | 33,535 | 27,526 |
| Total $CO_2$ equivalent emissions excluding LULUCF (percent) | 0.5% | 0.5% | 0.6% | 0.6% | 0.7% | 0.6% | 0.8% | 0.8% | 0.7% | 0.8% | 0.7% |

Table 10.4 provides an overview of recalculations for the EU-15 key categories for 1990 and 2008 (see Section 1.5 for information on identification of EU-15 key categories). The table shows that the largest recalculations in absolute terms were made in the key category $CO_2$ from 2C ‘Metal Production’ for both 1990 and 2008.

Table 10.5 and Table 10.6 give an overview of absolute and percentage changes of Member States’ emissions due to recalculations for 1990 and 2008. Large recalculations in absolute terms were made in Germany, France, the UK and Italy. Recalculations in relative terms of more than 2 % were made in France, Germany and Luxembourg.

**Table 10.4 Recalculations for the EU-15 key source categories 1990 and 2008 (difference between latest submission and previous submission in Gg of $CO_2$ equivalents and in percentage)**

| Greenhouse Gas Source Categories | Gas | Recalculations 1990 | | Recalculations 2008 | |
|---|---|---|---|---|---|
| | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) |
| 1A1 Energy Industries | $CO_2$ | 4574 | 0.4% | 9904 | 0.9% |
| 1A1 Energy Industries | $N_2O$ | -65 | -0.7% | -120 | -1.3% |
| 1A2 Manufacturing Industries | $CO_2$ | 19669 | 3.2% | 22862 | 4.5% |
| 1A3 Transport | $CO_2$ | -5489 | -0.8% | -6199 | -0.7% |
| 1A3 Transport | $CH_4$ | 427 | 10.2% | 100 | 8.3% |
| 1A3 Transport | $N_2O$ | 381 | 6.8% | 996 | 13.5% |
| 1A4 Other Sectors | $CO_2$ | 993 | 0.2% | 1660 | 0.3% |
| 1A4 Other Sectors | $CH_4$ | 78 | 0.7% | -44 | -0.6% |
| 1A5 Other | $CO_2$ | -11 | 0.0% | -340 | -4.9% |
| 1B1 Solid Fuels | $CH_4$ | -2 | 0.0% | -35 | -0.4% |
| 1B2 Oil and Natural Gas | $CH_4$ | -1209 | -3.9% | -589 | -2.6% |
| 2A Mineral Products | $CO_2$ | 759 | 0.7% | 127 | 0.1% |
| 2B Chemical Industry | $CO_2$ | 1764 | 6.1% | 2111 | 7.2% |
| 2B Chemical Industry | $N_2O$ | -18 | 0.0% | 1383 | 5.9% |
| 2C Metal Production | $CO_2$ | -24493 | -31.1% | -24051 | -33.2% |
| 2C Metal Production | PFC | 6 | 0.0% | 1 | 0.1% |
| 2C Metal Production | $SF_6$ | 0 | 0.0% | 0 | 0.0% |
| 2E Production of Halocarbons and SF6 | HFC | 4329 | 18.7% | 425 | 28.9% |
| 2F Consumption of Halocarbons and SF6 | HFC | 47 | 7.8% | 656 | 1.1% |
| 2E Production of Halocarbons and SF6 | PFC | 11 | 0.2% | -285 | -4.9% |
| 2F Consumption of Halocarbons and SF6 | $SF_6$ | 11 | 0.2% | -285 | -4.9% |
| 4A Enteric Fermentation | $CH_4$ | 2600 | 1.9% | 3081 | 2.5% |
| 4B Manure Management | $CH_4$ | 209 | 0.5% | 279 | 0.7% |
| 4B Manure Management | $N_2O$ | 299 | 1.2% | -46 | -0.2% |
| 4D Agricultural Soils | $N_2O$ | 7530 | 3.4% | 5768 | 3.0% |
| 6A Solid Waste Disposal on Land | $CH_4$ | 11705 | 8.2% | 12783 | 17.0% |
| 6B Waste-water Handling | $CH_4$ | 466 | 3.7% | -141 | -1.3% |
| 6B Waste incineration | $CO_2$ | -241 | -5.8% | -268 | -10.8% |

*Note: Many of these source categories are more aggregated than the EU-15 key source categories identified in Section 1.5.*

**Table 10.5 Contribution of Member States to EU-15 recalculations of total GHG emissions without LULUCF for 1990–2008 (difference between latest submission and previous submission Gg of $CO_2$ equivalents)**

| | 1990 | 1995 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Austria | 0 | -11 | 180 | -189 | -112 | -37 | 1 | -32 | 415 | 416 | 320 |
| Belgium | -50 | 508 | 772 | 494 | 808 | 504 | 1,426 | 1,265 | 1,508 | 2,699 | 1,902 |
| Denmark | -916 | -685 | -448 | -149 | -55 | -438 | -108 | -192 | -98 | 84 | -191 |
| Finland | 7 | 1 | 57 | 20 | 47 | 32 | 54 | 50 | 58 | 74 | 282 |
| France | -354 | 2,700 | 9,769 | 9,952 | 14,026 | 11,630 | 13,654 | 12,487 | 12,666 | 14,313 | 12,152 |
| Germany | 16,148 | 18,571 | 17,399 | 16,243 | 16,187 | 16,782 | 21,280 | 22,191 | 18,821 | 22,538 | 23,051 |
| Greece | 1,078 | 1,116 | 1,150 | 1,261 | 1,300 | 1,321 | 1,540 | 1,528 | 2,053 | 1,519 | 1,663 |
| Ireland | 9 | 12 | 108 | 100 | 131 | 330 | 382 | 400 | 378 | 387 | 378 |
| Italy | 2,108 | 507 | 1,829 | 2,176 | 2,595 | 2,733 | 2,483 | 2,255 | 1,865 | 1,940 | 264 |
| Luxembourg | -291 | -260 | -135 | 68 | -234 | -231 | -305 | -124 | -176 | -393 | -234 |
| Netherlands | -151 | -1,295 | -1,407 | -979 | -1,250 | -1,477 | -1,445 | -1,252 | -1,551 | -1,508 | -2,310 |
| Portugal | 125 | -479 | -71 | -420 | -411 | -568 | -572 | -629 | -851 | -758 | -437 |
| Spain | -1,955 | -128 | -1,234 | -680 | -615 | -870 | -937 | -1,265 | -1,259 | -1,547 | -970 |
| Sweden | 52 | 38 | 39 | 41 | 31 | 33 | -72 | -121 | 14 | -369 | -393 |
| UK | 4,450 | -1,843 | -2,719 | -1,689 | -1,488 | -2,880 | -3,147 | -3,701 | -4,971 | -5,861 | -7,949 |
| **EU-15** | **20,260** | **18,755** | **25,289** | **26,251** | **30,959** | **26,864** | **34,234** | **32,863** | **28,872** | **33,535** | **27,526** |

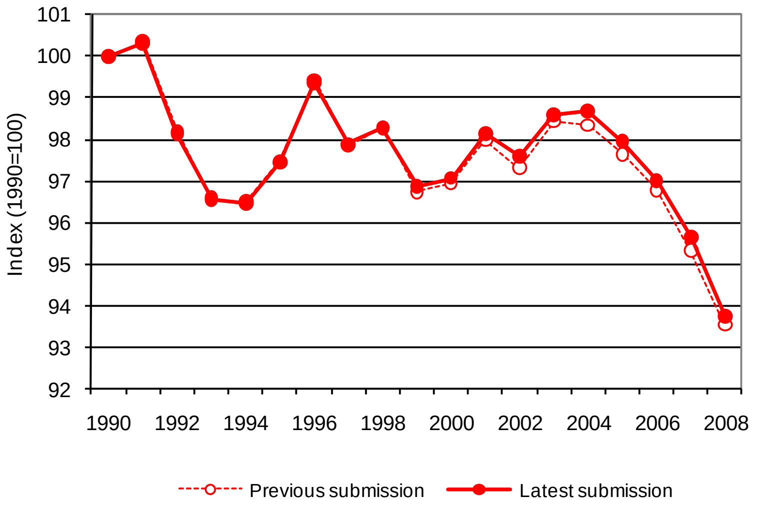
**Table 10.6 Contribution of Member States to EU-15 recalculations of total GHG emissions without LULUCF for 1990–2008 (difference between latest submission and previous submission in percentage)**

| | 1990 | 1995 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Austria | 0.0 | 0.0 | 0.2 | -0.2 | -0.1 | 0.0 | 0.0 | 0.0 | 0.5 | 0.5 | 0.4 |
| Belgium | 0.0 | 0.3 | 0.5 | 0.3 | 0.6 | 0.3 | 1.0 | 0.9 | 1.1 | 2.1 | 1.4 |
| Denmark | -1.3 | -0.9 | -0.7 | -0.2 | -0.1 | -0.6 | -0.2 | -0.3 | -0.1 | 0.1 | -0.3 |
| Finland | 0.0 | 0.0 | 0.1 | 0.0 | 0.1 | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 | 0.4 |
| France | -0.1 | 0.5 | 1.8 | 1.8 | 2.6 | 2.1 | 2.5 | 2.2 | 2.3 | 2.7 | 2.3 |
| Germany | 1.3 | 1.7 | 1.7 | 1.6 | 1.6 | 1.7 | 2.1 | 2.3 | 1.9 | 2.4 | 2.4 |
| Greece | 1.0 | 1.0 | 0.9 | 1.0 | 1.0 | 1.0 | 1.2 | 1.2 | 1.6 | 1.2 | 1.3 |
| Ireland | 0.0 | 0.0 | 0.2 | 0.1 | 0.2 | 0.5 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 |
| Italy | 0.4 | 0.1 | 0.3 | 0.4 | 0.5 | 0.5 | 0.4 | 0.4 | 0.3 | 0.4 | 0.0 |
| Luxembourg | -2.2 | -2.5 | -1.4 | 0.7 | -2.1 | -2.0 | -2.3 | -0.9 | -1.3 | -3.1 | -1.9 |
| Netherlands | -0.1 | -0.6 | -0.7 | -0.5 | -0.6 | -0.7 | -0.7 | -0.6 | -0.7 | -0.7 | -1.1 |
| Portugal | 0.2 | -0.7 | -0.1 | -0.5 | -0.5 | -0.7 | -0.7 | -0.7 | -1.0 | -0.9 | -0.6 |
| Spain | -0.7 | 0.0 | -0.3 | -0.2 | -0.2 | -0.2 | -0.2 | -0.3 | -0.3 | -0.4 | -0.2 |
| Sweden | 0.1 | 0.1 | 0.1 | 0.1 | 0.0 | 0.0 | -0.1 | -0.2 | 0.0 | -0.6 | -0.6 |
| UK | 0.6 | -0.3 | -0.4 | -0.2 | -0.2 | -0.4 | -0.5 | -0.6 | -0.8 | -0.9 | -1.3 |
| **EU-15** | **0.5** | **0.5** | **0.6** | **0.6** | **0.7** | **0.6** | **0.8** | **0.8** | **0.7** | **0.8** | **0.7** |

## 10.3 Implications for emission trends, including time series consistency

Table 10.7 shows that due to the fact that both the 1990 and 2008 emissions have increased, the emission trend in the EU-15 did not hardly change. In the previous submission the trend of GHG excluding LULUCF between 1990 and 2008 was – 6.5 %. In the latest submission the trend is -6.3 %.

**Table 10.7 Comparison of EU-15 GHG emission trends 1990–2008 (excl. LULUCF) of the latest and the previous submission**



## 10.4 Recalculations, including in response to the review process, and planned improvements to the inventory

### 10.4.1 EU response to UNFCCC review

Table 10.8 provides an overview of the improvements in the 2011 submission including responses to UNFCCC findings.

**Table 10.8 Improvements in 2011 including in response to UNFCCC review findings**

| NIR chapter / Sectors | Source category / Issues | Recommendations/improvements planned | Reference | Status |
|---|---|---|---|---|
| General | Transparency | Transparency could be enhanced by ensuring that where notation keys have been used by member States, explanations are provided where appropriate in the EC CRF. (para 8, para 32) | IRR 2007 | Implemented |
| General | Transparency | Prepare an overview table of key categories with shares of MS using higher tier methods. | Internal | Implemented |
| General | Transparency | The ERT encourages the Party to include the base year emissions of the European Union (calculated on the basis of the current submission) in the national inventory report (NIR). (para 3) | draft ARR 2010 | Implemented |
| General | Completeness | The completeness of the Party’s inventory is dependent on the completeness of the member States’ inventories. As mentioned above, some categories are reported as “NE” by all member States. In response to a question raised by the ERT during the review, the European Union confirmed that member States’ emissions are set to zero in the summation process. As a result, the European Union’s CRF tables contain emission estimates for only part of the European Union for these categories, which means that these categories are potentially underestimated at the European Union level. The European Union further explained that several categories reported as “NE” should have been reported as not occurring (“NO”). It seems that the notation keys are used in different ways by the member States. The ERT therefore recommends that the European Union harmonize the use of notation keys between the member States. The ERT requested further clarification from the European Union as part of the list of the potential problems. (para 11) | draft ARR 2010 | We focused on improving the consistent use of notation keys in LULUCF and on eliminating NEs |
| General | Completeness | In addition, the European Union informed the ERT that a general assessment of completeness will be included in a separate chapter of the NIR. The ERT recommends that the European Union include this information in its NIR in order to reflect the progress which was explained to the ERT during the review in the next annual submission. (para 14) | draft ARR 2010 | Implemented |
| General | Accuracy | Work with member States to move to higher tiers in their inventories where this is appropriate according to IPCC good practice guidance. (para 41) | IRR 2007 | Overview of use of higher tiers available in the NIR |
| General | QA/QC | The European Union provided information on QA/QC procedures in line with the “Guidelines for the preparation of national communications by Parties included in Annex I to the Convention, Part I: UNFCCC reporting guidelines on annual inventories” (hereinafter referred to as the UNFCCC reporting guidelines). An elaborated QA/QC plan is in place in accordance with decision 19/CMP.1 and the IPCC good practice guidance. It is not part of the submission but was sent to the ERT during the review in response to a request. The QA/QC plan is very detailed and includes general QC procedures (tier 1) as well as category-specific procedures (tier 2). QA by internal and external review is also described in the NIR. The GHG inventory now includes reported data from the European Union emissions trading scheme (EU ETS) for the period 2005–2008. EU ETS data are widely used throughout the member States. The ERT encourages the European Union to utilize EU ETS data for QA/QC processes to the extent possible in order to improve the quality of its inventories. (draft ARR 2010, para 24) | draft ARR 2010 | The EU will continue working with MS in order to improve the quality of its inventories through the use of EU ETS data, to the extent possible. |

| NIR chapter / Sectors | Source category / Issues | Recommendations/improvements planned | Reference | Status |
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| General | QA/QC | In CRF table 9(a), several categories are listed as included elsewhere ("IE"), but no explanations are given in the table. The ERT recommends that the European Union make efforts to reduce the number of categories reported as "IE" in order to increase the comparability and transparency of its inventory and to provide the required information in CRF table 9(a) in the next submission. (draft ARR 2010, para 26) | draft ARR 2010 | Annex 1.4 provides a list of all NEs and IEs and includes explanations taken from the Member States' CRF Tables 9. This information is equivalent to CRF Table 9 which cannot be filled-in automatically for the EU-15 due to the amount of information from the Member States. |
| General | Uncertainty analysis | The European Union has performed a tier 1 uncertainty analysis for the GHG inventory based on the tier 1 uncertainty estimates of the EU-15. The NIR provides information on the uncertainty analysis based on each member State's individual uncertainties for each category. An incomplete table in the NIR presenting an overview of uncertainty estimates available from the EU-15 member States was completed during the review following a request from the ERT. Uncertainty estimates are also listed in each sectoral chapter. The ERT encourages the European Union to perform a tier 2 uncertainty analysis based on the Monte Carlo approach (which was used for the waste sector). The description of the uncertainty analysis in chapter 1.7 of the NIR should be more transparent (e.g. the inclusion of a table with the uncertainties at the individual category level which are used to compile the uncertainty estimate of the European Union as a whole) and focus on the description of the overall uncertainty analysis of the European Union (e.g. by carrying out a Monte Carlo analysis). (draft ARR 2010, para 22) | draft ARR 2010 | This will be implemeted for the 2012 submission (due to late receipt of the draft ARR 2010) |
| General | Key category analysis | The documentation relating to the key category analysis is not fully transparent (e.g. the tier 2 analysis is only documented in one table in annex 1 to the NIR). The tier 2 analysis does not contain the LULUCF sector. The ERT recommends that the European Union give priority to the tier 2 key category analysis, that it include the LULUCF sector and that it document the tier 2 analysis in the NIR. (draft ARR 2010, para 20) | draft ARR 2010 | This will be implemeted for the 2012 submission (due to late receipt of the draft ARR 2010) |
| General | Key category analysis | The key categories for KP-LULUCF activities are listed for various member States but are not calculated at the European Union level. The ERT encourages the European Union to include this information in its next annual submission under the Kyoto Protocol following the guidance on establishing the relationship between the activities under the Kyoto Protocol and the associated key categories in the UNFCCC inventory as provided in chapter 5.4.4 of the IPCC good practice guidance for LULUCF. (draft ARR 2010, para 21) | draft ARR 2010 | This will be implemeted for the 2012 submission (due to late receipt of the draft ARR 2010) |
| General | Status reports | Adapt status reports to reflect completeness findings | Kick-off meeting 2011 | Implemented |
| Chapter 3 / Sector Energy | Reference approach | The ERT welcomes the improvements to the reference approach implemented since the previous review. In CRF table 1.A(b), several fuels are reported as "NE" (orimulsion, natural gas liquids, other kerosene, shale oil, other oil, oil shale, and BKB and patent fuel), although the NIR indicates that some of these fuels are aggregated under other fuels (e.g. "orimulsion" is included in "residual fuel oil"; "natural gas liquids" is included in "crude oil"; and "other kerosene" is included in "total kerosene"). "Anthracite", "coking coal" and "other bituminous coal" are included in "other bituminous coal" and are correctly reported as "IE". The ERT recommends that the European Union use the correct notation keys and explain the reasons for their use in the next NIR. (draft ARR 2010, para 35) | draft ARR 2010 | Implemented |

| NIR chapter / Sectors | Source category / Issues | Recommendations/improvements planned | Reference | Status |
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| Chapter 3 / Sector Energy | Reference approach | The comparison between the Eurostat data and the national reference approach for apparent consumption and $CO_2$ emissions from fuel combustion resulted in a difference of 0.5 per cent between the two approaches for 2006. In most member States the difference is within 2.0 per cent (Austria, Belgium, Denmark, Finland, Greece, Luxembourg, Netherlands, Portugal, Spain, Sweden and United Kingdom of Great Britain and Northern Ireland). Only for Ireland did the results from two approaches differ by more than 5.0 per cent. The ERT encourages the European Community to assess those differences in order to improve the quality of estimates and the NIR, and to provide explanations in its next annual submission. (ARR 2008 para 30) | ARR 2008 | The quality of the energy statistics data has improved due to reporting under the new energy statistics regulation.<br>The reasons for the remaining differences are being analysed in a project in 2011. The NIR 2012 will include the results of this project. |
| Chapter 3 / Sector Energy | International bunker fuels | 37. The NIR includes a brief summary of a study on bunker fuel emissions conducted in 2007 by the ETC/ACC comparing the aviation emissions reported by member States with modelling results provided by Eurocontrol and discussed in the previous review report. The ERT again recommends that the European Union continue such QA exercises, that it try to address the issues identified, and that it continue to work on making data from Eurocontrol available to member States on a regular basis. (draft ARR 2010, para 37) | draft ARR 2010 | EEA is working on this issue in order to obtain Eurocontrol data on a regular basis for quality checking |
| Chapter 3 / Sector Energy | 1A1, 1A2 | As pointed out in the previous review, the $CO_2$ implied emission factor (IEF) for the whole time series except 1990 (78.32–90.51 t/TJ) is the third lowest among reporting Parties (3.29–216.75 t/TJ). The European Union informed the ERT that the IEF is largely dominated by the German IEF, as Germany accounts for 42 per cent of total EU-15 $CO_2$ emissions in 2008. The low German IEF is due the fact that Germany reports $CO_2$ emissions from blast furnace gas under metal production (steel) but the AD data are reported under fuel combustion (energy industry, and manufacturing industries and construction). The ERT recommends that the European Union work with Germany to correctly allocate these emissions. (draft ARR 2010, para 38) | draft ARR 2010 | Implemented |
| Chapter 4 / Industrial processes | Transparency | Explanations of the major reasons underlying the largest recalculations are provided in the NIR but this information is missing for some member States. In order to improve transparency, the ERT recommends that the European Union provide correct and complete information on sector-specific recalculations along with an explanation of the major reasons underlying the largest recalculations in its next annual submissions. (draft ARR 2010, para 41) | draft ARR 2010 | Implemented |
| Chapter 5 / Solvents | QA/QC | According to the information provided in the NIR, there are no sector-specific QA/QC procedures for the solvent and other product use sector. During the review, the European Union informed the ERT that its focus had been on the key categories and, consequently, the Party has not yet implemented QA/QC procedures for the solvent and other product use sector. However, the European Union plans to do so for the 2011 submission. The ERT welcomes this plan and recommends that the European Union carry it out. (draft ARR 2010, para 44) | draft ARR 2010 | not yet implemented due to lack of resources |
| Chapter 4 / Industrial processes | 2A3 | The NIR explains that France reports emissions from limestone and dolomite use in cement production and in lime production under limestone and dolomite use. According to the IPCC good practice guidance, these emissions should be reported under the cement production and lime production categories. During the review, the European Union explained that if limestone is being used to manufacture lime, the emissions are included in the category lime production and, if it is used directly in processes such as cement and/or glass, then emissions are recorded in the consumer sectors, respectively. The European Union clarified that, in France, the category limestone and dolomite use includes the use of limestone in the process of agglomeration of ore steel and that emissions were previously reported in the category iron and steel (fuel combustion). This was described incorrectly in the NIR and the European Union will correct it for the 2011 submission. The ERT welcomes this clarification. (draft ARR 2010, para 45) | draft ARR 2010 | Implemented |

| NIR chapter / Sectors | Source category / Issues | Recommendations/improvements planned | Reference | Status |
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| Chapter 4 / Industrial processes | 2A3 | Additionally, the French IEF (0.05 t/t) is the lowest among all reporting Parties (0.31–0.59 t/t) and lower than the IPCC default EF of 0.44 t/t. During the review, the European Union clarified that the AD reported by France refer to the quantity of limestone used for strings in the process of agglomeration. The use of these AD does not justify the very low French IEF of 0.05 t/t compared to the other reporting Parties. In order to improve transparency, the ERT recommends that the European Union provide explanations of the methods, AD and EFs used for estimating $CO_2$ emissions from limestone and dolomite use in France. (draft ARR 2010, para 46) | draft ARR 2010 | Description included in NIR. France announced to change its calculation of the French IEF. |
| Chapter 4 / Industrial processes | 2A3 | The NIR indicates that the comparably low IEF (in 2008) in the Netherlands (0.31 t/t) for limestone and dolomite use (table 4.11) could be explained by the incomplete AD of limestone use (the amount of limestone used in desulphurizing installations is not included). However, incomplete AD would result in a higher (not lower) IEF. During the review, the European Union informed the ERT that not only is the use of limestone in desulphurizing installations missing but also the $CO_2$ emissions from these installations in the estimates of the Netherlands. The European Union also clarified that, in the Netherlands, the AD of limestone use consist of the limestone used for fertilizer for road construction (dolomite as a filler) and the limestone used in steel production. As this does not explain the reason why the IEF in the Netherlands is so low compared to the other reporting Parties and to the IPCC default EF (0.44 t/t), the ERT recommends that the European Union improve the completeness of this category by including $CO_2$ emissions from desulphurizing installations and by providing explanations in the NIR on the methods, AD and EFs used for estimating $CO_2$ emissions from limestone and dolomite use in the Netherlands. (draft ARR 2010, para 47) | draft ARR 2010 | Implemented |
| Chapter 4 / Industrial processes | 2A3 | Finally, the allocation of $CO_2$ emissions from limestone and dolomite use varies across the member States. These emissions are reported in different categories of the industrial processes sector and even in different sectors (industrial processes and energy). In order to increase comparability, the ERT encourages the European Union to undertake actions to harmonize the allocation of $CO_2$ emissions across member States in this category. (draft ARR 2010, para 48) | draft ARR 2010 | Will be further discussed in WG1 |
| Chapter 4 / Industrial processes | 2A7 | The NIR does not explicitly mention $CO_2$ emissions from glass production in Ireland, Sweden or the United Kingdom. The EC explained during the initial review that $CO_2$ emissions from glass production were included in other categories in Sweden and the United Kingdom and that Ireland had not yet estimated these emissions. The ERT notes that this does not comply with the UNFCCC reporting guidelines and recommends that the EC include this information in the NIR and encourage Ireland to estimate this category. (IRR 2007 para 77) | IRR 2007 | Implemented. The UK indicated to reallocate emissions from glass production from 2A3 to 2A7 in 2012. |
| Chapter 4 / Industrial processes | 2B1 | The previous ERT also recommended that the European Community encourage Greece to reallocate $CO_2$ emissions from ammonia (NH3) production in the energy sector to this category. However, the ERT found that emissions from Greece have been reallocated as recommended only for recent years, while the notation key included elsewhere ("IE") is still used for 1990. The European Community explained during the review that Greece had difficulty implementing the reallocation throughout the timeseries because of the lack of detailed fuel consumption data for NH3 production prior to 1998; however, the European Community also explained that Greece is trying to solve this problem. The ERT recommends that the European Community encourage Greece to continue to make efforts to improve time-series consistency in the next annual submission. (draft ARR 2009 para 51) | draft ARR 2009 | Implemented. |
| Chapter 4 / Industrial processes | 2B1 | In the European Union inventory, Greece has reported $CO_2$ emissions from ammonia production from 1990 to 1997 as "IE", while estimates are provided from 1998 to 2008. During the review, the European Union informed the ERT that up to 1999, there were two ammonia plants in Greece. Since 1998 (and up to today) the one plant still operating is using natural gas as the raw material of ammonia. According to expert information, the other plant, which closed in 2000, used lignite as feedstock until 1991, and liquid fuels until its closure. In the absence of detailed fuel consumption data on natural gas for the years 1998–1999, only $CO_2$ emissions from the first plant have been estimated. $CO_2$ emissions in the industrial processes sector refer to emissions from natural gas (for the years 1998–2007), whereas emissions from the other fuels | draft ARR 2010 | Implemented. |

| NIR chapter / Sectors | Source category / Issues | Recommendations/improvements planned | Reference | Status |
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| | | used (for the years 1990–1999) are included in the energy sector. The notation key “IE” was used, as the required data concerning the liquid and solid fuel consumption of the closed plant for the years 1990–1998 were not available. Greece is exploring ways of addressing this issue. The ERT recommends that the European Union encourage Greece to continue to make efforts to improve the time-series consistency of this category in the next annual submission. (draft ARR 2010, para 49) | | |
| Chapter 4 / Industrial processes | 2B1 | Recovering/capturing the $CO_2$ emitted by the ammonia production process has become commonplace in the European Union. The method used to report the recovered/captured amount varies from Party to Party. Some Parties continue to report these emissions, including the recovered/captured $CO_2$, while others do not report them at all or report them in the categories where the recovered $CO_2$ is used or stored. For example, the NIR states that, in Italy, the recovered $CO_2$ in ammonia production has been investigated and accounted for in the 2010 submission; in Belgium, the $CO_2$ recovered is taken into account; in the United Kingdom, a correction has to be made for the $CO_2$ recovered; and Austria subtracts the carbon stored in melamine. During the review, the European Union informed the ERT that it plans to study this issue further as part of the European Union's internal review. The ERT welcomes this plan and encourages the European Union to undertake actions to harmonize the reporting of the member States with regard to the recovered $CO_2$ emissions from ammonia production. (draft ARR 2010. para 50) | draft ARR 2010 | Will be further discussed in WG1 |
| Chapter 4 / Industrial processes | 2B4 | $CO_2$ emissions from carbide production decreased by 76 per cent from 1990 to 2008 but information to explain this trend is not provided in the NIR. During the review, the European Union informed the ERT that this is due to the fact that carbide production is not a key category. An overview of member States’ methodologies, EFs, quality estimates and emission trends is only provided in the NIR if identified as a key category at the EU-15 level. However, the European Union explained that the EU-15 $CO_2$ emissions trend from carbide production is mainly influenced by Germany and France. In Germany, emissions dropped by 79 per cent in 1991 compared to 1990. During the reunification period, calcium carbide production took place primarily in the former East Germany. Shortly after reunification, production discontinued in the former East Germany, while only one producer remained in the former West Germany. In the period 1990–2008, this producer cut production by about half. In France, carbide production occurred in one plant up to 2003, and since 2003 there has been no carbide production in France. The ERT commends the European Union for this explanation and encourages the Party to provide this additional information in the NIR, even if it is not a key category. (draft ARR 2010, para 53) | draft ARR 2009 | Implemented; information is included in NIR 2011 |
| Chapter 4 / Industrial processes | 2C1 | The allocation of emissions from pig iron production, which is the largest source in this category, differs between member States. Some member States report these emissions under fuel combustion, and others report them under industrial processes. The European Union has looked into the issue of the consistency of the allocation of $CO_2$ emissions from iron and steel production on several occasions. It concluded that, due to the complexity of the sector and the use of country-specific models, further harmonization in this sector towards more consistent reporting across member States would be very difficult. Therefore, the European Union aims to provide information on the methods, EFs and allocation of emissions used by member States as transparently as possible in the NIR. The ERT welcomes this proposal in order to further enhance transparency at the European Union level and recommends that the Party provide more complete information on the methods, EFs and allocation of emissions used by member States as well as information on the actions undertaken at the European Union level to ensure the consistency of the allocation of $CO_2$ emissions from iron and steel production. (draft ARR 2010, para 51) | draft ARR 2010 | As for the actions undertaken at the European Union level to ensure the consistency, currently no further action is planned as no solution for the problem caused by the complexity of the sector has yet been found. |
| Chapter 4 / Industrial processes | 2C – 2F | Add definition of source categories for every source category described in the NIR | Kick-off meeting 2011 | Implemented |

| NIR chapter / Sectors | Source category / Issues | Recommendations/improvements planned | Reference | Status |
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| Chapter 4 / Industrial processes | 2E2 | HFC emissions from fugitive emissions decreased by 88.9 per cent between 1992 (1,590.05 Gg $CO_2$ eq) and 1993 (176.69 Gg $CO_2$ eq), but no explanation for this trend is provided in the NIR. The European Union explained to the ERT that the decrease is due to the emissions decline in France following the installation of abatement technologies (thermal oxidizer) in HCFC-22 production, and that this category is not described in the NIR because it is not identified as a key category. Until 1993, France was the only member State to report emissions in this category and in 1993 Spain began to report emissions as well. In 2008, Spain was emitting approximately 75 per cent of all emissions in this category. The French emissions have decreased considerably since 1990 (–95 per cent) due to the implementation of abatement technologies. The ERT encourages the European Union to provide information on this category in order to improve transparency in the NIR, even if it is not identified as a key category. (draft ARR 2010, para 54) | draft ARR 2010 | Implemented |
| Chapter 4 / Industrial processes | 2F | The following member States reported potential and actual emissions of HFCs as "NE": Belgium, for other applications using ozone-depleting substance (ODS) substitutes; Greece, for solvents; and Luxembourg, for fire extinguishers and solvents. During the review, the European Union indicated that the main reason given by member States for not providing potential emissions was that the relevant data were not available at member State level and that the estimation of potential emissions of fluorinated gases (F-gases) is of lower priority because actual emissions of F-gases are estimated. The European Union also indicated that emissions from other applications using ODS substitutes in Belgium did not occur and that the notation keys will be changed in the 2011 submission. The ERT recommends that the European Union encourage these countries to comply with the UNFCCC reporting guidelines by using the appropriate notation keys (Belgium) and by preparing and reporting estimates of actual emissions of HFCs (Greece for solvents and Luxembourg for fire extinguishers and solvents). (draft ARR 2010, para 42) | draft ARR 2010 | Implemented |
| Chapter 4 / Industrial processes | 2F | The notation key "NE" is used to report PFC emissions from foam blowing, aerosols/metered dose inhalers, solvents, and other applications using ODS substitutes due to the fact that Greece reported PFC emissions from foam blowing, aerosols/metered dose inhalers and solvents as "NE" and Belgium reported the emissions from other applications using ODS substitutes as "NE". During the review, the European Union informed the ERT that emissions from these categories and in these countries did not occur and that the notation key "NE" had been incorrectly used in the 2010 submission for the EU-15 and in the member States' submissions. The ERT recommends that the European Union correctly use the notation keys in the reporting of PFC emissions from those categories and that the Party encourage Greece and Belgium to correct those notation keys in their next annual submissions. (draft ARR 2010, para 43) | draft ARR 2010 | Implemented |
| Chapter 4 / Industrial processes | 2F | The NIR does not contain any information on HFC emissions from fire extinguishers. In the European Union submission, HFC emissions from fire extinguishers<br><br>were identified as a key category for the first time in the 2010 submission. The ERT recommends that the European Union increase transparency and add the relevant information which can make readers replicate the calculation on this category in the NIR of the next annual submission. (draft ARR 2010, para 52) | draft ARR 2010 | Implemented |
| Chapter 6 / Agriculture | QA/QC | The previous ERT had encouraged the European Union to explore the possibility of developing an alternate inventory using the IPCC tier 1 methods and default factors along with data from readily available international sources; however, the NIR states that this exercise has been postponed due to a lack of resources and time. In response to a question raised by the ERT during the review as to whether the European Union is planning to implement the previous review report's suggestion, the Party informed the ERT that a project is currently being carried out at the European Commission Joint Research Centre (JRC), which has been commissioned to evaluate the contribution of the livestock production in Europe to overall European Union GHG emissions, the results of which will be included in the 2011 annual submission. The ERT encourages the European Union to include the results obtained from this approach this project and to compare them with member States' submissions in its 2011 annual submission. (draft ARR 2010, para 61) | draft ARR 2010 | In the 2011 NIR the results of the GGELS project were included. |

| NIR chapter / Sectors | Source category / Issues | Recommendations/improvements planned | Reference | Status |
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| Chapter 6 / Agriculture | Transparency | Most of the recommendations made by the previous ERT have been addressed in the 2010 submission. With regard to the issue of Germany applying the methods and default values contained in the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (hereinafter referred to as the 2006 IPCC Guidelines), the previous review report mentioned that, in order for Germany to use those methods and default values, it must provide an explanation as to why the default values contained in the 2006 IPCC Guidelines are more appropriate to its particular circumstances than the methods and default values contained in the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories (hereinafter referred to as the Revised 1996 IPCC Guidelines) elaborated by the IPCC good practice guidance. The 2010 NIR of the European Union states that the German NIR contains an extensive table describing in detail the difference between the methods and default values contained in the Revised 1996 IPCC Guidelines and the 2006 IPCC Guidelines, and justifying the use of the default factors contained in the 2006 IPCC Guidelines. To facilitate the review of the European Union's inventory, the ERT recommends that the European Union include this information in its NIR in the next annual submission. (draft ARR 2010, para 60) | draft ARR 2010 | Germany has revised its use of factors from the 2006 Guidelines (see below). Where relevant, information has been added to the EU NIR. |
| Chapter 6 / Agriculture | 4A | The ERT noted that the $CH_4$ conversion rates of dairy cattle (18.6 per cent) and swine (16.9 per cent) for Germany reported in the NIR are much higher than the values reported by other member States and the IPCC default values. During the review, the European Union informed the ERT that the $CH_4$ conversion rates reported by Germany were wrong and that those values were not used for the calculation of $CH_4$ emissions. The ERT recommends that the European Union check the values indicated in the NIR as well as the calculation of those emissions in its next annual submission. (draft ARR 2010, para 63) | draft ARR 2010 | Germany has corrected the $CH_4$ conversion rates for dairy cattle and swine. Reported values are now 6% for dairy cattle and 0.6% for swine, in accordance with IPCC 1997 guidelines. |
| Chapter 6 / Agriculture | 4B | The $N_2O$ IEF (0.005 kg $N_2O$-N/kg-N) from solid storage provided in the 2006 IPCC Guidelines was applied in the estimation of $N_2O$ emissions from solid storage and dry lot by Germany, which is lower than the default $N_2O$ EF provided in the Revised 1996 IPCC Guidelines, and lower than the $N_2O$ EF (0.02 kg $N_2O$-N/kg-N) from dry lot provided in the 2006 IPCC Guidelines. The ERT recommends that the European Union provide further information to justify the use of lower values in its next annual submission. (draft ARR 2010, para 64) | draft ARR 2010 | The justification on the use of the $N_2O$ emissions factors from the IPCC 2006 guidelines was included in the EU NIR 2011. |
| Chapter 6 / Agriculture | 4C | The IEF of $CH_4$ emissions from rice cultivation in Portugal increased from 31.9 g $CH_4$/m2 in 1990 to 69.8 g $CH_4$/m2 in 2008. There is no explanation of the reasons for the rising IEF value. The ERT recommends that the European Union provide related background information to explain the change in this IEF in its NIR in the next annual submission. (draft ARR 2010, para 66) | draft ARR 2010 | Information included in the 2011 NIR |
| Chapter 6 / Agriculture | 4D | Most member States rely on the IPCC default EF to estimate $N_2O$ emissions from agricultural soils. For direct emissions from agricultural soils, the $N_2O$ EFs from the 2006 IPCC Guidelines which were used in Germany's last annual submission have been replaced by default EFs from the Revised 1996 IPCC Guidelines in response to the recommendations made in the 2009 review report. For indirect $N_2O$ emissions from N used in agriculture, Germany applied the $N_2O$ IEF (0.0075 kg $N_2O$-N/kg-N) for leaching and runoff provided in the 2006 IPCC Guidelines, which is much lower than the default value indicated in the IPCC good practice guidance (0.025 kg $N_2O$-N/kg-N). The ERT recommends that the European Union provide further justification for the use of the default values provided in the 2006 IPCC Guidelines, which are significantly different from the values of the IPCC good practice guidance and the Revised 1996 IPCC Guidelines, in its next annual submission. (draft ARR 2010, para 65) | draft ARR 2010 | Germany uses the default EF from the Revised 1996 IPCC Guidelines in the submission 2010. |
| Chapter 7 / LULUCF | Transparency | Add definition of source/sink categories for every source category described in the NIR | Kick-off meeting 2011 | Information provided in the EU NIR 2011. It is also rechecked and updated yearly. |

| NIR chapter / Sectors | Source category / Issues | Recommendations/improvements planned | Reference | Status |
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| Chapter 7 / LULUCF | Completeness | The tables in the NIR highlight the missing components of the inventory. The majority relate to the land-use transitions that several member States report as "NE". The ERT recommends that the European Community continue and increase the support for member States that are not able to fulfill the requirements of the GHG inventory. (ARR 2008 para 65) | ARR 2008 | Implemented |
| Chapter 7 / LULUCF | Completeness | In response to recommendations made during previous reviews, the 2009 NIR of the European Community shows notable improvements in the completeness of reporting of forest land and cropland remaining cropland, and in providing further documentation on the LULUCF sector. Some subcategories are still reported as "NE" such as carbon stock changes and non-$CO_2$ emissions in land-use change transitions, as well as emissions due to biomass burning in several land-use categories for several member States. The European Community has indicated its continuous efforts to encourage all member States to improve their LULUCF inventories and prepare for reporting activities under Article 3, paragraphs 3 and 4, of the Kyoto Protocol, for their 2010 submissions. The ERT welcomes the improvements in the reporting of the LULUCF sector and recommends that the European Community continue to encourage its member States to develop the ability of the various national systems to identify activities under Article 3, paragraphs 3 and 4, of the Kyoto Protocol and increase support to those member States that are still unable to fulfill the requirements of reporting a complete LULUCF inventory under the Convention. (draft ARR 2009 para 66) | draft ARR 2009 | Implemented |
| Chapter 7 / LULUCF | Completeness | In response to recommendations made in previous review reports, the 2010 NIR of the European Union shows continued improvements in the completeness of reporting of emissions and removals of all categories/subcategories, and in the reporting of carbon pools. However, some categories/subcategories are still reported as "NE" by several member States, such as the carbon stock changes in dead organic matter (DOM), as well as the emissions due to biomass burning in several land-use categories, and significant gaps exist in the reporting of all carbon pools. The European Union has provided information on its continuous efforts to encourage all member States to improve their LULUCF inventories, including for the reporting of activities under Article 3, paragraphs 3 and 4, of the Kyoto Protocol for future submissions. The ERT welcomes the improvements in the reporting of the LULUCF sector and recommends that the European Union continue to encourage its member States to develop the ability of the various national systems to report complete emissions and removals from the LULUCF sector and identify activities under Article 3, paragraphs 3 and 4, of the Kyoto Protocol. It further encourages the Party to provide further support to those member States that are still unable to fulfil the requirements of reporting a complete LULUCF inventory under the Convention. (draft ARR 2010, para 69) | draft ARR 2010 | On going<br>Improvement in estimation and consistent reporting is followed "case by case" with MS by direct interaction. |
| Chapter 7 / LULUCF | Comparability | In response to comments made in previous review reports and to concerns raised by the ERT with regard to the comparability and differences in the definitions and methods used between member States in terms of both land-use definitions and the reported time series, the European Union indicated that some harmonization efforts have been made. However, the Party acknowledges that there are unavoidable differences in the definitions and methodologies used by member States, due to the fact that statistics are prepared in different ways in the member States and the type of data available also differs among the member States. The European Union indicated that, as long as the methodologies used by member States are consistent with the IPCC good practice guidance for LULUCF, the comparability of the methods used for the estimation of emissions has been achieved and the aggregated data can be used to assess emission trends. The ERT welcomes the efforts of the European Union and encourages the Party to continue its efforts to improve comparability and consistency among member States in future submissions. (draft ARR 2010, para 70) | draft ARR 2010 | Implemented (in NIR 2011, chapter 7.1.3) |

| NIR chapter / Sectors | Source category / Issues | Recommendations/improvements planned | Reference | Status |
|---|---|---|---|---|
| Chapter 7 / LULUCF | Consistency / QA/QC | In response to recommendations made in previous review reports regarding discrepancies between the values of net $CO_2$ emissions and removals in the land-use change matrix of lands from forests in table 7.4 of the NIR for the years 1990 and the corresponding totals in CRF table 5 for the same year, improvements have been made in harmonizing the information in the 2010 inventory. Discrepancies between NIR table 7.4 and CRF table 5 still exist, but are much smaller than in the previous annual submissiion. The ERT commends the European Union for these improvements and recommends that the Party continue to provide support to member States to improve consistency between the NIR and the CRF tables. (draft ARR 2010, para 71) | draft ARR 2010 | Ongoing |
| Chapter 7 / LULUCF | Accuracy / Transparency | As noted in the previous review report, the total area of organic soil reported in the LULUCF sector does not match the area of cultivated organic soil reported in the agriculture sector (CRF table 4.D). For instance, the areas reported in the LULUCF sector for 2007 are 11,254.64 kha of forest land, 1,382.23 kha of cropland and 1,324.94 kha of grassland, whereas the total area reported in the agriculture sector is 2,221.33 kha. The European Union has provided some additional information on these inconsistencies, noting differences in the definitions and methodologies among member States as the causes of such inconsistencies. The ERT encourages the European Union to continue to support member States in their efforts to improve accuracy and transparency in the reporting of these sectors. (draft ARR 2010, para 72) | draft ARR 2010 | Ongoing<br>Improvement in estimation and consistent reporting is followed "case by case" with MS by direct interaction. |
| Chapter 7 / LULUCF | 5A1 | In response to a question raised by the ERT regarding the significant decrease in DOM for forest land remaining forest land between 1999 and 2000, the European Union explained that this change is due to France reporting a significant decrease in the DOM pool after a storm event in 1999. The European Union provided the answer given by France in response to its question on the same issue. France informed the European Union that the change was due to a large storm which increased the amount of dead wood at the end of 1999. France noted that the amount of dead wood in the forest was high in 2000 and has decreased since then towards its lower original stock. This answer does not explain why the 2000 value should drop so significantly. The ERT recommends that the European Union clarify with France the reporting of this estimate and provide additional information in its NIR in the next annual submission. (draft ARR 2010, para 74) | draft ARR 2010 | Implemented |
| Chapter 7 / LULUCF | 5A1 | An issue identified in previous review reports continues to be observed in the current inventory. In table 7.2 of the NIR, Italy’s share of LULUCF sinks is reported to be 34.1 per cent of the total share of all 15 member States. According to Italy’s 2008 inventory submitted in 2010, the area of forest land remaining forest land equals 8,838.7 kha, the implied carbon stock change factor for living biomass is 0.96 Mg C/ha, and the implied carbon stock change factor for soils is 0.86 Mg C/ha. By comparison, France’s implied carbon stock change factor is 0.33 Mg C/ha for living biomass, and 0.01 Mg/C/ha for soils. As noted in the previous review report, Italy’s approach assumes that soils build up their carbon stock almost as fast as vegetation. This assumption is not supported by adequate evidence and thus may lead to an overestimation of the increase in soil carbon stocks under growing forest vegetation. Hence, the approach is not fully consistent with the IPCC good practice guidance for LULUCF. The ERT recommends that the European Union continue to work with member States like Italy, which have elected to report forest management under Article 3, paragraph 4, of the Kyoto Protocol to improve the reporting of forest land remaining forest land and to ensure that the reported values are as accurate as possible. (draft ARR 2010, para 76) | draft ARR 2010 | ongoing<br>Improvement in estimation and consistent reporting is followed "case by case" with MS by direct interaction. |
| Chapter 7 / LULUCF | 5A2 | The ERT notes an improvement in the completeness of reporting in this category since the last annual submission. Further, the European Union has provided additional information on questions raised by the ERT during the review concerning carbon fluxes in France and the United Kingdom. However, the European Union also noted in its NIR that information provided by France regarding the large area reported in this category is not sufficiently transparent to evaluate. The ERT therefore recommends that the European Union follow up with France regarding this issue and report any results in the NIR in its next annual submission. (draft ARR 2010, para 77) | draft ARR 2010 | Implemented |

| NIR chapter / Sectors | Source category / Issues | Recommendations/improvements planned | Reference | Status |
|---|---|---|---|---|
| Chapter 7 / LULUCF | 5A2 | The ERT acknowledges the difficulties in harmonizing the reporting in this category given the range of methodologies used by member States. The ERT commends the European Union for the improvements made with regard to transparency and completeness in this category and encourages the Party to continue to encourage member States to improve their methodologies and make efforts to harmonize their reporting approaches with other reporting Parties. (draft ARR 2010, para 78) | draft ARR 2010 | ongoing<br>Improvement in estimation and consistent reporting is followed "case by case" with MS by direct interaction. |
| Chapter 7 / LULUCF | 5B2 | Most member States report land conversions to cropland with emissions exceeding any reported removals. In an improvement compared to last year's report, the NIR includes table 7.9, which lists the EFs used by member States for many subcategories. The ERT commends the European Union for this improvement, and some member States still use lower-tier method to estimates emissions/removals. Given the importance of this category for the European Union, the ERT encourages the Party to continue to support member States in improving the reporting in this area by using a higher-tier method where possible, as well as by improving the completeness of reporting. (draft ARR 2010, para 80) | draft ARR 2010 | ongoing<br>EU QA/QC procedure keeps implementing TACCC in both EU level and MS GHG inventories, for all land use subcatagories and pools. |
| Chapter 7 / LULUCF | 5C1 | The area of grassland has steadily increased in the European Union since 1990, with a small decrease reported between 2007 and 2008. Overall, this category is a source, with emissions of 11,859.79 Gg $CO_2$ . Germany is the largest contributor to the emissions, with 12,743 Gg $CO_2$ Italy has reported the largest sink, with removals of –7,032 Gg $CO_2$. Only four member States have reported biomass data for this category. The ERT recommends that the European Union support member States to improve the completeness of reporting of this category. (draft ARR 2010, para 81) | draft ARR 2010 | ongoing<br>EU QA/QC procedure keeps implementing TACCC in both EU level and MS GHG inventories, for all land use subcatagories and pools. |
| Chapter 7 / LULUCF | Transparency | The previous ERT noted that, although most member States report emissions and removals from the conversion of land to settlements, the corresponding EFs are not provided in the NIR. The ERT reiterates the recommendations of the last two review reports that member States include the EFs used in their NIRs in order to improve the transparency of reporting. (draft ARR 2010, para 82) | draft ARR 2010 | ongoing<br>EU QA/QC procedure keeps implementing TACCC in both EU level and MS GHG inventories, for all land use subcatagories and pools. |
| Chapter 8 / Waste | QA/QC | Industrial waste is not taken into consideration by six member States in solid waste disposal on land and Sweden does not estimate $CH_4$ emissions from domestic and commercial wastewater. The ERT encourages the European Union not only to collect and reorganize the information in its NIR and the data included in the CRF tables from member States, but also to create incentives for the assurance of inventory improvements in order to increase the transparency, accuracy and completeness of the European Union's inventory. (draft ARR 2010, para 85) | draft ARR 2010 | Industrial Waste: Additional data provided for Ireland, Italy, Luxembourg and Spain in NIR 2011. $CH_4$ from domestic and commercial wastewater: Implemented. SE provided estimates; information has been included in NIR. |
| Chapter 8 / Waste | 6A1 | There is a significant difference in the rate of waste generation per capita among the member States (figure 8.3 of the NIR). The European Union explains in its NIR that the waste generation rate is not well defined in the additional information box of the CRF tables or in the NIR of individual member States. It is therefore difficult to explain the difference in the waste generation rate among member States. The ERT encourages the European Union to enhance cooperation with member States and to collect relevant information with a view to better understand the background of the significant difference in waste generation rates among member States (0.18–7.78 kg/capita/day). (draft ARR 2010, para 86) | draft ARR 2010 | Data from Eurostat as a more homogenous data source is used to show the waste generation rate for EU-15 and EU-27 MS. Implemented. |

| NIR chapter / Sectors | Source category / Issues | Recommendations/improvements planned | Reference | Status |
|---|---|---|---|---|
| Chapter 8 / Waste | 6A1 | Industrial waste is neither mentioned nor considered by six member States in the NIR in solid waste disposal on land (Greece, Ireland, Italy, Luxembourg, Netherlands and Spain). The ERT strongly recommends that the European Union investigate the reasons for this and that the Party encourage member States to eliminate the potential underestimations in this key category for the sake of inventory completeness. (draft ARR 2010, para 87) | draft ARR 2010 | Additional data provided for Ireland, Italy, Luxembourg and Spain in NIR 2011. |
| Chapter 8 / Waste | 6A1 | Table 8.5 of the NIR, which provides information on the recalculations conducted in 1990 and 2007, does not contain information on the contributors to the emission recalculation results for the period 1990–2007. It provides explanations for the largest recalculations in absolute terms only (Italy and Spain). In response to a question raised by the ERT during the review, the European Union submitted explanations for the recalculations in other member States. The ERT encourages the Party to include more information on recalculations, such as the information provided to the ERT during the review, in the next NIR. (draft ARR 2010, para 88) | draft ARR 2010 | Implemented |
| Chapter 8 / Waste | 6B | The methods used to calculate $CH_4$ and $N_2O$ emissions from wastewater handling vary between member States, with some reporting methods as “confidential” and others reporting them as “tier 2”. All EU-15 member States except Sweden (“IE”) reported their $CH_4$ emissions from domestic and commercial wastewater handling. All EU-15 member States reported their $N_2O$ emissions from commercial wastewater handling in accordance with the IPCC good practice guidance. Six member States (Finland, Greece, Italy, the Netherlands, Portugal and Spain) reported $CH_4$ emissions from industrial wastewater in 2007, while one member State (Denmark) reported these emissions as “IE” and the remaining member States reported these emissions as “NE”. Six member States (Austria, France, Italy, Luxembourg, Portugal and Sweden) reported $N_2O$ emissions from industrial wastewater, while the remaining member States reported these emissions as “not applicable” (“NA”), “NE” and “IE”. The ERT recommends that the European Community encourage those member States reporting “NE” for this category to provide emission estimates. (ARR 2009 para 85) | draft ARR 2009 | Additional information has been included in NIR; only BE is indicating 'NE' for $CH_4$ emissions from 6B1. |
| Chapter 8 / Waste | 6B | $CH_4$ emissions from domestic and commercial wastewater handling are a significant emission source in this sector and have been identified as a key category for the European Union. Nevertheless, one member State (Sweden) has reported emissions from this category as “NE” in the CRF tables due to a lack of data. The ERT recommends that the European Union encourage Sweden to eliminate the potential underestimations in this key category in order to improve the completeness of the inventory. (draft ARR 2010, para 89) | draft ARR 2010 | Implemented. SE provided estimates; information has been included in NIR. |
| Chapter 8 / Waste | 6B | Tables 8.8 and 8.10 of the NIR on the recalculations conducted for $CH_4$ emissions in 1990 and 2007 do not contain information on the contributors to the emission recalculation results. In response to a question raised by the ERT during the review, the European Union submitted explanations for the recalculations in member States. The ERT encourages the Party to include more information on recalculations, such as the information provided to the ERT during the review, in the next NIR. (draft ARR 2010, para 90) | draft ARR 2010 | Implemented |
| Chapter 8 / Waste | 6B | Six member States (Finland, Greece, Italy, Netherlands, Portugal and Spain) reported $CH_4$ emissions from industrial wastewater in 2008 while Denmark reported these emissions as “IE” and the remaining member States reported these emissions as “NE”. Six member States (Austria, France, Italy, Luxembourg, Portugal and Sweden) reported $N_2O$ emissions from industrial wastewater, while the remaining member States reported these emissions as “NA”, “NE” and “IE”. The ERT recommends that the European Union encourage those member States reporting these emissions as “NE” to provide emission estimates. (draft ARR 2010, para 91) | draft ARR 2010 | Additional information has been included in NIR; only BE is indicating 'NE' for $CH_4$ emissions from 6B1. |

| NIR chapter / Sectors | Source category / Issues | Recommendations/improvements planned | Reference | Status |
|---|---|---|---|---|
| Chapter 11 / KP-LULUCF | Accuracy / QA/QC | The European Union has provided, in table 11.6 of the NIR, the definitions of forest for all 15 member States, including all required parameters. Denmark, Finland, France, Germany, Greece, Italy, Portugal, Spain, Sweden and the United Kingdom have all elected forest management, Denmark, Portugal and Spain have elected cropland management, while Denmark and Portugal have elected grassland management. Denmark and France have elected annual accounting with all other countries electing end-of-commitment-period accounting. The European Union notes in the NIR that it will neither issue nor cancel units based on the emissions and removals reported by member States for KP-LULUCF activities. The European Union further notes in the NIR that several member States have improved their land identification system and ensured that the definitions and methods used are consistent over the entire time series in order to meet the requirements under the Kyoto Protocol. The NIR states that land transition matrices have been developed, based on available databases and methodologies in each member State, but notes that several member States had difficulties in assessing land-use change. The ERT encourages the European Union to support member States in improving their ability to accurately track land-use change. (draft ARR 2010, para 94) | draft ARR 2010 | ongoing<br>EU QA/QC procedure keeps implementing TACCC in both EU level and MS GHG inventories, for all land use subcatagories and pools. |
| Chapter 11 / KP-LULUCF | Transparency | Tables 11.9 and 11.10 of the NIR list the different approaches used by member States to identify land and units of land. Most member States use a national forestry inventory (NFI) to identify land subject to activities under Article 3, paragraph 3, of the Kyoto Protocol (afforestation and reforestation, and deforestation). While land areas are provided, limited information on whether the countries have provided georeferencing or geographical boundaries for multiple or single activities is provided. The ERT recommends that the European Union work with member States to provide more detailed information on geographical boundaries for land subject to activities under Article 3, paragraph 3, of the Kyoto Protocol, including maps and/or databases to identify the geographical locations and the system of identification codes for the geographical locations. (darft ARR 2010, para 95) | draft ARR 2010 | ongoing<br>EU QA/QC procedure keeps implementing TACCC in both EU level and MS GHG inventories, for all land use subcatagories and pools. |
| Chapter 11 / KP-LULUCF | Completeness | Not all member States have reported the carbon stock changes for each of the five carbon pools as required for all activities under Article 3, paragraphs 3 and 4, of the Kyoto Protocol. The ERT recommends that the European Union work with member States to report on all pools for activities under Article 3, paragraphs 3 and 4, or to demonstrate that a particular pool is not a net source. (draft ARR 2010, para 96) | draft ARR 2010 | ongoing<br>EU QA/QC procedure keeps implementing TACCC in both EU level and MS GHG inventories, for all land use subcatagories and pools. |
| Chapter 11 / KP-LULUCF | Uncertainty analysis | Not all member States have provided an uncertainty analysis for Kyoto Protocol estimates. The European Union notes that several member States are planning to include uncertainty estimates in their next annual submission. The ERT encourages the European Union to work with member States in order to include uncertainty analyses for activities under Article 3, paragraphs 3 and 4, of the Kyoto Protocol. (draft ARR 2010, para 96) | draft ARR 2010 | ongoing<br>EU QA/QC procedure keeps implementing TACCC in both EU level and MS GHG inventories, for all land use subcatagories and pools. |
| Chapter 11 / KP-LULUCF | Afforestation / Reforestation | The European Union has included in its NIR a table (11.16) listing the justifications provided by member States as to why afforestation and reforestation activities are directly human-induced. Several member States have not provided adequate information on the size and geographical location of forest areas that have lost forest cover but which are not yet classified as deforested. As the European Union has noted in the NIR, further improvement is needed in this area and the ERT recommends that the European Union work with member States to provide more complete information on this category. (draft ARR 2010, para 97) | draft ARR 2010 | ongoing<br>EU QA/QC procedure keeps implementing TACCC in both EU level and MS GHG inventories, for all land use subcatagories and pools. |

| NIR chapter / Sectors | Source category / Issues | Recommendations/improvements planned | Reference | Status |
|---|---|---|---|---|
| Chapter 11 / KP-LULUCF | Deforestation | The European Union has also included information (table 11.17 of the NIR) on how harvesting or forest disturbance is distinguished from deforestation. The information provided is not complete for all member States. The ERT recommends that the European Union support member States in improving the reporting in this category. (darft ARR 2010, para 98) | draft ARR 2010 | ongoing<br>EU QA/QC procedure keeps implementing TACCC in both EU level and MS GHG inventories, for all land use subcatagories and pools. |
| Chapter 11 / KP-LULUCF | Deforestation | The ERT notes that there are inconsistencies and inappropriate uses of notation keys in some CRF cells for this category. The European Union has acknowledged this issue and states that it has raised it with individual member States. The ERT recommends that the European Union continue to work with member States to ensure that the appropriate notation keys are used and, where appropriate, to provide explanations for missing data. (draft ARR 2010, para 99) | draft ARR 2010 | ongoing<br>EU QA/QC procedure keeps implementing TACCC in both EU level and MS GHG inventories, for all land use subcatagories and pools. |
| Chapter 11 / KP-LULUCF | Cropland management | Denmark, Portugal and Spain have elected this activity. Portugal has reported $CO_2$ emissions from this activity in 1990 as "NE" for all carbon pools, and Denmark and Spain have reported emissions from some carbon pools using notation keys, while this activity is net-net accounting. The ERT noted that the European Union will not issue removal units (RMUs) for this activity; however, the ERT encourages the European Union to work with these member States to prepare complete information for the next annual submission. (draft ARR 2010, para 101) | draft ARR 2010 | Implemented |
| Chapter 11 / KP-LULUCF | Grazing land management | Denmark and Portugal have elected this activity. Portugal has reported $CO_2$ emissions from this activity in 1990 as "NE" for all carbon pools, Denmark has reported emissions from some carbon pools for this activity in 1990 using notation keys, while this activity is net-net accounting. The ERT noted that the European Union will not issue RMUs for this activity; however, the ERT encourages the European Union to work with these member States to prepare complete information for the next annual submission. (draft ARR 2010, para 102) | draft ARR 2010 | Implemented |

### 10.4.2 Member States' responses to UNFCCC review

Since the improvement of the EU inventory depends on Member States' efforts regarding completeness of estimation and improvement of methods and parameters used, Table 10.9 provides an overview of Member States' responses to the UNFCCC review ([35]). The table shows that a considerable amount of improvements were made compared since the previous submissions of Member States. In addition to the response to the UNFCCC review, a large number of additional improvements were implemented by Member States. However, an aggregation of all improvements conducted in all Member States would be too much information and too detailed to be included in this report.

**Table 10.9 Improvements made by EU-15 Member States in response to the UNFCCC review**

| Member State | Improvements as recommended by the review team | Improvements in response to UNFCCC review as indicated in the NIR |
|---|---|---|
| **Austria** | The ERT identifies the following cross-cutting issues for improvement in Austria's next annual submission:<br><br>(a) The review of the QA/QC plan to see if further checks need to be added to the existing procedures or whether its implementation could potentially be further enhanced; | Not yet addressed. |
| | (b) The enhancement of efforts to provide transparent and verifiable information, especially regarding the LULUCF and energy sectors; | Not yet addressed. |
| | (c) The inclusion in the tier 1 uncertainty analysis of all categories in the LULUCF sector, in line with the IPCC good practice guidance for LULUCF; | Not yet addressed. |
| | (d) Reporting on the results of the corrective actions that have been taken to prevent future discrepancies in transactions of the national registry.<br><br>**(FCCC/ARR/2010/AUT, para 36)** | Not yet addressed. |
| **Belgium** | The ERT identifies the following cross-cutting issues for improvement:<br><br>(a) The improvement of the key category analysis by reporting results both excluding and including the LULUCF sector; | a) Belgium performed the key category analysis by incorporating immediately the LULUCF sector. Belgium recognizes that the analysis should be first performed excluding the LULUCF sector and secondly including it, as explained on page 5.30 of the IPCC LULUCF GPG. [Belgian responses to review 2010_150311.xls] [NIR 2011, p.184] |
| | (b) The assessment of how the implementation of improvements to the key category analysis (above) affects the selection of methodologies for the new key categories that result; | Not yet addressed. |
| | (c) The improvement of transparency through the inclusion of CRF tables summary 7 and 8(b), and discussion of time-series consistency in the NIR; | c) Belgium will provide table 7 for the next submission (for the latest years). However, key categories analysis has been performed in chapter 1.5 of the NIR. Although Belgium provided a separate table 8(b), This table will be included in CRF for the 15/4/2011 submission (at least for the last year). [Belgian responses to review 2010_150311.xls] |
| | (d) The further implementation of existing tier 1 QC measures and confirmation that they are implemented across all regions and sectors; | d) In the 2011 submission a table providing an overview of the QC checks that are performed on the regional and national level in Belgium is included. [NIR 2011, p.21] |

([35]) Issues related to the NIR are not included in this table as already addressed in Table 1.11.

| Member State | Improvements as recommended by the review team | Improvements in response to UNFCCC review as indicated in the NIR |
|---|---|---|
| | (e) The inclusion of a transparent explanation of the comments included in the CRF tables which follow from the use of the CRF aggregator software; | e) An explanation is only included in the Excel File [Belgian responses to review 2010_150311.xls]. |
| | (f) The inclusion of a key category analysis of KP-LULUCF activities and of all KP-LULUCF reporting elements, in accordance with the annex to decision 15/CMP.1. **(FCCC/ARR/2010/BEL, para 29)** | f) Due to time constraints, the key source analysis on the KP-LULUCF has not been performed yet. It is planned for the 15/4/2011 submission. [NIR 2011, p.15] |
| **Denmark** | The ERT identifies the following cross-cutting issues for improvement:<br><br>(a) The provision of more precise descriptions of the methodologies that differ from those of the IPCC; | |
| | (b) The improvement of transparency regarding the description of models used in different sectors and EU ETS data; | b) Denmark has included a general description of the use of EU ETS data including the quality of the available data and how this is in accordance with the IPCC good practice guidance. [NIR 2011, p.575] |
| | (c) The creation and consistent implementation of a QA/QC management system for Denmark, Greenland and the Faroe Islands; | c) Denmark has as indicated during the review included information on recalculations and QA/QC procedures for the aggregated submission of Denmark and Greenland. QA/QC analysis will be included in Chapter 17 in the April submission to UNFCCCC. [NIR 2011, p.575] |
| | (d) The improvement in the uncertainty analysis with the correct distribution shapes and ranges of uncertainties; | d) An extended version of the Tier 2 uncertainty analysis has been performed applying defined uncertainty ranges for all input parameters e.g. for the Waste sector, Solid waste disposal on land [NIR, p.585] |
| | (e) The improvement in consistency in land-area representation in the LULUCF sector and consistency in the reporting of the LULUCF sector under the Convention and KP-LULUCF reporting; | e), f), h) Many improvements took place in the LULUCF and the agricultural sector. [NIR 2011, p.580-584]<br><br>g) Related to the time-series consistency in the energy sector, the $CO_2$ emission factors for coal have been recalculated for 1990-2008. The recalculation has resulted in an improved time-series consistency. [NIR 2011, p. 550] |
| | (f) The improvement in completeness, particularly in the agriculture and LULUCF sectors; | |
| | (g) The improvement in time-series consistency in the energy and industrial processes and solvent and other product use sectors; | |
| | (h) The improvement in the completeness and consistency in the reporting of land representation and carbon pools under Article 3, paragraphs 3 and 4, of the Kyoto Protocol.<br><br>**(FCCC/ARR/2010/DNK, para 42)** | |
| **Finland** | The ERT identified the following cross-cutting issues for improvement:<br><br>(a) The improvement of the consistency between the NIR and CRF table summary 3, and the NIR and CRF table 7; | a) Efforts to continue the improvement have been made. All sectoral chapters now include a summary table on tier levels for methods, AD and EF. [NIR 2011, p.373] |
| | (b) The improvement of transparency in the NIR on the N mass flow model in the agriculture sector by including the information provided during the centralized review and the reference of the paper on the | b) The model is described in the report Grönroos et al. (2009) The report is now included in the reference list of NIR. The report can be downloaded from http://www.ymparisto.fi/download.asp?contentid=105290&lan=en. Description of the N mass flow model is put in NIR(Section |

| Member State | Improvements as recommended by the review team | Improvements in response to UNFCCC review as indicated in the NIR |
|---|---|---|
| | model in the NIR list of references; | 6.3.2.1) [NIR 2011, p. 226] |
| | (c) The provision of information on internal audits identified annually in the bilateral quality meetings; | c) Finland has included information on internal audits in the NIR. (Section 1.6) [NIR 2011, p.373] |
| | (d) The provision of uncertainty estimates for activities under Article 3, paragraphs 3 and 4, of the Kyoto Protocol; | Not yet addressed. |
| | (e) The inclusion of more detailed information on the minimization of adverse impacts in accordance with Article 3, paragraph 14, of the Kyoto Protocol.<br><br>(**FCCC/ARR/2010/FIN, para 24)** | e) Finland has provided more specific information on the implementation of commitments under Article 3.14 in the NIR. (Section 15) [NIR 2011, p.373] |
| **France** | Review report (In-country review 2010) not yet available. | |
| **Germany** | Review report (In-country review 2010) not yet available | |
| **Greece** | The ERT identifies the following cross-cutting issues for improvement:<br>(a) Further improvement and strengthening of the national system, in particular with respect to the LULUCF sector (see para. 13 above); | Not yet addressed. |
| | (b) Improvement of the key category analysis by using a finer disaggregation of categories and addressing categories with very high uncertainties (see para. 14 above); | The disaggregation of the categories has been performed. See also Annex I of current NIR. [NIR 2011, p. 308] |
| | (c) Improvement of the implementation and coverage of the QA/QC activities (see para. 21 above); | Not yet addressed. |
| | (d) Further improvement of the transparency of the explanations/justifications provided in relation to the QA/QC procedures for the data supplied by external sources and country-specific methodologies, data, EFs and parameters (see para. 23 above); | Not yet addressed. |
| | (e) Ensuring consistency between the amounts of natural gas used as feedstock in industrial processes (ammonia production) and/or for hydrogen production in refineries (reported under petroleum refining) and the amount reported in CRF table 1.A(d) and in the reference approach (see para. 41 below); | Done. [NIR 2011, p. 310] |
| | (f) Providing transparent and comprehensive information on all recalculations (e.g. for the LULUCF sector) (see para. 19 above); | Not yet addressed. |
| | (g) Addressing the recommendations made in previous review reports that have not yet been addressed (see para. 26 above).<br><br>(**FCCC/ARR/2010/GRC, para 29)** | Not yet addressed. |
| **Ireland** | The ERT identified a number of cross-cutting issues for improvement, and recommends that Ireland:<br><br>(a) Provide more precise and transparent descriptions of methodologies for some categories in the energy, industrial processes and waste sectors (see paras. 51, 56, 64, 68, 69 and 103 below); | Para 51: Information is provided in NIR 2011. Fuels are split by domestic and international in the National Energy Balance. [NIR 2011, p.270]<br><br>Para 56, para 69, para 103: Additional information is provided in NIR 2011. [NIR 2011, p.271] |

| Member State | Improvements as recommended by the review team | Improvements in response to UNFCCC review as indicated in the NIR |
|---|---|---|
| | | Para 64: Additional information on AD and EFs for Industrial Processes sector is provided in Annex E of NIR 2011. [NIR 2011, p. 272]<br><br>Para 68: The timing of Ireland's draft ARR 2010 did not allow sufficient time for this recommendation to be implemented in submission 2011. [NIR 2011, p.272] |
| | (b) Improve the transparency of the reporting on the national system by including more detailed information on its archiving system; | Additional information is provided in NIR 2011. [NIR 2011, p. 269] |
| | (c) Improve the transparency of the reporting by including more information on implemented QA/QC activities for all sectors, particularly for the industrial processes and LULUCF sectors; | Sector specific QA\QC for the Industrial Processes sector is now documented in NIR 2011. Additional information on the use of EU ETS data is provided for the Power Generation sector of Energy Industries. [NIR 2011, p.268] |
| | (d) Improve the uncertainty analysis by the use of a higher level of category disaggregation for the LULUCF sector, in accordance with the IPCC good practice guidance for LULUCF; | This will be considered for the 2012 submission. The timing of Ireland's draft ARR 2010 did not allow sufficient time for this recommendation to be implemented in submission 2011. [NIR 2011, p.267] |
| | (e) Improve the completeness of the inventory, in particular by reporting estimates for the remaining emissions reported as "NE" in the LULUCF sector (see para 89 below); | Notation Keys have been revised in CRF Submission 2011. [NIR 2011, p.276] |
| | (f) Reconcile the AD from the national energy balance used to estimate emissions from the energy sector with the EU ETS data (see para 53 below); | The timing of Ireland's draft ARR 2010 did not allow sufficient time for this recommendation to be implemented in submission 2011. The inventory agency has already arranged meetings with Energy Balance provider to address these issues in 2011, for reporting in Submission 2012. [NIR 2011, p.270] |
| | (g) Improve the methodological tier level used to estimate emissions for categories in the LULUCF sector other than forest land, in particular for grassland, in accordance with the recommendations in the IPCC good practice guidance for LULUCF; | Not yet addressed. |
| | (h) Improve the consistency of the information reported for the LULUCF sector under the Convention and on KP-LULUCF activities, and provide more detailed information on forest-related land-use changes that occurred prior to 2006 (see paras 92 and 115 below). (**FCCC/ARR/2010/IRL, para 39)** | Notation Keys have been amended in CRF Submission 2011. Additional information is provided in NIR 2011. [NIR 2011, p.277] |
| **Italy** | The ERT identifies the following cross-cutting issues for improvement:<br><br>(a) The ERT recommends that Italy implement its planned reallocation of emissions using EU ETS data within the petroleum refining subcategory for the entire time series, ensuring times-series consistency, following the IPCC good practice guidance; | The reallocation of emissions using EU ETS data within the petroleum refining subcategory for the entire time series has been implemented [NIR 2011, p.480] |
| | (b) The ERT also recommends that Italy report in its next annual submission the use of reductants in iron and steel production under the industrial processes sector instead of under the energy sector, ensuring that there is no double-counting between the two sectors, and that, in doing so, the Party take account of the quantity of carbon stored in steel<br><br>produced; | The quantity of carbon stored in steel produced has been accounted for in the carbon balance of the iron and steel production ensuring no double counting occurs. The carbon balance methodology does not imply to separate off input between the energy and industrial sectors. [NIR 2011, p.480] |

| Member State | Improvements as recommended by the review team | Improvements in response to UNFCCC review as indicated in the NIR |
|---|---|---|
| | (c) The ERT recommends that Italy include more discussion in the NIR as to why the current approach to estimating PFC emissions from aluminium production is conservative; | The rationale behind the estimation of PFC emissions from aluminium production has been further detailed in the related section. [NIR 2011, p.480] |
| | (d) The ERT also strongly recommends that the Party explain the rationale behind and justify (theoretically and/or factually) its approach of accounting for all soil carbon stock changes as a result of a land-use conversion when the conversion takes place instead of spreading those changes across a number of years (20 years is the default period), as this approach might lead to a loss of soil carbon and thus an overestimation of $CO_2$ removals.<br><br>(**FCCC/ARR/2010/ITA, para 24)** | A detailed and transparent description of the rationale used in the estimation process of soil carbon stock changes is provided in NIR (par. 7.1, par. 7.3.4 for land converting to cropland, par. 7.4.4 for land converting to grassland). [NIR 2011, p.480] |
| **Luxembourg** | The ERT identifies the following cross-cutting issues for improvement:<br><br>(a) The strengthening of the elements of the national system relating to timeliness of reporting; | Not yet addressed. |
| | (b) The improvement of transparency by including annexes to the NIR as recommended in the UNFCCC reporting guidelines, and by discussing time-series consistency in the NIR. (**FCCC/ARR/2010/LUX, para 27)** | Not yet addressed. |
| **Netherlands** | Review report (Centralized review 2010) not yet available. | |
| **Portugal** | The ERT identifies the following cross-cutting issues for improvement:<br><br>(a) Increase the completeness of reporting by including estimates for categories reported as “NE”, giving priority to missing categories for which the Revised 1996 IPCC Guidelines, the IPCC good practice guidance and the IPCC good practice guidance for LULUCF provide estimation methodologies; | The final ERT Review Report from 2010 was made available to the inventory team just recently therefore there could be adicional ERT comments which are yet not included in the list below. Most of the issues raised during the review of 2010 are still under consideration by the inventory team and will be convered in the NIR as soon as possible. [NIR 2011, p.533] |
| | (b) Increase the accuracy of estimates by using higher-tier methods with country specific EFs and parameters for key categories and increase the consistency by replacing the use of surrogate or forecast data with national statistics in the industrial processes sector; | We are now using ETS data and methodology with plant specific values for the Industrial Processes sector. [NIR 2011, p.535] |
| | (c) Enhance the transparency of reporting by improving the description of international bunkers estimates, reporting in the NIR category-specific QC and verification activities for all categories, including the rationale for the choice of AD, parameters and EFs in the agriculture sector, and including the description of methods and assumptions made for estimates in the LULUCF sector; | A separate section in NIR for international bunkers has been included. [NIR 2011, p.534] |
| | (d) Enhance the completeness and transparency of the reporting of KP-LULUCF by completing the calculations for 1990, reporting consistent land area representation figures and calculating carbon stock changes for the unaccounted pools or providing a clear description that these pools are not net sources of GHG emissions. (**FCCC/ARR/2010/PRT, para 32)** | Several improvements have been done in other to tackle most of the recommended issues. [NIR 2011, p.536] |

| Member State | Improvements as recommended by the review team | Improvements in response to UNFCCC review as indicated in the NIR |
|---|---|---|
| **Spain** | Review report (Centralized review 2010) not yet available. | |
| **Sweden** | Review report (Centralized review 2010) not yet available | |
| **United Kingdom** | The ERT identifies the following cross-cutting issues for improvement, namely that the Party should:<br><br>(a) Address outstanding recommendations made in previous review reports and include in the NIR either more details on the actions taken to address these recommendations or clear time frames for undertaking such actions in the future; | Not yet addressed. |
| | (b) Improve the transparency of the NIR by including more information to justify the choice of country-specific EFs and explanations of how time-series consistency has been maintained where data sources have changed or there have been recalculations; | Not yet addressed. |
| | (c) Improve the transparency of the reporting on the OTs and CDs by including information on the methods and data used for estimating their emissions and reporting those emissions under the appropriate categories and subcategories; | Emissions of methane from enteric fermentation in the OTs and CDs are reported under 4A10. [NIR 2011, p.264] |
| | (d) Review its use of the notation keys in the CRF tables; | The UK has included estimates of emissions for a number of sources that were previously reported as NE in the current submission and also reviewed notation keys and amended where appropriate. [NIR 2011, p.272] |
| | (e) Improve the QC of the CRF tables and the NIR prior to their submission. The ERT also encourages the Party to undertake additional tier 2 category-specific QC checks, such as comparisons of its IEFs with the IPCC default EFs and the IEFs of other Parties, where country-specific methods have been used; | Not yet addressed. |
| | (f) Undertake a qualitative analysis to ensure that categories which are particularly significant in level or trend are identified as key categories. (**FCCC/ARR/2010/GBR, para 29)** | Not yet addressed. |

### *10.4.3 Improvements planned at EU level*

The following activities are planned at EU level with a view to improving the EU GHG inventory:

- Further implement the recommendations from the past reviews;
- Continue sector-specific QA/QC activities within the EU internal review;
- Further develop the EU QA/QC activities on the basis of the experience in 2010/2011

# PART 2: SUPPLEMENTARY INFORMATION REQUIRED UNDER ARTICLE 7, PARAGRAPH 1

# 11 KP-LULUCF

This chapter presents:

- The activities elected by European Union Member States (MS) under Art. 3.4 and the accounting frequency,
- An overview of emissions / removals and information reported in the KP LULUCF tables submitted by EU-15 Member States for 2008 and 2009
- A synthesis of the supplementary information required for 3.3 activities and any elected 3.4 activities, as reported by EU-15 Member States in their NIRs,
- Short information on KP LULUCF activities by EU-12 MS, in act the 10 new EU Member States. Malta and Cyprus are not included because do not have commitments under Kyoto Protocol

As shown by Table 11.1, 17 member states of EU-27 have elected forest management (FM), while only 3 have elected cropland management (CM), 2 grazing land management (GM) and 1 revegetation (RV). Only 3 MS have chosen to account annually.

**Table 11.1 Activities elected under Art. 3.4 and accounting frequency. FM: forest management, CM: cropland management, GM: grazing land management, RV: revegetation, CP: commitment period.**

| Member State | | Art 3.4 elected activities | Accounting frequency |
|---|---|---|---|
| EU-15 Member States | Austria | - | end of CP |
| | Belgium | - | end of CP |
| | Denmark | FM, CM, GM | annual |
| | Finland | FM | end of CP |
| | France | FM | annual |
| | Germany | FM | end of CP |
| | Greece | FM | end of CP |
| | Ireland | - | end of CP |
| | Italy | FM | end of CP |
| | Luxemburg | - | end of CP |
| | Netherlands | - | end of CP |
| | Portugal | FM, CM, GM | end of CP |
| | Spain | FM, CM | end of CP |
| | Sweden | FM | end of CP |
| | United Kingdom | FM | end of CP |
| New Member States | Bulgaria | - | end of CP |
| | Czech Republic | FM | end of CP |
| | Estonia | - | end of CP |
| | Hungary | FM | annual |
| | Latvia | FM | end of CP |
| | Lithuania | FM | end of CP |
| | Poland | FM | end of CP |
| | Romania | FM, RV | end of CP |
| | Slovakia | - | end of CP |
| | Slovenia | FM | end of CP |

*It is important to note that the EU will neither issue nor cancel units* based on the emissions and removals reported by EU-15 or EU-27 for KP-LULUCF activities. Therefore, all the emissions / removals and any information on KP LULUCF activities presented here are shown for information purpose *only*.

## 11.1 Overview of emissions / removals and information reported by EU-15 MS in the KP LULUCF tables

### *11.1.1 Coverage of carbon pools and GHG reported (KP CRF NIR 1)*

All EU-15 countries report on all mandatory and elected activities (Table 11.2). In general, biomass carbon stock changes are directly estimated, whereas IE or NR notation keys are often used for the three other pools. Concerning the GHG emissions from sources, the situation is rather country-specific. Compared to previous reporting year the coverage, notation keys and transparency of KP CRF improved. NE is used in more harmonized way by the MS for GHG sources when emissions are considered to be "*negligible*" or in case that there is no IPCC methods available to estimate it, but NE may still include few cases when the estimation is not yet performed (i.e. Greece reported R for some pools under D, but indeed no estimate is provided in the sectorial tables). IE is used according to the data availability and to manage the uncertainty, there is no possible separation on pools.

**Table 11.2** **Synthesis of pools and GHG coverage for KP LULUCF activities for 2009 in EU-15 MS (from tables NIR 1)**

| Activity | Member State | Change in C pool reported | | | | | Greenhouse gas sources reported | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Above-ground biomass | Below-ground biomass | Litter | Dead wood | Soil | Fertilization | Drainage of soils under FM | Disturbance associated to conversion to CL | Liming | Biomass burning | | |
| | | | | | | | N2O | N2O | N2O | CO2 | CO2 | CH4 | N2O |
| Afforestation/ Reforestation | Austria | R | R | IE | NO | R | NO | | | NO | NO | NO | NO |
| | Belgium | R | R | R | NR | R | NO | | | NO | NO | NO | NO |
| | Denmark | R | R | R | R | NR | IE | | | IE | NO | NO | NO |
| | Finland | R | IE | IE | IE | R | IE | | | NA | IE | IE | IE |
| | France | R | R | R | R | R | NO | | | NO | R | R | R |
| | Germany | R | R | R | NO | R | NO | | | R | R | R | R |
| | Greece | R | R | NR | NR | NR | NO | | | NO | R | R | R |
| | Ireland | R | R | R | R | R | IE | | | NO | R | R | R |
| | Italy | R | R | R | R | R | NO | | | NO | IE | R | R |
| | Luxembourg | R | IE | IE | NO | R | NO | | | NO | NO | NO | NO |
| | Netherlands | R | R | NR | NR | NR | NO | | | NO | NE | NE | NE |
| | Portugal | R | R | NE | NE | NE | IE | | | NE | IE | NR | NR |
| | Spain | R | R | NR | NR | NR | NO | | | NO | NO,IE | NO,IE | NO,IE |
| | Sweden | R | R | R | R | R | NO | | | NO | NO | NO | NO |
| | UK | R | IE | R | IE | R | R | | | NO | IE | IE | IE |
| Deforestation | Austria | R | R | IE | IE | R | | | NO | NO | NO | NO | NO |
| | Belgium | R | R | R | R | R | | | NE | NO | NO | NO | NO |
| | Denmark | R | R | R | R | NR | | | R | IE | NO | NO | NO |
| | Finland | R | IE | IE | IE | R | | | R | R | NA | NA | NA |
| | France | R | R | R | R | R | | | R | NO | R | R | R |
| | Germany | R | R | R | R | R | | | R | NO | NO | NO | NO |
| | Greece | R | R | NR | NR | NR | | | NO | NO | R | R | R |
| | Ireland | R | R | R | R | R | | | NO | NO | NO | NO | NO |
| | Italy | R | R | R | R | R | | | NO | NO | NO | NO | NO |
| | Luxembourg | R | IE | IE | | R | | | NO | NO | NO | NO | NO |
| | Netherlands | R | R | R | R | NR | | | NE | R | NE | NE | NE |
| | Portugal | R | R | NE | NE | NE | | | NR | NE | IE | NR | NR |
| | Spain | R | IE | NR | NR | NR | | | NO | NO | NO | NO | NO |
| | Sweden | R | R | R | R | R | | | R | NO | NO | NO | NO |
| | UK | R | IE | IE | IE | R | | | NO | NO | R | R | R |
| Forest Management | Austria | NA | NA | NA | NA | NA | NA | NA | | NA | NA | NA | NA |
| | Belgium | NA | NA | NA | NA | NA | NA | NA | | NA | NA | NA | NA |
| | Denmark | R | R | R | R | R | IE | R | | IE | NO | NO | NO |
| | Finland | R | IE | IE | IE | R | R | NR | | NA | R | R | R |
| | France | R | R | R | R | R | NO | NO | | NO | R | R | R |
| | Germany | R | R | NO | R | R | NO | R | | R | R | R | R |
| | Greece | R | R | NR | NR | NR | NO | NO | | NO | R | R | R |
| | Ireland | NA | NA | NA | NA | NA | NA | NA | | NA | NA | NA | NA |
| | Italy | R | R | R | R | R | NO | NO | | NO | IE | R | R |
| | Luxembourg | NA | NA | NA | NA | NA | NA | NA | | NA | NA | NA | NA |
| | Netherlands | NA | NA | NA | NA | NA | NA | NA | | NA | NA | NA | NA |
| | Portugal | R | R | NR | NR | NR | IE | NO | | NE | IE | NR | NR |
| | Spain | R | IE | NR | NR | NR | NO | NO | | NO | IE,NR | R,NR | R,NR |
| | Sweden | R | R | R | R | R | R | NE | | NO | R | R | R |
| | UK | R | IE | R | IE | R | NO | NE | | NO | R | R | R |
| Cropland management | Denmark | R | IE | NO | NO | R | | | R | R | NO | NO | NO |
| | Portugal | NR | NR | NR | NR | R | | | NR | NE | IE | NR | NR |
| | Spain | R | IE | NR | NR | R,NO | | | NO | NO | NO,IE | NO,IE | NO,IE |
| Grazingland management | Denmark | R | IE | NO | NO | R | | | | IE | NO | NO | NO |
| | Portugal | NR | NR | NR | NR | R | | | | NE | IE | NR | NR |

*Notation keys: R – C stock change or emissions from source is reported; NR – the pool is not reported, using the "not a source" principle; NE – removal/emission is not estimated; IE – included elsewere; NO –not occuring; NA – MS does not account the activity.*

### 11.1.2 Areas and changes in areas between KP LULUCF activities (KP CRF NIR 2)

MS report land areas for all mandatory and elected activities (Table 11.3). At the EU-15 level, total area of AR (5842 kha) is much larger than D (1765 kha), i.e. total forest land area is increasing. In the year 2009, at the EU-15 level, 230 kha were afforested/reforested, 109 kha were deforested and 110 339 kha were reported under forest management.

The areas of AR and D area vary considerably also among countries with rather similar situations. To some extent, this is explainable by different definitions used by countries for forestland and land conversions. Despite this diversity somehow hampers a harmonized assessment of land use changes in Europe, the essential thing is that MS follow the IPCC GPG-LULUCF.

**Table 11.3 Synthesis of total area (kha) of KP-LULUCF activities as reported by EU-15 MS at the end of the 2009 (from tables NIR 2). Grey cells indicate that the activity has not been elected.**

| | Art. 3.3 activities | | Article 3.4 activities | | | |
|---|---|---|---|---|---|---|
| | AR | D | FM | CM | GM | RV |
| **Member State** | | | | | | |
| Austria | 220 | 103 | | | | |
| Belgium | 20 | 19 | | | | |
| Denmark | 43 | 7 | 533 | 2860 | 162 | |
| Finland | 161 | 276 | 21823 | | | |
| France | 1101 | 687 | 21669 | | | |
| Germany | 357 | 140 | 10866 | | | |
| Greece | 33 | 3 | 1183 | | | |
| Ireland | 271 | 8 | | | | |
| Italy | 1544 | 14 | 7451 | | | |
| Luxembourg | 9 | 7 | | | | |
| Netherlands | 51 | 40 | | | | |
| Portugal | 359 | 154 | 3766 | 1865 | 1892 | |
| Spain* | 1092 | 11 | 12577 | 20494 | | |
| Sweden | 292 | 272 | 29096 | | | |
| UK | 289 | 21 | 1375 | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| **EU-15** | **5842** | **1762** | **110339** | **25219** | **2054** | |
| EU-12 (see Table 11.20) | 1609 | 142 | 26265 | | | 9 |
| EU-27 | 7451 | 1904 | 136604 | 25219 | 2054 | 9 |

*AR: forestation/Reforestation, D: deforestation, FM: forest management, CM: cropland management, GM: grazing land management, RV: revegetation.*

Most of AR area is reported in Italy, Spain and France (together account for some 65% of total area reported in EU-15). Most of D area is reported by France, Finland, Sweden. Only in Finland deforested area is larger than afforested area. Also, Finland reports emissions from afforestation/reforestation because of emissions from soils, both on mineral and organic soils, in 2008 and 2009.

At EU-15 level, D area for 2009 is 40 % less as compared to 2010 submission (reported for 2008), mainly caused by recalculations of Portugal and France. Significant recalculations in AR area occurred in Portugal, France, Italy and Germany, with the EU-15 AR area reported for the inventory year 2009 decreasing by 15 % compared to that submitted previously for 2008. Both EU-15 GM and CM areas are mainly due to Portugal (caused by new land use matrix available with 2009).

### 11.1.3 Key categories for KP LULUCF activities (KP CRF NIR 3)

Majority of EU-15 MS performed and transparently report on the key category for KP activities (Table 11.4). In most cases, AR and FM are key categories, whereas D is key category in only 6 MS. CM results key categories in all MS which elected it. Some MS did not perform key category analysis for 2008 and 2009 which make difficult a proper assessment if they are approaching the correct tier methods to estimate the GHG associated with KP activities.

**Table 11.4 Synthesis of KP-LULUCF activities being key category as reported by EU-15 Member States (from tables NIR 3). "K" indicates a key category. Grey cells indicate that the activity has not been elected.**

| **MS** | **AR** | **D** | **FM** | **CM** | **GM** | **RV** | **Comments** (qualitative/ quantitative criteria used) |
|---|---|---|---|---|---|---|---|
| Austria | K | K | | | | | Corresponding LU categories are key under Convention inventory |
| Belgium | | | | | | | KC analysis is not available in the NIR 3 |
| Denmark | | | | | | | KC analysis is not available in the NIR 3 |
| Finland | K | K | K | | | | Corresponding LU categories are key under Convention inventory |
| France | | | | | | | KC analysis is not available in the NIR 3 |
| Germany | | K | K | | | | For D and FM, corresponding LU categories are key under Convention inventory, despite AR expected further increase it is no key category |
| Greece | K | | K | | | | Level assessment & trend assessment for FM, trend assessment for AR |
| Ireland | K | | | | | | Level assessment |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Italy | | | K | | | | Corresponding LU categories are key under Convention inventory |
| Luxembourg | | | | | | | KC analysis is not available in the NIR 3 |
| Netherlands | | | | | | | KC analysis is not available in the NIR 3 |
| Portugal | K | K | K | K | | | FM is key category also for $CH_4$ |
| Spain | K | | K | K | | | Corresponding LU categories are key under Convention inventory |
| Sweden | K | K | K | | | | Corresponding LU categories are key under Convention inventory, qualita-tive apprpch for AR and D |
| UK | K | K | K | | | | Corresponding LU categories are key under Convention inventory and qua-litative criteria |

### *11.1.4 Summary of emissions/removals and accounting quantities for KP LULUCF activities by EU-15 MS (KP CRF “Accounting” table)*

From Table 11.5results that, at the EU-15 level, in 2009 annual removals by AR exceeded by 40% emissions from D. By far, the largest contributor is France, responsible of 40 % of total emissions from deforestation in EU-15. Further on, Sweden and Finland are each responsible of some 15%.

The highest removals for AR are reported by France, Spain and Italy, all three achieving more than half (52%) of 2009 sink on EU-15 afforestation/reforestation units of land.

The FM largest sinks are reported by Italy, Finland and France. Few countries (i.e. Sweden, Finland and France) offset debits under Art 3.3 with removals from forest management, under high emissions from deforestation and low removal by afforestation.

Table 11.5 results that, at the EU-15 level, in 2009 annual removals by AR exceeded by 40% emissions from D. By far, the largest contributor is France, responsible of 40 % of total emissions from deforestation in EU-15. Further on, Sweden and Finland are each responsible of some 15%.

The highest removals for AR are reported by France, Spain and Italy, all three achieving more than half (52%) of 2009 sink on EU-15 afforestation/reforestation units of land.

The FM largest sinks are reported by Italy, Finland and France. Few countries (i.e. Sweden, Finland and France) offset debits under Art 3.3 with removals from forest management, under high emissions from deforestation and low removal by afforestation.

**Table 11.5 Emissions / removals and accounting quantities in 2009 for KP-LULUCF activities as reported by EU-15 Member States**

| MS | Net emissions (+) and removals (-), Gg $CO_2$eq | | | | | | | | | | | | | | | | Accounting quantity on KP activities (2008+2009) (from “accounting” sheet of KP LULUCF table) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A. Art 3.3 activities | | | | B. Art. 3.4 activities | | | | | | | | | | | 3.3 off-set (2008+ 2009) | | | | | | |
| | A.1 AR | | A.2. D | | B.1 FM | | B.2 CM | | | B.3 GM | | | B.4 RV | | | | AR | D | FM | CM | GM | Rv |
| | 2008 | 2009 | 2008 | 2009 | 2008 | 2009 | 1990 | 2008 | 2009 | 1990 | 2008 | 2009 | 1990 | 2008 | 2009 | | | | | | | |
| Austria | -2531 | -2648 | 1224 | 1264 | | | | | | | | | | | | | -5179 | 2488 | | | | |
| Belgium | -219 | -223 | 168 | 168 | | | | | | | | | | | | | -441 | 336 | | | | |
| Denmark | -45 | -145 | 32 | 33 | -4829 | -2591 | 2566 | 2299 | 1183 | 314 | 185 | 186 | | | | | -190 | 66 | -916 | -2447 | -257 | |
| Finland | 200 | 202 | 3515 | 3564 | -38017 | -50310 | | | | | | | | | | 7592 | 402 | 7190 | -10525 | | | |
| France | -6713 | -6898 | 11509 | 9905 | -79041 | -73294 | | | | | | | | | | 8223 | -13611 | 21835 | -16133 | | | |
| Germany | -4476 | -4779 | 1076 | 1062 | -20657 | -20642 | | | | | | | | | | | -9256 | 2145 | -22733 | | | |
| Greece | -351 | -351 | 4 | 0 | -2052 | -1955 | | | | | | | | | | | -701 | 4 | -1650 | | | |
| Ireland | -2709 | -2863 | 26 | 34 | | | | | | | | | | | | | -5564 | 59 | | | | |
| Italy | -6346 | -6731 | 388 | 390 | -51162 | -48494 | | | | | | | | | | | -13039 | 778 | -50967 | | | |
| Luxembourg | -77 | -78 | 141 | 141 | | | | | | | | | | | | | -155 | 282 | | | | |

| | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Netherlands | -485 | -537 | 820 | 832 | | | | | | | | | | | | | -1022 | 1655 | | | | |
| Portugal | -3173 | -3296 | 1361 | 1396 | -8378 | -9463 | 145 | -136 | -259 | -618 | -953 | -964 | | | | | -6387 | 2831 | -4033 | -698 | -681 | |
| Spain | -6397 | -6545 | 106 | 107 | -18608 | -18629 | -712 | -3559 | -3000 | | | | | | | | -12909 | 213 | -12283 | -5135 | | |
| Sweden | -1270 | -981 | 4039 | 3516 | -37887 | -44603 | | | | | | | | | | 5310 | -2250 | 7561 | -15944 | | | |
| UK | -2695 | -2823 | 635 | 431 | -10888 | -9912 | | | | | | | | | | | -5518 | 1284 | -6783 | | | |
| **EU-15** | **-37287** | **-38696** | **25044** | **22843** | **-271519** | **-279893** | **1999** | **-1396** | **-2076** | **-304** | **-768** | **-778** | | | | **21125** | **-75820** | **48727** | **-141967** | **-8280** | **-938** | |
| **EU 12** | -11260 | -12154 | 2859 | 3057 | -126550 | -125470 | | | | | | | -5 | -48 | -48 | 1730 | -23261 | 6103 | -63672 | | | -86 |
| **EU-27** | -48548 | -50850 | 27903 | 25900 | -398069 | -405363 | 1999 | -1396 | -2076 | -304 | -768 | -778 | -5 | -48 | -48 | 22855 | -99081 | 54830 | -205639 | -8280 | -938 | -86 |

*1 FR did not include removals from AR for accounting purposes*

*2 The sum of MS' emissions/removals is shown for information purpose only. The EU-15 will neither issue nor cancel accounting units.*

## 11.2 Synthesis of supplementary information on KP LULUCF activities reported by EU-15 MS in their NIRs

This chapter attempts to synthesize relevant supplementary mandatory information requested for KP LULUCF activities by Annex of Decision 16.CMP.1, as reported by MS in their NIRs. Although most MS followed the structure suggested by the annotated NIR, the approach used to include the supplementary information sometimes differed among countries, which made it difficult to include everything in an exhaustive and synthetic way. For more detailed information, it is suggested to refer to the individual MS' NIRs.

### *11.2.1 General information*

#### 11.2.1.1 Definition of forest land and other lands and any other criteria

The parameters used to define "forest" under the Kyoto Protocol by EU-15 MS are summarized in Table 11.6. In most cases, parameters and definitions used for reporting FM under the Kyoto Protocol are identical to those used to report forest land under the Convention.

**Table 11.6 Parameters used to define "forest" under the Kyoto Protocol**

| Member State | Minimum crown cover (%) | Minimum height (m) | Minimum area (ha) | Minimum width (m) |
|---|---|---|---|---|
| Austria | 30 | 2 | 0.05 | 10 |
| Belgium | 20 | 5 | 0.5 | - |
| Denmark | 10 | 5 | 0.5 | 20 |
| Finland | 10 | 5 | 0.5 | 20 |
| France[36] | 10 | 5 | 0.5 | 20 |
| Germany | 10 | 5 | 0.1 | - |
| Greece | 25 | 2 | 0.3 | - |
| Ireland | 20 | 5 | 0.1 | 20 |
| Italy | 10 | 5 | 0.5 | - |
| Luxemburg | 10 | 5 | 0.5 | - |
| Netherlands | 20 | 5 | 0.5 | 30 |

[36] France definition applies for the forest under the European "metropolitan" territory and the French "territoires d'Outre-mer" which are also part of EU (Martinique, French Guyana, Reunion, and Guadeloupe). In Guyana forêt cover 8000 kha out of which 1500 kha are under management (19%), subject to Kyoto Protocol

| | | | | |
|---|---|---|---|---|
| Portugal[37] | 10 | 5 | 0.1 | 20 |
| Spain | 20 | 3 | 1.0 | 25 |
| Sweden | 10 | 5 | 0.5 | 10 |
| United Kingdom[38] | 20 | 2 | 0.1 | 20 |

Countries where definitions under the KP and the Convention differ, include, Finland, the Netherlands and Sweden. Finland reports minimal area of 0.5 ha under KP, whereas different minimal areas are used under the Convention (minimal forest area in Southern is 0.25 and 0.5 ha in Northern Finalnd)[39]. The Netherlands reports that forests reported under the Convention have a smaller width than those reported under the KP. Sweden also reports under different definition. In Sweden, the different methods to cumulate the areas under conversion in 5B2,5C2,5D2,etc and deforestation generate a very large difference (i.e. only some 50 % of conversion is reported under KP as deforestation).

A difficulty in comparing various reports under national or international processes is given by the use of different forest definitions under UNFCCC/KP vs. other international reporting (e.g. Portugal reports minimum forest areas of 1 ha for KP, while it is 0.5 ha for FAO, providing justification that the KP requirements could be met only with 1 ha resolution).

#### 11.2.1.2 Elected activities under Article 3, paragraph 4, of the Kyoto Protocol

The 3.4 activities elected by EU-15 Member States were already included in the initial reports (IRR) and are provided again in the 2011 NIRs (see Table 11.1).

##### 11.2.1.2.1 Description of how the definitions of each activity under Art. 3.3 and each elected activity under Art. 3.4 have been implemented and applied consistently over time

In most cases, definitions of KP activities have been applied with a broad interpretation. For instance, many countries considered as "directly human induced AR" any expansion in forest area since 1990 (see following chapters for more details), although some country (e.g. France) revised downward the AR estimate for areas with improving availability of data. For FM, most countries considered all forest area as subject to "forest management" activity; with few exceptions (e.g. France reports that in Guyana only 1,500 kha of forests are managed (out of total 8000 kha); Greece reports under FM only one third of its forestland areas).

In order to meet the KP reporting requirements related to consistent land representation, identification and tracking several Member States improved the land representation system used for reporting to UNFCCC. In general, consistency in time is ensured by statistical methods, reclassification of base year land data and aggregation methods. GHG estimating methods were developed and implemented as to ensure time consistency with and within GHG inventory under UNFCCC reporting.

[37] Portugal definition applies also for Autonomous Regions of Açores and Madeira

[38] Kyoto commitment extends coverage to the UK's Crown Dependencies (Guernsey, Jersey and the Isle of Man) and Overseas Territories that have ratified the Kyoto Protocol (the Cayman Islands, the Falkland Islands, Bermuda, Monserrat and Gibraltar)

[39] The proportion of National Forest Inventory sample plots located in forest areas under 0.5 ha is 0.1% (according Finland NIR 2011)

Usually in the EU-15 the data necessary for the KP activities estimations is provided by repeated cycles of the National Forest Inventories (NFIs), with additional involvement of maps, aerial photos or other databases especially for the base year (e.g. Corine Land Cover). In some MS, the NFI covers the entire country, so it is able to determine the time series of land use activities since 1990 under constant land use and activity definitions (e.g. Austria, Finland). Other Member States have put in place procedures to follow any change involving forests (e.g. procedures based on processing of aerial photographs or satellite images: Belgium, France). Some countries currently report that they did not complete yet the statistics on AR and D (e.g. UK) and small changes could occur for future submissions.

In order to check the consistency, MS have also performed comparison and internal verification of the activity data area among various national datasets, if such datasets are available (i.e. Finland compared AR and D data generated from NFI with forest authority statistics).

#### 11.2.1.3 Description of precedence conditions and/or hierarchy among Art. 3.4 activities, and how they have been consistently applied in determining how land was classified

Areas with potential conflict or overlapping between activities could occur within the main generic land use (i.e. broad definitions for forest management, afforestation and deforestation) or among different land uses (e.g. agroforestry systems in Southern Europe). MS performs specific QA/QC analysis of data used for reporting on KP (i.e. DK) as to avoid any double counting or missing areas. For forest related activities, MS implement methods that make possible to avoid double counting of land (ranging from field repeated assessment to field verification of the automatic procedures). For forest land related activities, the hierarchy applied by all MS is D-AR-FM.

Table 11.7 shows the land hierarchy applied among the land categories by those MS which elected multiple activities under Art. 3.4 of the Kyoto Protocol.

**Table 11.7 Precedence condition in those MS which elected multiple activities under art 3.4.**

| MS | Hierarchy applied | Comments |
|---|---|---|
| Denmark | FM-CM-GM | No land elected under Art. 3.4 activities has been converted to Other Land, changes since inventory year 2008 are related to changes among 3.4 lands, afforestation and methodological adjustments. |
| Portugal | CM-GM-FM | Extensive areas of agro-forestry systems would be classified either as Cropland or Grassland, according to the prevalent practice. However, in this submission, the agro-forestry systems are classified as Forest land, therefore, included in activities such as ARD or FM. Changes are likely according methodological developments. |
| Spain | FM-CM-FM | Additionally there is defined a secondary hierarchy within the CM lands, as follows: i) transitions from herbaceous crops (including fallow lands) to woody crops, ii) practice of soil management in woody crops and iii) transitions between woody crops. |

Once the land started to be accounted can not leave the accounting, so they have to be continually accounted over the commitment period (i.e. DK reports transitions to wetlands and settlements). Spain does not apply this requirement properly and seems that between 2008 and 2009 a small share of the CM area is not reported anymore.

## 11.2.2 Land-related information (EU-15)

### 11.2.2.1 Spatial assessment unit used for the area of the units of land under Art. 3.3

The majority of the EU-15 Member States reported a single geographical boundary at country level due to the fact that the systems underpinning estimations of national GHG inventory (data collecting systems, databases, QA/QC and verification procedures) have been designed at the entire country scale. Consequently, any further breakdown of the country area into several reporting regions would risk generating larger uncertainty for sub-national scale estimates. Nevertheless, several large countries report two (e.g. Finland) or more geographical boundaries (e.g. France, Greece, Italy, Spain and UK, all of them on administrative regions).

Units of land area used for the assessment of the Art 3.3 activities are the same as minimal area or width defining forest for each MS. Methodologies developed to estimate land use conversions under GHG inventory are in line with the minimum defined area or sometimes the resolution is even better than that reported in the initial report (e.g. Germany, Netherland, Sweden).

### 11.2.2.2 Methodology used to develop the land transition matrix

"Units of land" under Art 3.3 or "lands" under Art 3.4 of the Kyoto Protocol represent subsets of the land categories reported under the LULUCF sector of the national GHG inventory. So, the activity data has to be fully consistent between GHG inventory and Kyoto supplementary reporting (i.e. or match all land categories which are under anthropogenic intervention), which is ensured by the land transition matrix. With 2011 submission this "land balance principle" appears satisfied in all EU-15 MS. The land transition matrix allows, among others, to check the consistency of land area reporting over time (i.e. to be complete and consistent, the sum of total reported area should match the official statistics of total national area (within the confidence limits) and be constant over time). In order to ensure full time consistency, additional procedures were implemented for previous NFIs datasets to become compatible with latest NFI (i.e. field assessments to fully identify ARD areas in Austria).

Land transition matrices have been developed based on available databases and methodologies, covering all land use categories while define lands relevant for KP activities. Methodologies are based either on the extrapolation/interpolation of two/several points in time with uniform yearly distribution or on precise annual data provided by specific land surveys (subsidies schemes, land registries), and often combines several sources of data (Table 11.8). The matrix developed by each MS implements country specific criteria and rules for land allocation (i.e. land hierarchy), and focus on high accuracy of land estimates for activities for which country has to report. On the other hand, the recalculations occurred in 2011 (especially on D area) indicate that some improvements already occurred.

**Table 11.8 Methods used to develop the land transition matrix by MS.**

| MS | Method used for developing the land transition matrix |
|---|---|
| **Austria** | NFI based on successive assessment in permanent plots grid. Land-use change areas from/to forests for the NFI plots between successive cycles are extrapolated statistically to the entire country level. |
| **Belgium** | Geoprocessing of the country level grid of points on interpretations of aerial photographs for 1990 and 2008. |
| **Denmark** | Annual data derived based on Earth Observation images processing (in 1990 and 2005) combined with several other type of information in intermediary years (1992-2005) and extrapolated after 2006. |
| **Finland** | The matrix is developed by adding and subtracting the conversion areas to/from land-use categories area. Annual forest area and conversion area (AR & D) are interpolated from successive NFI. |
| **France** | Method for surveying land use/cover and estimate the conversions on a national scale grid. |

| | |
|---|---|
| **Germany** | For former Western Lands the land use is derived based on successive NFIs with an annual fixed rate interpolation between 1987 and 2002, further extrapolated till 2007. In former Eastern Lands the soil and land use map of East Germany in 1990 and 2005 is used, with annual data interpolated and then extrapolated till 2007. Since 2008 a unified annual topographic-cartographic wall-to-wall approach is implemented. |
| **Greece** | Annual land registry data on relevant land use and activities. |
| **Ireland** | Spatially annual explicit GIS databases are derived from agro-environmental funding scheme and CORINE land cover data. |
| **Italy** | Successive NFIs for afforestation/reforestation. Land registries provide annual deforestation data. |
| **Luxembourg** | Geoprocessing of successive land use / land cover map in digital format for 1898, 1999, 2007. |
| **Netherlands** | Complete wall-to-wall land use mapping for 1990 and 2004, with intermediary years interpolated and extrapolated after. ARD activities are recorded on a pixel basis. |
| **Portugal** | Successive NFIs, land use cartography (CLC90, 06), fire maps, and georeferenced database on agro-environmental scheme allow derivation of annual data |
| **Spain** | Data on afforestation/reforestation and cropland management is given by sectoral statistics (agro-environmental scheme). Data on forest management and deforestation is derived from CORINE LAND COVER and Mapa Forestal Españo. Deforestation is interpolated as equal annual rate. |
| **Sweden** | NFI data is used. Annual AR data is assumed to occur at a random year between NFI cycles before 2006, since 2006 with annual record of conversions and activities |
| **United Kingdom** | Calendaristic adjusted annual data planting statistics available. Data on deforestation is provided by Unconditional Felling Licenses and the Land Use Change Statistics surveys. FM area is given by statistics |

In case of activities involving land conversions, it is very often the precise year of event is not known, so the mean annual rate of these activities are derived from data in available years or as random distribution between known years (see Sweden for the afforestation rate before 2006).

#### 11.2.2.3 Maps and/or database to identify the geographical locations, and the system of identification codes for the geographical locations

Member States developed various methods and approaches to identify “lands” under Art3.3 and “units of land” under art 3.3 of the Kyoto Protocol, according to availability of data and resources (Table 11.9). In many cases the existing data characteristics were considered sufficient as to meet the land identification and tracking requirements.

**Table 11.9** **Geographical locations requirement coverage by systems adopted by the EU-15 MS of the land or units of land**

| MS | Methods | | | Land identification and tracking features for the “lands” or “units of lands” |
|---|---|---|---|---|
| | NFI | Mapping (including EO – Earth Observations methods) | Land registry systems | |
| Austria | X | | | Statistical methods, random distribution of units of land. |
| Belgium | X | X | | Georefereneced points strengthen by aerial photographs interpretations. |
| Denmark | X | X | | Classification based on land cover EO generated maps. |
| Finland | X | | | Statistical methods, GPS coordinate of the NFI plots, random distribution of units of land. |
| France | | X | | Statistical methods, random distribution of units of land or lands. |
| Germany | | X | | Precise geographical locations and its shapes in wall-to-wall mapping approach. |
| Greece | | | X | National land registry. |
| Ireland | | X | | Sectoral ARD land registry, GPS database. Data pass rigorous verification. |
| Italy | X | | X | NFI plots coordinates (AR), thus random distribution of units of land. Land statistics for D for each region. |
| Luxembourg | | | | Geoprocessing based on successive land use maps. |
| Netherlands | | X | | ARD activities are recorded on a pixel basis. |
| Portugal | X | X | | NFI codes and intersection overlayed on Land use map. |
| Spain | | X | X | AR data is based on land registry system. D is based on CLC maps. |
| Sweden | X | | | NFI data, random distribution of units of land. |
| United Kingdom | | | X | Statistics by forest authorities. |

Most of the national estimating systems rely on NFI to identify and track units of lands under AR and D and land under FM, very often strengthen with additional filed or remote sensing support.

In case of availability of non annual data, the assessments were set as to overlap the commitment period. Mapping based on Earth Observation (e.g. Corine Land Cover) and other map types (e.g. soils distribution) are used as such or in combination with NFI. MS report in their NIR that developments and thorough checks (e.g. with aerial photos) and harmonization of various databases and sources were performed on the maps as to meet the requirements of land identification (e.g. NL).

National systems sometimes rely on land parcel identification systems (e.g. as used for subsidy payments) which allow each individual parcel recorded and traceable over time since the onset of the subsidized activity (often digitized and available in GIS, like in Ireland). Such systems are supported by adequate verification and validation/audit procedure at the country level as they are under public funding (e.g. Spain, Greece). In this respect, for example Ireland states that “afforestation areas recorded by the Forest Service are verified using a strict control and referrals process, following a post establishment site visit by a forestry inspector”.

**Table 11.10** **Key information on methods to identify the geographical locations under KP activities and the data used**

| MS | Reporting Method used for identifying the geographical locations | Approach used for land representation |
|---|---|---|
| **Austria** | 1 | 2/3 |
| **Belgium** | 1 | 3 |
| **Denmark** | 1 | 3 |
| **Finland** | 1 | 3 |
| **France** | 1 | 3 |
| **Germany** | 1 | 2 (3 starting with 2008) |
| **Greece** | 1 | 2 |
| **Ireland** | 2 for AR and 1 for D | 3 |
| **Italy** | 1 | 3 for AR and 2 for D |
| **Luxembourg** | 1 | 3 |
| **Netherlands** | 2 | 3 |
| **Portugal** | 1 | 3 |
| **Spain** | 1 | 2 |
| **Sweden** | 1 | 3 |
| **UK** | 1 | 2 |

There is not much information on the EU-15's MS NIR on the system of identification coding for the geographical locations. MS that relays on land registries or sectoral statistics have to be more transparent on that in their NIRs.

## *11.2.3 Activity-specific information*

### 11.2.3.1 Methods for carbon stock changes and GHG emission and removal estimates

Methods used for the estimation of emissions/removals related to the Art 3.3 and 3.4 activities are consistent with those used for reporting on the corresponding land use subcategories under the Convention, as described under Chapter 7 of this NIR. In same chapter, these methods are more in detailed described, for each of the relevant land use subcategory (5A2, 5B2, 5C2, …). The check if an appropriate Tier is used by a national estimating system MS (i.e. higher tiers for key categories) is part of the country own and EU QA/QC process.

**Description of the methodologies and the underlying assumptions used**

The main source of data for estimates in ARD and FM is the NFI of each MS (

Table 11.11). In few cases annual removals are modeled based on non-NFI data. SOC emissions associated with any conversion to/from forestland are estimated by modeling or by country specific reference C stock in soils on different land uses. All methodologies consider ground vegetation in steady state and thus it is not estimated. The most problematic pools are LT and DW, followed by soils, for which reporting the effort is still undergoing (in many cases by ongoing filed work, either sampling or processing).

**Table 11.11** **SOC relevant information methodologies and data sources used by EU-15 MS. Pools are: DW-DW, LT-LT, SOC-soil organic carbon.**

| MS | Methods | Comments |
|---|---|---|
| **Austria** | Annual biomass net increment (for AR) and standing biomass (for D) are considered constant in time derived from NFI data (with CS's BEF). DW change is considered as NO. SOC is computed based on *reference C stocks* on land use type with 20 years transition period (includes LT). | Biomass associated with previous LU is not considered, updated data expected with latest NFI. No harvest occurs on AR areas. |
| **Belgium** | NFI based data. For AR annual net change in C stocks in living biomass is a weighted average of the various coniferous and deciduous species. For D the C stock in living biomass is the country average living biomass C stock for deciduous and coniferous trees. SOC is computed based on reference C stocks on regions and land use type with 20 yrs transition period. | No detailed data is available on the species planted on the lands under conversion to forest land. No data on harvest of AR areas. |
| **Denmark** | Composition in tree species of AR and FM is available form Forest Census (1990-2000) and from NFI for 2000 on. Carbon stock change caused by D is given by the mean values of carbon stock in the total forest. | C stock change methods is used starting from individual tree biomass on NFI plots, expanded to strata area. |
| **Finland** | In AR from Cropland the mean annual increment is estimated as current stock per area unit divided by the number of years since the conversion, from NFI. For AR on Grassland and Wetlands current biomass and annual increment generated from tree rings. For D a mean tree biomass stock on the destination of deforested land (e.g. cropland or grassland) and type of soil (organic or mineral). DW, LT and SOC are modeled. | Current C stock is evenly distributed in time with the age for ARD. In AR initial tree biomass is assumed to be zero. Deforested areas drain (biomass loss) is separated by harvest. |
| **France** | NFI based data. For AR the LT is computed based as linear interpolation till a country reference of 9tC/ha in mature forests on 20 years transition. SOC is also computed based on C stock reference on 20 years. DW is considered as NO in AR, but it is assumed emitted in 1 year in D. | Forest under 20 years old are not subject of harvesting. |
| **Germany** | Annual C stocks are generated based on two successive NFI plots, calculated for each LULUCF class (origin of land for AR or destination for D). | In D all pools are considered emission in the event year. Average C stock in LT is considered. Successive NFIs are performed only for Old Lander, but AR data was expanded to all country. The C stocks of previous land use classes were estimated and deducted. |
| **Greece** | C stock change method based on data from forest management plans of managed forests. | DW, LT and SOC not assessed yet. |
| **Ireland** | Gain-loss model based on national forest research results and single tree growth models in successive NFIs. | All pools are estimated. |
| **Italy** | Model is applied at administrative regions level. | |
| **Luxembourg** | Calculated based on yield-tables, assuming an average biomass for younger stands. | |
| **Netherlands** | NFI plot level biomass C stock is derived for AR activities. | DW, LT are not estimated. SOC is a small sink. Emissions from D are reported in the year of event. |
| **Portugal** | C stock change simulators with yield tables on NFI data. LT is country specific. SOC uses country specific data. | For computation it is assumed an average site index and with a normal standing stock. |
| **Spain** | Mapped potential increment of biomass is used for estimation of AR. SOC change is determined based on reference C stocks in land uses. | SOC and DOM are computed based on Tier 1. |

| | | |
|---|---|---|
| **Sweden** | Modeled from repeated NFI cycles. | |
| **United Kingdom** | A model is used to estimate the net change in C stocks in all pools and type of forests. | |

The range of values of the Implied Emission Factor (IEF of C stock change factor) reported for Afforestation/Reforestation (Table 11.12) are same to those reported used for estimation of GHG inventory estimates. Among MS, there are notable differences between IEF on net biomass increment reported by the MS, caused by the type of species and climatic conditions and other characteristics (i.e. non-uniform annual rate, different species). One additional reason for large differences is the use of either time averaged or actual data, depending on the methodological approach of the MS. DW and LT are mainly reported as "no source" with justification provided in the NIR (see Chapter 7 and Table 11.15 below).

**Table 11.12 IEF for net C stock changes (Mg C/ha) by pool on lands under AR activity in EU-15 (in the year 2008)**

| Member State | Above ground Biomass | Below ground Biomass | Litter | Dead wood | Min Soils | Org Soils |
|---|---|---|---|---|---|---|
| Austria | 1.0 | 0.2 | 0.8 | NO | 1.4 | NO |
| Belgium | 1.9 | 0.4 | 0.0 | NO | 0.8 | NO |
| Denmark | 0.5 | 0.1 | 0.1 | 0.4 | -0.2 | -0.3 |
| Finland | 0.4 | IE | IE | NO | -0.1 | -2.0 |
| France | 0.9 | 0.4 | 0.3 | 0.0 | 0.1 | NO |
| Germany | 2.6 | 0.5 | 0.5 | NO | 0.1 | -0.7 |
| Greece | 2.0 | 0.9 | 0.0 | 0.0 | 0.0 | NO |
| Ireland | 1.3 | 0.6 | 1.2 | 0.1 | NA,NO | -0.4 |
| Italy | 0.8 | 0.2 | 0.0 | 0.0 | 0.2 | NO |
| Luxembourg | 1.5 | IE | IE | NO | 0.9 | NO |
| Netherlands | 2.2 | 1.0 | NE | NE | 0.2 | -6.5 |
| Portugal | 1.4 | 0.2 | 0.1 | IE | 0.9 | NO |
| Spain | 1.5 | IE | NE | NE | 0.1 | NO |
| Sweden | 0.6 | 0.2 | 0.3 | 0.0 | -0.1 | -0.6 |
| United Kingdom | 2.4 | IE | 0.1 | IE | 0.1 | 0.4 |

*Notation keys: IE – data is reported elsewhere i.e. included in other pools. NO – not occurring. NA- not applicable, NE-not estimated (the countries using NE still justify these pools as"no source" or negligible).*

IEF values reported for deforestation (

Table 11.13) are generally consistent with those reported under relevant CRF tables in the GHG inventory. Greece reports that no emissions from deforestation occurred in 2009, in contrast to small amount (4 Gt$CO_2$eq) reported for the inventory year 2008. The high IEF reported by Spain is caused by the fact that it erroneously used the area deforested in 2009 in table 5(KP-I)A.2, instead of the total area deforested since 1990 (without necessary the emission/removal estimate to be wrong). It should be noted that the IEF of deforestation since 1990 is of limited value. To make the IEF of D more meaningful, MS were encouraged to report, when possible, the same disaggregation used for activity data in NIR 2 also for the net emissions reported in table 5(KP-I)A.2 (i.e. disaggregating emissions from D events occurred in 1990-2008 and occurred in 2009). In this submission, however, only very few MS were able to implement this suggestion.

**Table 11.13 IEF for net C stock changes (Mg C/ha) in the pools under Deforestation activity in EU-15 (in the year 2008)**

| Member State | Above ground Biomass | Below ground Biomass | Litter | Dead wood | Min Soils | Org Soils |
|---|---|---|---|---|---|---|
| Austria | -0.7 | -0.2 | -0.7 | IE | -1.7 | NO |
| Belgium | -2.0 | -0.4 | 0.0 | 0.0 | -0.1 | NO |
| Denmark | -0.9 | -0.2 | -0.2 | 0.0 | 0.1 | -2.5 |
| Finland | -2.6 | IE,NE,NO | IE,NE,NO | 0.0 | -0.1 | -3.3 |
| France | -2.3 | -0.5 | -0.2 | -0.1 | -0.9 | NO |
| Germany | -0.8 | -0.1 | -1.0 | -0.2 | 0.0 | -0.1 |
| Greece | NA,NO | NA,NO | 0.0 | 0.0 | 0.0 | 0.0 |
| Ireland | -0.8 | -0.2 | -0.1 | 0.0 | NA,NO | 0.0 |
| Italy | -2.4 | -0.5 | -0.2 | -0.4 | -4.3 | NO |
| Luxembourg | -4.7 | IE | IE | -0.1 | -0.4 | NO |
| Netherlands | -3.1 | -0.6 | -1.6 | -0.1 | 0.0 | -6.5 |
| Portugal | -0.8 | -0.1 | -0.1 | IE | -1.5 | NO |
| Spain | -29.5 | IE | -4.3 | -4.9 | -15.4 | NO |
| Sweden | -0.8 | -0.3 | -1.2 | 0.0 | -1.2 | -0.3 |
| United Kingdom | -4.1 | IE,NO | IE,NO | IE,NO | -1.7 | IE,NO |

*Notation keys: IE – values are reported together with other pools (their separation is not possible under the availability of data without increasing uncertainty of estimates). NA- not applicable, NO-not occurring.*

For Forest Management (

Table 11.14), the difference in IEF among MS is mainly caused by the different proportion of increment which is harvested, and for some country by the occurrence of natural disturbances or potential of growth. DW and LT are mainly reported as “no source” with justification provided in the NIR (see Chapter 7 and Table 11.15 below).

**Table 11.14. IEF for net C stock changes (Mg C/ha) in the pools under Forest management activity in EU-15 (in the year 2009)**

| | Above ground Biomass | Below ground Biomass | Litter | Dead wood | Min Soils | Org Soils |
|---|---|---|---|---|---|---|
| Austria | NA | NA | NA | NA | NA | NA |
| Belgium | NA | NA | NA | NA | NA | NA |
| Denmark | 0.8 | 0.2 | 0.3 | 0.0 | NA | -0.3 |
| Finland | 0.6 | IE | IE | IE | 0.1 | -0.4 |
| France | 0.6 | 0.2 | NO | 0.1 | NO | NO |
| Germany | 0.3 | 0.1 | NO | 0.1 | NO | -0.7 |
| Greece | 0.3 | 0.1 | 0.0 | 0.0 | 0.0 | NO |
| Ireland | NA | NA | NA | NA | NA | NA |
| Italy | 0.9 | 0.2 | 0.0 | 0.3 | 0.4 | NO |
| Luxembourg | NA | NA | NA | NA | NA | NA |
| Netherlands | NA | NA | NA | NA | NA | NA |
| Portugal | 0.9 | 0.2 | 0.0 | IE | -0.4 | NO |
| Spain | 0.4 | IE | NE | NE | NE | NO |
| Sweden | 0.2 | 0.1 | 0.0 | 0.1 | 0.2 | -0.6 |
| United Kingdom | 1.0 | IE | 0.4 | IE | 0.6 | 0.6 |

### Direct $N_2O$ emissions from N fertilization (Table 5(KP-II)1)

Some countries report fertilization in old forests (e.g. Sweden), other in young plantations (e.g. UK). For the majority of MS, N fertilization of forests do not occur or, if any, emissions are reported under agriculture. Only UK provides estimates for this source category.

### $N_2O$ emissions from drainage of soils Table 5(KP-II)2

Several MS did not report $N_2O$ and $CH_4$ emissions from drainage of soils under FM, as the method of estimation is included only in the Appendix 3a.2 of the IPCC GPG for LULUCF (i.e. the reporting is not mandatory). Nevertheless, Denmark and Germany reports emissions from this source category, based on IPCC default factor. Finland reports NE and mentions that a country specific method and emission factors for this source are under development. Estimation methods are consistent with those described under Chapter 7 of this report.

**$N_2O$ emissions from disturbance associated with land use conversion to cropland (Table 5(KP-II)3)**

Forested areas converted to cropland are rather small in EU-15 (some 700 kha in EU-15). Currently, the consistency among KP and Convention tables was specifically checked by the EU QA/QC procedure, so there is more harmonized approach in the 2011 submissions. Estimation method is consistent with that described under Chapter 7 of this report.

**Carbon emissions from lime application (Table 5(KP-II)4)**

Liming is not practiced often; as it is not economically reasonable at the heavy rates required (e.g. UK's NIR). Sometimes liming is separately reported for deforestation area (e.g. Finland, Netherland). In general, even if liming may occur occasionally, there are no separate reliable statistics, thus it is often reported under Chapter 4 Agriculture. Estimation method is consistent with that described under Chapter 7.

**GHG emissions from biomass burning (Table 5(KP-II)5)**

Forest fires on ARD unit of lands are generally reported as not occurring. A specific check during the EU QA/QC identified a number of misallocation with potential accounting effects (e.g. emissions from burning occurring on AR were included under FM). Consequently, the countries made effort to estimate separately emission from biomass burning, including forest fires. Under missing data on burnt AR areas, conservatively it was assumed that burnt AR areas in total burnt equals AR area share in total Forestland (i.e. Finland). Estimation method is consistent with that described under Chapter 7.

**Justification when omitting any carbon pool or any GHG emissions/removals**

The "not a source" principle has been applied by several MS for the DOM and SOC pools (Table 11.15). During the EU QA/QC process, MS were encouraged to use the notation key "NR" in CRF tables to indicate pools not reported because "not a source", along with the reference to the NIR (in the documentation box) where it is demonstrated that the respective pool is not a source, and also to add a comment to the reporting cell mentioning it.

**Table 11.15 Overview of reasons for omissions of carbon pools.**

| Member State | Pools/ sources not considered | Activity | Demonstration/ Reasoning, including the very short methods description |
|---|---|---|---|
| **Austria** | DW | AR | DW, LT are assumed not to occur, if any it would be a sink, under slow ecosystem dynamics/ DW as standing dead tress is IE (considered in "biomass loss") |
| **Belgium** | LT, DW | AR | Reasoning based on system functioning (assumed Tier 1). |
| **Denmark** | SOC | FM | Reasoning based on system functioning (assumed Tier 1). Organic soils emissions are still NE for Greenland. |
| **Finland** | LT,DW | AR | DW assumed to be marginal over short period of time since 1990. LT is IE in the SOC. |
| | LT,DW | FM | DW and LT are both included in SOC. |
| **France** | LT, SOC | FM | Small sinks are confirmed by national research project. |
| **Germany** | LT, SOC | FM | Estimated to be zero (LT) or small sink (SOC min) based on sampling. |

| | | | |
|---|---|---|---|
| | LT,DW | AR | Estimated as not occurring based on sampling data. |
| **Greece** | LT,DW,SOC | ARD,FM | Reasoning based on system functioning (assumed Tier 1). Emissions from D from SOC are considered negligible under the time distribution of deforestation. |
| **Ireland** | SOC | AR | Statistical supported data that this pool is not a source |
| **Italy** | | | No C pool is omitted. |
| **Luxembourg** | DW | AR | Reasoning based on system functioning. LT is IE in the SOC. |
| **Netherlands** | LT, DW | AR | No source based on NFI data. |
| **Portugal** | DW | AR,FM | This pool is included within biomass. |
| **Spain** | LT,DW | AR, FM | Reasoning based on system functioning. |
| | DW,LT | CM | Reasoning based on system functioning (assumed Tier 1). |
| **Sweden** | | | No C pool is omitted. |
| **United Kingdom** | DW | AR,FM | DE is IE in the LT pool. |

Given the numerous issues identified during the 2010 UNFCCC review, in the next years specific additional effort will be needed by some MS to provide either more robust justification for omitting a carbon pool or estimates of the carbon stock change in all pools.

#### 11.2.3.2 Information on whether or not indirect and natural GHG emissions and removals have been factored out

In general, it is recognized that: (i) for Article 3, paragraph 4 activities the issue of “factoring out” was solved during negotiations with the *cap* for Forest Management and with the net-net accounting for the other Article 3, paragraph 4 activities; (ii) for Article 3, paragraph 3 activities, the dynamic effect of age is not relevant since all these activities have occurred after 1990; (iii) for the elevated $CO_2$ concentration and the indirect nitrogen deposition, there are no methodologies adopted by the UNFCCC.

#### 11.2.3.3 Changes in data and methods since the previous submission (recalculations)

Some important recalculation occurred as compared to previous submission, mostly due to availability of new data. Emissions from D in 2008 decreased by 40% from 2010 to 2011 submission, mainly due to changes in the land identification systems of Germany and Portugal. Removals from AR in 2009 remained nearly constant at EU-15 level, but minor recalculations occurred in some MS. Removals from FM in 2009 also remained nearly constant at EU-15 level, but significant recalculations occurred in some MS (e.g. Spain, Sweden, Portugal and France).

Many countries highlighted the improvement of data would continue for next two years before the final submissions (i.e. BE increased the sampling intensity on ARD activity data).

MS implement additional research projects on the development of new datasets in order to fully meet the requirements for accounting purpose, so for this reason recalculations are expected also over next years, including in the last year of the commitment period (e.g. DK research project implemented within NFI on forest soils), as many planned NFI or data sampling in other schemes, precisely in the last year of the commitment period.

Specific check during the EU QA/QC identified a number of misallocation with potential accounting effects (e.g. emissions from burning occurring on AR were included under FM), which were addressed by each individual MS or at least planned for improvement for next year. Under missing of relevant datasets the effort to separately estimate emissions on activities is quite challenging (i.e. when bulk statistics are available).

#### 11.2.3.4 Uncertainty estimates

For the current submission there is an improvement of the information provided on uncertainty analysis performed by the EU-15 Member States on the emissions/removals of the LULUCF land subcategories. Detailed information and discussion on uncertainty on emission/removal on land subcategories is provided in Chapter 7 of this report. Several MS report they are planning KP activities uncertainty estimates for the next submissions (eg. Austria in 2012).

Under full consistency between the KP activities and relevant lands in the GHG inventory, the uncertainty of the estimates could be approximated (see Chapter 7 of this NIR). In general, uncertainty of the activity data tends to be slightly higher for emission /removal associated with activities on lands under conversion, than for stable lands. The uncertainty of annual removal associated with Forest Management activity on 5A1 – forestland remaining forestland was around 18% in 2009. Activities associated with conversions reached 26 % for 5A2 (assumed similar with Afforestation/Reforestation) and 53% for 5B2 and 5C2 (practically driven by high quality data of Deforestation related inputs).

#### 11.2.3.5 Information on other methodological issues

The methods used to estimate and reports under KP are the same tier method as those used for the UNFCCC reporting. Consistency of methods used for estimation was achieved by applying similar data processing to previous datasets (in NFI) or simply by implementation of compatible procedures for entire time series (in case of remote sensing).

### *11.2.4 Article 3.3*

#### 11.2.4.1 Information that demonstrates that activities under Art. 3.3 began on or after 1 January 1990 and before 31 December 2012 and are direct human-induced

Few Member States provide explicit annual time series for Art 3.3 activities in the NIR 2011. The information on the onset of the activity seems rather incomplete in the MS NIR; in some case, for AR it is mentioned the year of planting (e.g. DK, UK, GR, IE) or the encroaching of woody vegetation that will potentially meet the definition of forestland. NFI based methodologies (alone or combined with aerial photographs) allow for the assessment of the base year and thus any later change compared to that as “since 1990”. The annual area change rates are often assumed constant or randomly distributed over the assessed period (e.g., Sweden before 2006). Early afforested area (i.e. immediately after 1990) is more uncertain if NFI was not performed in exactly in the same year, which is does not occur for the commencement and end of the commitment period (assuming better planning of assessments and availability of better methods and data nowadays).

The demonstration of the "direct human-induced" nature of AR activities may be a rather controversial issue, at least for those countries where a considerable expansion of forest occurred on abandoned agricultural areas. According to the IPCC GPG LULUCF (Chapter 4.2.5.2) "*It is good practice to provide documentation that all afforestation and reforestation activities included in the identified units of land are direct human-induced. Relevant documentation includes forest management records or other documentation that demonstrates that a decision had been taken to replant or to allow forest regeneration by other means*". Table 11.16 shows a synthesis of current information reported by EU-15 Member States on the direct-human induced origin of AR lands.

**Table 11.16 Summary of current information reported by EU-15 MS aimed at demonstrating that Afforestation/Reforestation activities are direct human-induced**

| | **Type of information / justification provided** | | | | | |
|---|---|---|---|---|---|---|
| | Areas converted have been verified and reported in registries for authorization | Areas converted, either subject to subsidies or not, have been reported in registries either for authorization or compilation of land use changes | Whole national territory covered by legal instruments for Land planning and/or management, therefore any change in land use is directly human-induced | Where a conversion results in a land use subject to management practice, the conversion is considered directly human-induced | As all land area is under management (i.e. subject to some kind of human interactions), all changes are considered as directly human-induced | A decision to change the use of a land or a decision not to continue the previous management practices has been made, which allow for conversion |
| **Austria** | | | **X** | | | |
| **Belgium** | | | | | X | |
| **Denmark** | | | | | X | |
| **Finland** | | | | | | X |
| **France** | | | | X | | |
| **Germany** | | | X | | | |
| **Greece** | X | | | | | |
| **Ireland** | X | | | | | |
| **Italy** | | | X | | | |
| **Luxembourg** | | | X | | | |
| **Netherland** | | | | | X | |
| **Portugal** | | | | | X | |
| **Spain** | | X | | | | |
| **Sweden** | | | | X | | |
| **United Kingdom** | | X | | | | |

Although in most cases a rather "broad" interpretation of "direct human induced AR" is applied, some MS apply a stricter approach. For instance, UK does not report under AR the areas of planting that are not state-owned or grant-aided (i.e. whether these woodlands are explicitly managed is unknown). With the experience of first year reporting under Kyoto and the first review, several countries improved their approach on direct human-induced nature of AR (i.e. France, Portugal). Many countries show forest expansion which is earlier or later considered under forest management.

#### 11.2.4.2 Information on how harvesting or forest disturbance that is followed by the re-establishment of forest is distinguished from deforestation

Although the loss of forest cover is often readily identified, the classification of an area as deforested is more challenging. Most MS provided information on the criteria by which temporary removal or loss of tree cover can be distinguished from deforestation and how these criteria are consistently applied (Table 11.17). For instance, in the absence of detailed information of the future of land use, some MS defined the expected time periods (in years) between removal of tree cover and successful natural regeneration or planting. Most EU-15's Member States report that in most cases there are legal obligations to restore the forest on harvested areas, with these legal provisions enforced and applied according to country circumstances. Furthermore, legislation usually does not allow for a land use change following a natural disturbance.

**Table 11.17 Information on differentiation between temporary forest cover loss and deforestation (from MS' NIRs)**

| MS | Short description of the approach |
|---|---|
| **Austria** | Differentiation of temporarily unstocked areas (e.g. harvested area, disturbances) and deforestation is made by actual procedures implemented by NFIs (e.g. handbooks and guides for field assessment, training of field staff to rightly distinguish between them). For deforestation field assessment procedure involve identification of the significant visible changes in soil structure or ground vegetation which may not represent the natural succession of a forest (e.g. consequences of anthropogenic activities like plowing, crop production, mowing or construction activities or natural abortion of the forest and its stand by e.g. landslides). *Temporarily unstocked areas* by forest management or forests with biotic and abiotic reduction of their crown coverage (windfall, fire, beetles) maintain the natural succession of ground vegetation and soil and therefore remain part of the forest. |
| **Belgium** | Permits released by the regional forestry authorities, thus the fate of all land is known (usually deforestation occurs only for settlements purpose). |
| **Denmark** | Deforested land is detected by analysis of satellite images, further on confirmed by additional sources (i.e. documentations). Mandatory period for reforestation of cut areas is 10 years. |
| **Finland** | If a NFI sample plot is on a clearcut area, the field assessor assesses if there are signs for permanent conversion or only cut. Maximum period allowed for regeneration is 3 years, with a usual delay in reforestation of 2 years. |
| **France** | Land use/cover and ground assessment are able to identify the land use and activity change on annual basis. |
| **Germany** | Law and observance of its implementation ensure that cut or natural disturbance area is reestablished as forest. |
| **Greece** | Only legally executed deforestations are considered under deforestation while the land that lost illegally the forest cover is not classified as deforested, but as areas that temporary loss of woody vegetation. |
| **Ireland** | NFI to identify if the lands are unstocked or deforested (5 years periodicity). |
| **Italy** | Implementation of different legal procedure for harvesting and deforestation. |
| **Luxembourg** | Legal obligation that the owner has to ensure the regeneration of forest in 3 years after a clear cut |
| **Netherland** | Mapping method used to ensure differentiation between deforestation and non deforestation tree cover loss. |

| | |
|---|---|
| **Portugal** | With current methodology if in 5 years the forest is not restored then the land is considered as deforested. |
| **Spain** | NFI captures any not regenerated areas (e.g. after forest fires). NFI is performed every 10 years. |
| **Sweden** | Missing forest cover identified for two consecutive inventories is not enough to classify the plot as deforested, but additional observable changes (as presence of infrastructure). |
| **United Kingdom** | Felling licenses system, in the near future doubled by new NFI, ensures the relevant activity areas are fully captured. |

#### 11.2.4.3 Information on the size and geographical location of forest areas that have lost forest cover but which are not yet classified as deforested

The methodologies adopted by each MS ensure consistent reporting in time and space of these areas. Such areas may be found after either natural or man-made disturbances, and may result in misallocation of lands (i.e. a harvested land should remain under FM while a deforested land should be reported under D). In general, the distinction between deforested areas and temporarily unstocked areas is allowed by the methodology developed by the country, which regularly implement multiple assessment criteria and hierarchical phases (including precise guidelines for field checks). The simple combination of NFI data with remote sensing data may not be fully adequate to assess the areas which can be classified as deforested, and thus these data are often complemented by other type of information (i.e. a deforestation typically requires a specific permit or specific visible changes of the soils). Supplementary arguments for correct classification of the land status are given by the law requirements and enforcement according national circumstances.

#### 11.2.4.4 Information on emissions and removals of GHG from lands harvested during the first commitment period following AR on these units of land since 1990

Most Member States reports that for AR, due to normative technical rules or economical constraints, harvest do not usually occur before 20 years old of the plantations, with the exceptions of some fast growing species. The majority of the MS interpret “harvesting” as clear cut done on short rotation forests or woody biomass crops (e.g. only Ireland reports a small areas under Table 5(KP-I) A1.2, less than 1 % of its total AR area).

### *11.2.5 Article 3.4*

#### 11.2.5.1 Information that demonstrates that activities under Article 3.4 have occurred since 1 January 1990 and are human-induced

General consideration applies that all land that meet forest definition are forestland. Within that the land which are subject for forest management are defined at national level based on applicable definition and practices.

#### 11.2.5.2 Information relating to Forest Management

EU-15 MS apply rather broad definition of “Forest management”, with only few MS reporting some areas of forest not falling also in the FM definition. In few cases there are strict assumptions, i.e. that only the forests with a landscape or/and forest management plan in 1990 and 2009 are under FM (e.g., Greece reports under FM only 35% of forest land area reported under the Convention inventory). UK does not report the forest area already existing in 1920 (about 0.9 Million ha). France also does not report large areas of forest from overseas territories, because that is regarded as being unmanaged. Compared to previous approach of reporting only 60 % of forestland reported under the convention, Portugal reports in 2009 entire forestland area under FM.

Forest management is understood as the set of forest practices and operations, which occur at the stand-level: felling for natural and artificial/planting regeneration, site and soil preparation (including drainage, burning of slash), planting of seedlings, seeding, thinning, pruning, fertilization and liming, harvesting of cutting residues and conservation of important habitats, and fire prevention. Instruments for sustainable forest management are obligations under national legislation of all MS with adequate institutional framework, further enhanced by strategies/programs and management plans.

Sustainable forestry has a long tradition in Europe, with earliest management planning dating hundreds years back. Currently each MS has in force their own legislation on forest lands, as well as other laws supporting in general the improvement and protection of forests. At the EU level, forestry is not regulated directly by specific rules, but there are strong requirements for the protection of forests via common environmental obligation (on nature protection, biodiversity protection etc.), sustainable rural development and renewable energy policies. Some countries report certification of the forests as an additional tool to highlight the sustainability of the whole chain of forestry and wood products (i.e. many MS certified forests under various schemes).

Data reported under different international processes (e.g. FAO, MCFPE, CBD) may be different due to the different reference time and definitions applied underlying different reporting obligations. Thus, any comparisons have to be done cautiously.

#### 11.2.5.3 Information relating to Cropland Management, Grazing Land Management and Revegetation, if elected, for the base year

Cropland and Grazing land management activities consist in the implementation of specific practices and operations, which differ substantially from country to country. Cropland management is dedicated to agricultural cultures and crops, perennial and annual, woody and non woody, including lands temporary under reserve or out of the productive activity.

Data for the reference year 1990 and the first year of the commitment period are constructed based on remote sensing, some times enhanced by statistics (i.e. activity data) or surveys (i.e. crop species share). Data on improved technologies for cultivation are likely missing for the base year and generally it is realistically assumed that they did not occur (i.e. Portugal).

MS includes also some types of wooded vegetation areas (reported under cropland in the convention) as subject to management, implementing adequate stratification for estimation of C stock changes (also for the base year). Denmark includes under grazingland management “grassland having some wooden vegetation that does not meet the forest definition” and “wooded perennial fruit plantations and hedgerows” in the cropland management area.

### *11.2.6 Other information (EU-15)*

#### 11.2.6.1 Key category analysis for Art. 3.3 activities and any elected Art. 3.4 activity

Member States apply quantitative criteria for the assessment of the key categories (see Table 11.4), based on the correspondence between KP activities and land categories under the GHG inventory. Some MS use additional qualitative criteria (e.g. UK).

### *11.2.7 Information relating to Article 6*

There is no JI project developed within EU-15.

## 11.3 Overview of emissions / removals and information reported by new EU MS in the KP LULUCF tables

Forestland definition adopted by the new EU-12 MS is in line with national legislation and within the range defined by FAO and UNFCCC. Additional criteria apply for forestland classification and hierachizing with other land uses.

**Table 11.18 Parameters used by the new EU MS to define "forest" under the Kyoto Protocol**

| Member State | NIR 2011 | | | |
|---|---|---|---|---|
| | Crown cover (%) | Height (m) | Minimum area (ha) | Minimal Width (m) |
| Bulgaria | 10 | 5 | 0.1 | - |
| Czech Republic | 30 | 2 | 0.05 | 20 |
| Estonia | 30 | 2 | 0.5 | - |
| Hungary | 30 | 5 | 0.5 | 10 |
| Latvia | 20 | 5 | 0.1 | 20 |
| Lithuania | 10 | 5 | 0.1 | 10 |
| Poland | 10 | 2 | 0.1 | 10 |
| Romania | 10 | 5 | 0.25 | 20 |
| Slovakia | 20 | 5 | 0.3 | - |
| Slovenia | 30 | 2 | 0.25 | - |

### *11.3.1 Coverage of carbon pools and GHG reported (KP CRF NIR 1)*

Seven new EU MS have elected Forest Management and only one has elected revegetation (Romania). Among the new EU MS, only one country has chosen annual accounting (Hungary).

All new MS report biomass pools while provide estimates or justification for no source of other pools (Table 11.19). Litter pool is often reported together with SOC because of data availability (i.e. Bulgaria, Czech Republic) or assumed not occurring based on system functioning (in AR activities). In deforestation Hungary reports the amount of emission negligible under the period since the event occurred.

**Table 11.19 Synthesis of pools coverage for KP LULUCF activities for 2009 in new EU MS (from tables NIR 1)**

| KP activity/MS | | Changes in carbon pool reported | | | | | |
|---|---|---|---|---|---|---|---|
| | | Above-ground biomass | Below-ground biomass | Litter | Dead wood | Soil Min | Soil Org |
| AR | Czech Republic | R | R | IE | R | R | NO |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | Estonia | R | R | NE | NO | R | R |
| | Hungary | R | R | NR | NR | NR | NO |
| | Latvia | R | R | R | R | R | R |
| | Lithuania | R | R | R | R | R | R |
| | Poland | R | R | IE | R | R | NO |
| | Romania | R | IE | R | IE | R | NO |
| | Slovakia | R | R | IE | NO | R | NO |
| | Slovenia | NO | NO | NO | NO | NO | NO |
| **D** | Bulgaria | R | IE | R | R | R | NO |
| | Czech Republic | R | R | IE | R | R | NO |
| | Estonia | R | R | NE | R | R | R |
| | Hungary | R | R | NR | NR | R | NO |
| | Latvia | R | R | R | R | R | R |
| | Lithuania | R | R | R | R | R | R |
| | Poland | R | R | IE | R | R | NA |
| | Romania | R | R | R | IE | R | NO |
| | Slovakia | R | R | IE | R | R | NO |
| | Slovenia | R | R | R | R | R | NO |
| **FM** | Bulgaria | NA | NA | NA | NA | NA | NA |
| | Czech Republic | R | R | IE | R | NR | R |
| | Estonia | NA | NA | NA | NA | NA | NA |
| | Hungary | R | R | NR | NR | NR | NO |
| | Latvia | R | R | R | R | R | R |
| | Lithuania | R | R | R | R | R | R |
| | Poland | R | R | IE | R | R | NO |
| | Romania | R | R | NR | NR | R | NO |
| | Slovakia | NA | NA | NA | NA | NA | NA |
| | Slovenia | R | R | NR | R | NR | NO |

*Notation keys: R – C stock change or emissions from source is reported; NR – the pool is not reported, using the "not a source" principle; NE – removal/emission is not estimated (could be either negligible or truly not estimated); IE – included elsewhere; NO –not occurring; NA – MS does not account the activity.*

Land area on which different KP activities occur represents some 21 % for AR, 7% D and 20 % for FM out of total EU-27 MS land (

Table 11.20). Recalculation of AR area has been revised upward by Bulgaria, Poland and downward by Estonia, Latvia, while Lithuania provides estimates for the first time. The largest area of AR is reported by Bulgaria and Poland. Deforestation areas are small in all countries, with few countries showing practically very general small land conversions.

**Table 11.20** **Synthesis of total area (kha) of KP-LULUCF activities as reported by new EU MS at the end of the 2009 (from Tab. NIR 2). Grey cells indicate that the activity has not been elected.**

| Member State | Art. 3.3 activities | | Article 3.4 activities | | | |
|---|---|---|---|---|---|---|
| | AR | D | FM | CM | GM | RV |
| **Bulgaria** | 304 | 6 | | | | |
| **Czech Republic** | 40 | 13 | 2562 | | | |
| **Estonia** | 159 | 31 | | | | |
| **Hungary** | 162 | 9 | 1657 | | | |
| **Latvia** | 219 | 35 | 3131 | | | |
| **Lithuania** | 245 | 21 | 2160 | | | |
| **Poland** | 422 | 11 | 8873 | | | |
| **Romania** | 28 | 4 | 6696 | | | 9 |
| **Slovakia** | 30 | 7 | | | | |
| **Slovenia** | 0 | 5 | 1186 | | | |
| **EU 12** | **1609** | **142** | **26265** | | | **9** |
| EU-15 (see Table 11.3) | 5842 | 1762 | 110339 | 25219 | 2054 | |
| Total EU 27 | 7451 | 1904 | 136604 | 25219 | 2054 | 9 |

NO is used to report a proven key category for all MS that have elected it, while deforestation does not bring important share of emissions (Table 11.21). There is general full agreement between importance of the category and methodological tiers involved in the estimation.

**Table 11.21.** **Synthesis of KP-LULUCF activities being key category as reported by new EU MS (from tables NIR 3). "K" indicates a key category. Grey cells indicate that the activity has not been elected.**

| Member State | AR | D | FM | CM | GM | RV |
|---|---|---|---|---|---|---|
| **Bulgaria** | K | | | | | |
| **Czech Rep.** | | | K | | | |
| **Estonia** | K | K | | | | |
| **Hungary** | K | | K | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Latvia** | K | | K | | | |
| **Lithuania** | K | K | K | | | |
| **Poland** | K | K | K | | | |
| **Romania** | | | K | | | |
| **Slovakia** | K | K | | | | |
| **Slovenia** | | | K | | | |

### *Summary of emissions/removals and accounting quantities for KP LULUCF activities by EU-15 MS (KP CRF "Accounting" table)*

Out of total emission/removal amount that could be accounted by the EU-27 MS for their commitment compliance, the new MS contribution is 24 % from AR, 12 % from deforestation and 31 % from Forest Management. Three countries offset their emissions from 3.3 with removals from 3.4. Slovenia reports no afforestation/reforestation activity, but very small area of deforestation. Lithuania and Latvia report higher emissions from deforestation than in afforestation/reforestation, so they also implement the offset ruling.

**Table 11.22** **Emissions / removals and accounting quantities for KP-LULUCF activities as reported by new EU MS.**

| | Net emissions (+) and removals (-), Gg $CO_2$eq | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A. Art 3.3 activities | | | | B. Art. 3.4 activities | | | | | | | | | | | | 3.3 off-set (2008+2009) | Accounting quantity on KP activities (2008+2008) (from "accounting" sheet of KP LULUCF table) | | | | | |
| | A.1 AR | | A.2. D | | B.1 FM | | B.2 CM | | | B.3 GM | | | B.4 RV | | | | | AR | D | FM | CM | GM | Rv |
| MS | 2008 | 2009 | 2008 | 2009 | 2008 | 2009 | 1990 | 2008 | 2009 | 1990 | 2008 | 2009 | 1990 | 2008 | 2009 | | | | | | | | |
| **Bulgaria** | -1491 | -1673 | 272 | 153 | | | | | | | | | | | | | | -3164 | 424 | | | | |
| **Czech Rep.** | -272 | -295 | 160 | 170 | -6135 | -6441 | | | | | | | | | | | | -567 | 330 | -5867 | | | |
| **Estonia** | -186 | -208 | 423 | 423 | | | | | | | | | | | | | | -395 | 847 | | | | |
| **Hungary** | -1160 | -1155 | 35 | 33 | -2807 | -1878 | | | | | | | | | | | | -2313 | 67 | -4639 | | | |
| **Latvia** | -441 | -506 | 908 | 754 | -23779 | -21296 | | | | | | | | | | | 902 | -946 | 1848 | -6233 | | | |
| **Lithuania** | -252 | -378 | 402 | 576 | -4440 | -4413 | | | | | | | | | | | 348 | -630 | 978 | -5133 | | | |
| **Poland** | -6734 | -7198 | 256 | 264 | -42847 | -44858 | | | | | | | | | | | | -13781 | 519 | -15033 | | | |
| **Romania** | -272 | -272 | 74 | 74 | -36222 | -36222 | | | | | | | -5 | -48 | -48 | | | -543 | 148 | -20167 | | | -86 |
| **Slovakia** | -453 | -469 | 181 | 280 | | | | | | | | | | | | | | -922 | 461 | | | | |
| **Slovenia** | 0 | 0 | 148 | 330 | -10320 | -10362 | | | | | | | | | | | 480 | 0 | 481 | -6600 | | | |
| **EU 12** | **-11260** | **-12154** | **2859** | **3057** | **-126550** | **-125470** | | | | | | | **-5** | **-48** | **-48** | | **1730** | **-23261** | **6103** | **-63672** | | | **-86** |
| EU-15 | -37287 | -38696 | 25044 | 22843 | -271519 | -279893 | 1999 | -1396 | -2076 | -304 | -768 | -778 | | | | | 21125 | -75820 | 48727 | -141967 | -8280 | -938 | |
| EU-27 | -48548 | -50850 | 27903 | 25900 | -398069 | -405363 | 1999 | -1396 | -2076 | -304 | -768 | -778 | -5 | -48 | -48 | | 22855 | -99081 | 54830 | -205639 | -8280 | -938 | -86 |

** The sum of MS' emissions/removals is shown for information purpose only. The EU will neither issue nor cancel accounting units.*

## 11.1 Synthesis of supplementary information on KP LULUCF activities reported by EU-12 MS in their NIRs

Estimation methodologies adopted by the EU-12 MS are consistent with those used for reporting GHG inventory under the Convention. IEF for C stock change factors are within the ranges reported by EU-15 MS for afforestation/reforestation (Table 11.22), deforestation (Table 11.23) and forest management (Table 11.24).

**Table 11.22 IEF for net C stock changes (Mg C/ha) by pool on lands under AR activity in EU-15 (in the year 2009)**

| Member State | Above ground Biomass | Below ground Biomass | Litter | Dead wood | Min Soils | Org Soils |
|---|---|---|---|---|---|---|
| Bulgaria | 1.7 | IE,NO | 0.3 | NE,NO | -0.5 | NO |
| Czech Republic | 1.5 | 0.3 | IE | NO | 0.2 | NO |
| Estonia | 0.2 | 0.1 | NE | NO | NO | 0.1 |
| Hungary | 1.6 | 0.4 | NE | NE | NE | NO |
| Latvia | 0.5 | 0.2 | NE | NE | NO | -0.7 |
| Lithuania | 0.4 | 0.1 | NO | NO | NO | -0.3 |
| Poland | 2.1 | 0.6 | IE | 0.0 | 2.0 | NO |
| Romania | 1.3 | IE | 0.5 | IE | 0.9 | NO |
| Slovakia | 1.2 | 0.3 | IE | NO | 2.7 | NO |
| Slovenia | NO | NO | NO | NO | NO | NO |

NE is used for reporting, either as no source (supported by justification mainly based on system functioning reasoning) or data is not yet reported and planed for improvement. NO is reported for pools which are demonstrated as no source. Values of biomass IEF for deforestation range wider both under biomass stocks considered (i.e. average by majority of countries or specific determined by NFI by Slovenia). High value of Slovenia is reported because IEF is only reported to current year (which not necessarily overestimate the overall emissions).

**Table 11.23 IEf for net C stock changes (Mg C/ha) in the pools under Deforestation activity in EU-15 (in the year 2008)**

| Member State | Above ground Biomass | Below ground Biomass | Litter | Dead wood | Min Soils | Org Soils |
|---|---|---|---|---|---|---|
| Bulgaria | -4.1 | -0.5 | -0.3 | -0.2 | -2.6 | NO |
| Czech Republic | -2.7 | -0.7 | IE,NA | -0.1 | -0.1 | NO |
| Estonia | -3.1 | -0.1 | NE | 0.1 | NO | -0.2 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Hungary | -0.5 | -0.3 | NE | NE | -0.4 | NO |
| Latvia | -1.1 | -0.6 | -0.8 | -0.2 | -3.5 | 0.0 |
| Lithuania | -2.6 | -0.7 | -1.1 | -0.1 | -3.1 | -0.7 |
| Poland | -3.3 | -0.8 | IE | 0.1 | -2.7 | NA |
| Romania | -3.1 | -1.8 | -0.6 | IE | -0.8 | NO |
| Slovakia | -7.9 | -3.3 | IE | -0.3 | -0.2 | NO |
| Slovenia | -109.9 | -0.5 | -5.6 | -4.7 | -9.7 | NO |

In the forest management areas, DW and LT are reported as no source, under ecosystem functioning reasoning (mainly under lacking data).

**Table 11.24. IEf for net C stock changes (Mg C/ha) in the pools under Forest management activity in EU-15 (in the year 2009)**

| Member State | Above ground Biomass | Below ground Biomass | Litter | Dead wood | Min Soils | Org Soils |
|---|---|---|---|---|---|---|
| Bulgaria | NA | NA | NA | NA | NA | NA |
| Czech Republic | 0.7 | 0.1 | NE | NO | NE | 0.0 |
| Estonia | NA | NA | NA | NA | NA | NA |
| Hungary | 0.2 | 0.1 | NE | NE | NE | NO |
| Latvia | 1.5 | 0.5 | NO | NO | NO | -0.7 |
| Lithuania | 0.3 | 0.1 | 0.1 | 0.1 | 0.0 | -0.3 |
| Poland | 0.6 | 0.2 | IE | 0.0 | 0.5 | NO |
| Romania | 1.5 | IE | NE | NE | NO | NO |
| Slovakia | NA | NA | NA | NA | NA | NA |
| Slovenia | 1.8 | 0.4 | NA | 0.1 | NA | NO |

GHG emissions from sources associated with KP activities are generally reported by the MS as not occurring. Forest land conversions to cropland are generally not allowed by law in European countries.

In the new EU-12 MS there is an ongoing effort for improvement of reporting, especially for the problematic pools for which historical data is practically not available. These issues were identified over EU QA/QC procedure and strongly highlighted by 2010 UNFCCC review process (included in the Saturday Papers as critical issues for improvement).

# 12 INFORMATION ON ACCOUNTING OF KYOTO UNITS

## 12.1 Background information

The standard electronic format (SEF) for providing information on ERUs, CERs, tCERs, lCERs, AAUs and RMUs for the year 2010 for the Community registry is submitted together with this report (Annex 1.13). The data in the Community registry reflect only the transactions to and from the Community registry, but not the sum of all Member States' transactions. Member States' separately submit information on Kyoto units in SEF tables to the UNFCCC.

## 12.2 Summary of information reported in the SEF tables for the Community registry

The standard electronic format tables for the Community are included in the submission. The SEF reporting software has been used for this purpose. The tables include information on the AAU, ERU, CER, t-CER, l-CER and RMU in the Community registry at 31.12.2010 as well as information on transfers of the units in 2010 to and from other Parties of the Kyoto Protocol. Neither AAUs, nor ERUs or RMUs have been issued in the Community Registry in 2010.

The assigned amount for the EU, calculated pursuant to Article 3 paragraphs 7 and 8 as described in the EU's initial report, exceeds the sum of Member States' assigned amounts by 19,357,531 tonnes $CO_2$-equivalent. This arithmetical difference is due to the fact that the joint agreement under Article 4 of the Kyoto Protocol was formulated in percentage contributions based on base-year data available in 1998. As the Member States have revised their base-year emissions, the adopted percentage contributions under the burden sharing agreement no longer exactly match EU's 92 % commitment. As each assigned amount unit (AAU) can only be issued into a national registry once, the assigned amount of each Member State should be issued into its respective national registry after being recorded in the compilation and accounting database. The remaining assigned amount for the EU, amounting to 19,357,531 tonnes $CO_2$-equivalent (which is the arithmetical difference between the Community's assigned amount and the sum of the Member States' assigned amounts), will be issued in the registry of the EU. This amount has not yet been issued in the Community registry in 2010

The total quantities of AAUs acquired and transferred during the reporting period are provided in SEF table 2b and 2c.

## 12.3 Summary of information reported in the SEF tables of Member States

SEF tables for the Community registry, EU-15 and EU-25 are provided in Annex 1.13 and Annex 2.13. The SEF tables for EU-15 include aggregated information for EU-15 and EU-25 Member States. Note that the EU-15 SEF tables also include transactions between the Community registry and the new EU Member States and non-EU Member States. Table 11.1 provides an overview of transactions included in Table 2(b) in the Community registry, EU-15 SEF tables and EU-25 SEF tables.

**Table 12.1** **Transactions included in Table 2(b) in the Community registry, EU-15 SEF tables and EU-25 SEF tables**

| Table 2(b) | | Community registry SEF tables | EU-15 SEF tables | EU-25 SEF tables |
|---|---|---|---|---|
| **From** | **To** | | | |
| Community registry | EU-15 MS | Yes | | |
| Community registry | new MS | Yes | Yes | |
| Community registry | Non-EU MS | Yes | Yes | Yes |
| EU-15 MS | Community registry | Yes | | |
| EU-15 MS | new MS | | Yes | |
| EU-15 MS | Non-EU MS | | Yes | Yes |
| new MS | Community registry | Yes | Yes | |
| new MS | EU-15 MS | | | Yes |
| new MS | Non-EU MS | | | Yes |

## 12.4 Discrepancies and notifications

With respect to the respective paragraphs of decision 15/CMP.1 the following information is provided for the Community registry:

- **Paragraph 12:** No discrepancies identified by the transaction log.
- **Paragraph 13**: No notifications directed to the Party to replace ICERs in accordance with Paragraph 49 of the annex to decision 5/CMP.1.
- **Paragraph 14:** No notifications directed to the Party to replace ICERs in accordance with para 50 of the annex to decision 5/CMP.1.
- **Paragraph 15:** No issue of non-replacement.
- **Paragraph 16**: No KP Units that are not valid.
- **Paragraph 17:** No actions were necessary to correct any problem causing a discrepancy.

## 12.5 Publicly accessible information

The information based on the requirements in the annex to decision 13/CMP is publicly available on the European Commission website: http://ec.europa.eu/environment/climat/gge_registry.htm

In accordance with Decision 13 of the first Meeting of the Parties to the Kyoto Protocol (COP/MOP 1), the following information is made publicly available from the Community Registry.

**List of accounts**

| TYPE | COMM PRD | ACCOUNT HOLDER | REPRESENTATIVE ID | REPRESENTATIVE | TEL | FAX | EMAIL |
|---|---|---|---|---|---|---|---|
| Holding account | 0 | European Commission | EU2 | Ronald Velghe | +32-229-84052 | - | ronald.velghe@ec.europa.eu |

**Article 6 project information**

| |
|---|
| No ERU have been issued in the Community Registry in 2008<br>No ERU have been issued in the Community Registry in 2009<br>No ERU have been issued in the Community Registry in 2010 |

**The total quantity of ERUs, CERs, AAUs and RMUs in each account at the beginning of the year**

| |
|---|
| This information is confidential. |

**The total quantity of AAUs issued on the basis of the assigned amount pursuant to Article 3, paragraphs 7 and 8**

| |
|---|
| No AAU have been issued in the Community Registry in 2008<br>No AAU have been issued in the Community Registry in 2009<br>No AAU have been issued in the Community Registry in 2010 |

**The total quantity of ERUs issued on the basis of Article 6 projects**

| |
|---|
| No ERU have been issued in the Community Registry in 2008<br>No ERU have been issued in the Community Registry in 2009<br>No AAU have been issued in the Community Registry in 2010 |

**The total quantity of ERUs, CERs, AAUs and RMUs acquired from other registries and the identity of the transferring accounts and registries**

| YEAR | Registry | AAU | ERU | RMU | CER |
|---|---|---|---|---|---|
| 2008 | AT | 159,153 | 0 | 0 | 0 |
| 2008 | CZ | 1,884,071 | 0 | 0 | 0 |
| 2008 | ES | 10,229,902 | 0 | 0 | 0 |
| 2008 | FI | 792,678 | 0 | 0 | 0 |
| 2008 | LU | 72,000 | 0 | 0 | 0 |
| 2008 | PT | 2,235,418 | 0 | 0 | 0 |
| 2008 | SK | 2,684,303 | 0 | 0 | 0 |
| 2010 | GB | 633,525 | 0 | 0 | 303,069 |

No unit has been acquired from another registry in 2009.

**The total quantity of RMUs issued on the basis of each activity under Article 3, paragraphs 3 and 4**

| |
|---|
| No RMU have been issued in the Community Registry in 2008 |
| No RMU have been issued in the Community Registry in 2009 |
| No RMU have been issued in the Community Registry in 2010 |

**The total quantity of ERUs, CERs, AAUs and RMUs transferred to other registries and the identity of the acquiring accounts and registries**

| YEAR | Registry | AAU | ERU | RMU | CER |
|---|---|---|---|---|---|
| 2008 | BE | 162,019 | 0 | 0 | 0 |
| 2008 | DK | 2,593,754 | 0 | 0 | 0 |
| 2008 | FR | 5,664,238 | 0 | 0 | 0 |
| 2008 | HU | 131,000 | 0 | 0 | 0 |
| 2008 | IT | 579,204 | 0 | 0 | 0 |
| 2008 | NL | 3,062,720 | 0 | 0 | 0 |
| 2008 | PL | 90,000 | 0 | 0 | 0 |
| 2008 | SE | 18,429 | 0 | 0 | 0 |
| 2008 | GB | 5,627,661 | 0 | 0 | 0 |
| 2008 | IE | 128,500 | 0 | 0 | 0 |
| 2010 | GB | 508,009 | 0 | 0 | 0 |

No unit has been transferred to another registry in 2009.

**The total quantity of ERUs, CERs, AAUs and RMUs cancelled on the basis of activities under Article 3, paragraphs 3 and 4**

| YEAR | AAU | ERU | RMU | CER |
|---|---|---|---|---|
| 2008 | 0 | 0 | | |
| 2009 | 0 | 0 | | |
| 2010 | 0 | 0 | | |

**The total quantity of ERUs, CERs, AAUs and RMUs cancelled following determination by the Compliance Committee that the Party is not in compliance with its commitment under Article 3, paragraph 1**

| YEAR | AAU | ERU | RMU | CER |
|---|---|---|---|---|
| 2008 | 0 | 0 | 0 | 0 |
| 2009 | 0 | 0 | 0 | 0 |
| 2010 | 0 | 0 | 0 | 0 |

**The total quantity of other ERUs, CERs, AAUs and RMUs cancelled**

| YEAR | AAU | ERU | RMU | CER |
|---|---|---|---|---|
| 2008 | 0 | 0 | 0 | 0 |
| 2009 | 0 | 0 | 0 | 0 |

| | | | | |
|---|---|---|---|---|
| 2010 | 0 | 0 | 0 | 0 |

## The total quantity of ERUs, CERs, AAUs and RMUs retired

| YEAR | AAU | ERU | RMU | CER |
|---|---|---|---|---|
| 2008 | 0 | 0 | 0 | 0 |
| 2009 | 0 | 0 | 0 | 0 |
| 2010 | 0 | 0 | 0 | 0 |

## 12.6 Calculation of commitment period reserve (CPR)

The EU commitment period reserve is 17,659,243,358 tonnes $CO_2$eq. as indicated as revised estimate in the report of the review of the initial report of the European Union (FCCC/IRR/2007/EC). The commitment period reserve for the EU is calculated as 90 per cent of its assigned amount pursuant to article 3, paragraphs 7 and 8 of the Kyoto Protocol and therefore remains unchanged during the first commitment period.

## 12.7 KP-LULUCF accounting

Each EU Member State will account for net emissions and removals for each activity under Article 3, paragraphs 3 and 4, if elected, by issuing RMUs or cancelling Kyoto Protocol units based on the corresponding reported emissions and removals from these activities and the specific accounting rules. The EU will neither issue nor cancel units based on the reported emissions and removals from activities under Article 3, paragraph 3 and paragraph 4. The EU will report the sum of Member States' cumulative accounting quantities for these activities at the end of the commitment period, representing the Member States' cumulative additions to or subtractions from their assigned amount at the end of the commitment period.

# 13 INFORMATION ON CHANGES IN NATIONAL SYSTEM

## 13.1 Changes with regard to entities involved in the GHG inventory preparation (section 3.5.2)

In section 3.5.2 of its initial report "*The roles and responsibilities of various agencies and entities in relation to the inventory development process, as well as the institutional, legal and procedural arrangements made to prepare the inventory*", the EU identified "The European Topic Centre on Air and Climate Change" as one of the entities that have an active role in the preparation of the annual EU inventory.

Regulation (EEC) 401/2009 of 23 April 2009 on the European Environment Agency (EEA) and the European Environment Information and Observation Network (Eionet) describes in its Article 4(4)-(6) European Topic Centres as part of the Agency's network. European Topic Centres (ETCs) are centres of thematic expertise contracted by the European Environment Agency (EEA) to carry out specific tasks identified in the EEA strategy. The contract between the EEA and the previous Topic Centre, the European Topic Centre on air and climate change (ETC/ACC), expired end of 2010. Its replacement, the new European Topic Centre on air pollution and climate change mitigation (ETC/ACM), was established by a contract between the lead organisation Rijksinstituut voor Volksgezondheid en Milieu (RIVM) in the Netherlands and the EEA. The framework agreement entered into force 15/12/2010 and will expire 31/12/2013.

The ETC/ACM assists the European Environment Agency (EEA) in its support to EU policy in the field of air pollution and climate change mitigation. The specific tasks of the ETC/ACM are detailed in the annual implementation plans agreed between the EEA and the ETC/ACM. The ETC/ACM involves 10 organisations and institutions from different European countries. These organisations are: Rijksinstituut voor Volksgezondheid en Milieu (RIVM), AEA Technology PLC (AEA), Czech Hydrometeorological Institute (CHMI), EMISIA S.A. (EMISIA), Instituto de Diagnóstico Ambiental y Estudios del Agua (IDAEA – CSIC), Institut National de l'Environnement Industriel et des Risques (INERIS), Norsk Institutt for Luftforskning (NILU), Öko Institut e.V. (Öko), Planbureau voor de Leefomgeving (PBL), and Umweltbundesamt GmbH (UBA – Vienna). The key ETC/ACM partner assisting the EEA in the compilation of the EU greenhouse gas inventory and the implementation of the EU's QA/QC programme remains Umweltbundesamt GmbH (UBA – Vienna). UBA-Vienna (task leader), Öko Institut and EMISIA are the organisations in the ETC/ACM involved with the preparation of the EU greenhouse gas inventory. The inclusion of EMISIA in the ETC/ACM consortia has provided additional expertise in the transport sector. Other than this, the contractual agreement between the EEA and the new ETC/ACM does not change the previous tasks and responsibilities of the partners dealing with inventory compilation and has no effect in the EU's national system other than ensuring business continuity for the period covered by the present EEA's multiannual strategy 2009-2013.

## 13.2 Changes with regard to the QA/QC programme (section 3.5.6)

The "Saturday paper" that the EU received as part of the 2010 inventory review stated that:

- *"The ERT states that 'the procedures within the EU national system do not guarantee that the inventory of the European Union is complete for all categories for which methods are available in the IPCC guidelines'.*
- *The ERT noted that 'the national system of the European Union should ensure that the inventory of the European Union is complete in accordance with the Revised 1996 IPCC Guidelines*

*for National Greenhouse Gas Inventories, as elaborated by the IPCC good practice guidance as defined in paragraph 14 (b) of the annex to decision 19/CMP.1.'*

- *The ERT recommends that 'the European Union provide information on procedures that the European Union will put in place in order to ensure the completeness of the next submission of the inventory of the European Union by 8 November 2010'."*

In response to this Saturday paper the EU immediately mobilized the mechanisms of its national system to further enhance its QA/QC programme and develop an appropriate action plan, in consultation with the MS, geared in particular towards complementing the existing procedures and improving the completeness regarding NEs of the EU greenhouse gas inventory in 2011 and beyond.

The action plan that was implemented for the first time in 2011 in preparation of this year's submissions is based on two basic considerations:

1) Given the fairly wide interpretations and applications of notation keys, the identification of a "real" gap needs expert assessment which is provided by the UNFCCC review and which cannot be automated by existing EU internal procedures. Thus any action plan proposed by the EU needs to continue to be based primarily on the UNFCCC review reports. This is in particular evident in regards to the KP LULUCF, where a carbon pool can be not reported ('NR' should be used) provided that transparent and verifiable information is provided indicating that the pool is not a source, while notation keys such as NO and NA may also sometimes be linked to incomplete estimates. In this respect it needs to be stressed that the late availability of the review reports complicates the follow-up with Member States related to potential missing GHG estimates before the next EU inventory submission. In 2010, 3 Member states review reports were published by 9.4.2010, one by 13.4.2010, two by 15.4.2010, one by 19.4.2010 and one by 20.4.2010.
2) The notation key 'NE' is not in all cases an indication of a problem and neither the IPCC guidelines nor the UNFCCC review guidelines foresee an automatic procedure of gap filling when NEs are reported. For example, the notation "NE" can be used if a Party provides sufficient evidence that the emissions related to a particular source category are negligible. Overall, a fair and complete analysis of the use of "NE" including the situations highlighted in point 1 above was considered to be indispensable.

Given the above considerations the specific steps of the action plan followed in 2011 were as follows:

1. Member States are required by Decision 280/2004 to submit their national GHG inventories electronically to the European Commission by 15 January of each year. A software program was created by the EEA so that upon submission of the relevant XML/CRF files a report was generated containing a list of all non-estimated source categories per Member State, specifying which of these source categories have been flagged in the Saturday Papers and for which ones IPCC methods are available. This report was then immediately notified to each Member State. During February the experts of the EU inventory team consulted and discussed with Member States' experts inter alia:
   a) how MS have addressed and documented (or plan to address) the potential issues flagged in their Saturday Papers regarding missing estimates;
   b) the need for applying gap-filling procedures and the selection of the most appropriate methods;
   c) the need to use different notation keys.
2. The completeness of Member States' national submissions with regard to individual CRF tables was documented in the 'status reports' sent to the Member States on 28 February. The EEA redesigned the current 'status reports' to include a specific section on the provision of information relating to completeness, focusing on the latest inventory year. This new section is based on the automatic checks and the additional bilateral discussions with MS during January and February as specified above. It reflects the status of the consultation with the MS and lists the follow-up expected from the MS by 15 March. According to the procedures and time scales described in Annex VI

of the Implementing Provisions, the Draft EU inventory was sent to MS by 28 February. Updated or additional inventory data submitted by MS (to remove inconsistencies or fill gaps) and complete final national inventory reports were submitted to the European Commission by 15 March.

3. In cases where, even after the two preceding steps a Member State's GHG inventory as submitted to the European Commission by 15 March still contained NEs for categories where IPCC methods exist, and/or if such reporting has been identified as a problem in previous reviews, then the EU inventory experts, in close cooperation with Member States, prepared the missing GHG source estimates in accordance with the gap-filling provisions in articles 13-16 of Commission Decision 2005/166/EC. In particular as regards the LULUCF sector, a gap-filling procedure was applied in a case where all KP tables were filled with NE, despite the previous submission (2010) was filled correctly. In this case, the same values reported in previous submission were used also in the 2011 submission. In addition, for one Member States also NEs from fugitive emissions from oil and gas were gap-filled (see section 16.5) Article 16 requires Member States to use the gap-filled estimates in their national submissions to the UNFCCC to ensure consistency between the EU inventory and Member States' inventories.
4. A general assessment of completeness is included in the EU Greenhouse Gas Inventory Report (section 1.7 of the 2011 EU NIR). For transparency reasons, the EU's 2011 inventory submission contains now an improved description of this section to reflect the additional improvements discussed above.
5. In addition to the steps detailed above the regular QA/QC procedures established to ensure the transparency, accuracy, comparability, consistency, and completeness of the EU inventory continued to be applied. The WG1 on annual inventories continues to address issues of completeness giving them priority and the EU internal reviews will further focus on identifying issues that may lead to an underestimation of emissions as we are approaching the end of the first commitment period.

# 14 INFORMATION ON CHANGES IN NATIONAL REGISTRY

A description of the EU registry was provided in the EU initial report. This description was updated in 2008 and the revised description was provided as Annex 13 to the NIR 2008.

Referring to paragraph 22 of the annex to Decision 15/CMP.1, the following changes have occurred in the Community Registry since the last report:

- In 2010, the EU national registry was amended in one major release, CR V5.0.

  The primary reason for this release was to refine the functioning of the EU national registry to the rules of Commission Regulation 994/2008. The core of the required changes was limited to EU ETS processes and did not affect existing Kyoto Protocol operations.

In addition to these changes, the EU national registry was adapted to accommodate the DES change request for the new transaction message flow; the CR was changed to be backward compatible and to ignore out-of-sequence messages.

**CR V5.0 implemented changes in the following areas:**

- The STL web services serving the following functions:
  - National Allocation Plan table management processes – changes to allow allocation to and removal from previous years
  - Compliance management processes
  - Permit date management processes

# 15 INFORMATION ON MINIMIZATION OF ADVERSE IMPACTS IN ACCORDANCE WITH ARTICLE 3, PARAGRAPH 14

## 15.1 Information on how the EU is striving, under Article 3, paragraph 14, of the Kyoto Protocol, to implement the commitments mentioned in Article 3, paragraph 1, of the Kyoto Protocol in such a way as to minimize adverse social, environmental and economic impacts on developing country Parties, particularly those identified in Article 4, paragraphs 8 and 9, of the Convention

**Editorial comment: The EU is only required to report changes related to the information on minimizing adverse impacts in accordance with Article 3, paragraph 14. However for an improved understanding, the text from the last year's inventory report was included and updated parts are marked in bold.**

In this section the EU provides information on how it is implementing its commitment under Article 3, paragraph 14 of the Kyoto Protocol, i.e. how it is striving to implement its commitment under Article 3, paragraph 1 of the Kyoto Protocol in such a way as to minimize potential adverse social, environmental and economic impacts on developing countries. In order to strive for such a minimization, an assessment of potential positive and negative impacts – both of direct and indirect nature - is necessary with a double objective to maximize positive impacts and to minimize adverse impacts. The EU is well aware of the need to assess impacts, and has built up thorough procedures in line with our obligations. This includes bilateral dialogues and different platforms in which we interact with third countries, explain new policy initiatives and receive comments from third countries.

Impacts on third countries are mostly indirect and can frequently neither be directly attributed to a specific EU policy, nor directly measured by the EU in developing countries. Therefore, the reported information covers potential adverse social, environmental and economic impacts that result from complex assessments of indirect influences and that are based on accessible data sources in developing countries.

### *15.1.1 Impact assessment of EU policies*

In the EU a wide-ranging impact assessment system accompanying all new policy initiatives has been established. This regulatory impact assessment is a key element in the development of the Commission's legislative proposals. The Commission is required to take the impact assessment reports into account when taking its decisions, while the impact assessments are also presented and discussed during the scrutiny of legislative proposals from the Council and the Parliament. This approach ensures that potential adverse social, environmental and economic impacts on various stakeholders (in the case on developing country Parties) are identified and minimized within the legislative process. In general, impact assessments are required for all legislative proposals, but also other important Commission initiatives which are likely to have far-reaching impacts. Below the impact assessment process implemented in the EU policy making is explained in more detail in order to better demonstrate how the EU is striving for all strategies and policies to minimize their adverse impacts. Specific guidelines for the impact assessment have been adopted (European Commission 2009).

**The Impact Assessment Guidelines specifically address impacts on third countries and also issues related to international relations. In this area the following questions have to be assessed:**

- Trade relations with third countries: some policies may affect trade or investment flows between the EU and third countries; the impact assessment should analyse how different groups (foreign and domestic businesses and consumers) are affected, and help to identify options which do not create unnecessary trade barriers.
- Impact on WTO obligations: it should be analysed which impact each proposed policy option has on the international obligations of the EU under the WTO Agreement; the impact assessment should examine whether the policy options concern an area in which international standards exist.
- Impacts on developing countries: initiatives that may affect developing countries should be analysed for their coherence with the objectives of the EU development policy. This includes an analysis of consequences (or spill-overs) in the longer run in areas such as economic, environmental, social or security policies.

**Key economic questions to be assessed in relation to third countries are:**

- How does the policy initiative affect trade or investment flows between the EU and third countries? How does it affect EU trade policy and its international obligations, including in the WTO?
- Does the option affect specific groups (foreign and domestic businesses and consumers) and if so in what way?
- Does the policy initiative concern an area in which international standards, common regulatory approaches or international regulatory dialogues exist?
- Does it affect EU foreign policy and EU development policy?
- What are the impacts on third countries with which the EU has preferential trade arrangements?
- Does it affect developing countries at different stages of development (least developed and other low-income and middle income countries) in a different manner?
- Does the option impose adjustment costs on developing countries?
- Does the option affect goods or services that are produced or consumed by developing countries?

Key questions on social impacts in third countries are:

- Does the option have a social impact on third countries that would be relevant for overarching EU policies, such as development policy?
- Does it affect international obligations and commitments of the EU arising from e.g. the ACP-EU Partnership Agreement or the Millennium Development Goals?
- Does it increase poverty in developing countries or have an impact on income of the poorest populations?

Key questions on environmental impacts in relation to third countries are:

- Does the option affect the emission of greenhouse gases (e.g. carbon dioxide, methane etc) into the atmosphere?
- Does the option affect the emission of ozone-depleting substances (CFCs, HCFCs etc)?
- Does the option affect our ability to adapt to climate change?
- Does the option have an impact on the environment in third countries that would be relevant for overarching EU policies, such as development policy?

If third countries are likely to be affected, the impact assessment should analyse in greater detail what the specific impacts may be, how undesired effects can be avoided or minimised, or mitigated, how the policy options compare in this respect and what trade-offs have to be addressed in the final policy choice.

Consulting interested parties is an obligation for every impact assessment and all affected stakeholders should be engaged, using the most appropriate timing, forma and tools to reach them. Appropriate consultation tools can be consultative committees, expert groups, open hearings, ad hoc meetings, consultation via Internet, questionnaires, focus groups or seminars/workshops. Existing international policy dialogues are also be used to keep third countries fully informed of forthcoming initiatives, and as a means of exchanging information, data and results of preparatory studies with partner countries and other external stakeholders.

The EU's 5th national communication provides a detailed overview of the European policies and measures to mitigate GHG emissions in all sectors. All key strategies and climate policies have been subject to impact assessments as described above. All impact assessments and all opinions of the Impact Assessment Board are published online (see **http://ec.europa.eu/governance/impact/ia_carried_out/cia_2010_en.htm**). In addition to the general approach described above to address adverse social, environmental and economic impacts, more specific ways to minimize impacts depend on the respective policies and measures implemented. As the reporting obligation related to Article 3, paragraph 14 does not include an obligation to report on each specific mitigation policy, the EU choses the approach to provide some specific examples for a more complete overview on the ways how the EU is striving to minimize adverse impacts.

Two major EU policies, the Directive on the promotion of the use of renewable energy (Directive 2009/28/EC as well as the extension of the EU emission trading scheme (ETS) to the aviation sector (Directive 2008/101/EC) are presented in more detail as examples in this chaper, because the related impact assessments identified potential impacts on third countries.

The European Commission, DG Environment, in addition commissioned a study on the "Interactions of the climate change policies and measures with non-environmental policies" to assess how GHG mitigation strategies in the European Union affect development opportunities in developing countries in indirect and unintended ways and how such effects can be reduced by modifying the policy design or by other policies, and how positive effects can be enhanced as part of a sustainable development. This also shows the EU's strong commitment to strive to implement its commitment under Article 3, paragraph 1 of the Kyoto Protocol in such a way as to minimize potential adverse social, environmental and economic impacts on developing countries.

### *15.1.2 Directive on the promotion of the use of renewable energy - Promotion of biomass and biofuels*

The Directive on renewable energy (Directive 2009/28/EC), a part of the EU's climate and energy package, sets ambitious targets for all Member States, such that the EU will reach a 20% share of energy from renewable sources in the overall energy consumption by 2020 (with individual targets for each Member State) and a 10% share of renewable energy specifically in the transport sector, which includes biofuels, biogas, hydrogen and electricity from renewables. Biomass is one of the renewable energy sources promoted by this directive and biofuels will be important for the achievement of the renewable target in the transport sector.

The impact assessments related to enhanced biofuel and biomass use in the EU showed that the cultivation of energy crops have both potential positive and negative impacts. Positively, as the growing of EU demand for bioenergy generates new export revenues and employment opportunities for developing countries and boosts rural economies. Thus there could be clear economic and social benefits. At the same time, the new EU energy crop demand could increase the impact on biodiversity, soil and water resources and can have positive as well as negative effects on air pollutants. The extent of carbon reduction and other environmental effects from the promotion of biofuels can vary according to the feedstock employed, the way the feedstock and the biofuels are produced, how they are transported and how far. Growing future demand for biomass feedstock combined with growing global food consumption could add to the agricultural sector's pressure on land use and result in adverse land use change.

To address the risk of such adverse impacts, Article 17 of the EU's Directive on renewable energy sources creates pioneering "sustainability criteria", applicable to all biofuels (biomass used in the transport sector) and bioliquids.

**The sustainability criteria adopted are:**

- establish a threshold for GHG emission reductions that have to be achieved from the use of biofuels;
- exclude the use of biofuels from land with high biodiversity value (primary forest and wooded land, protected areas or highly biodiverse grasslands),
- exclude the use of biofuels from land with high C stocks, such as wetlands, peatlands or continuously forested areas.

Developing country representatives as well as other stakeholder were extensively consulted during the development of the sustainability criteria and preparation of the directive and the extensive consultation process has been documented.

The Directive also ensures that the Commission will report every two years, in respect to both third countries and Member States which constitute a significant source of biofuels or of raw material for biofuels consumed within the Union, on national measures taken to respect the sustainability criteria for soil, water and air protection.

The criteria pursuant to Article 17 apply to biofuels and bioliquids, not to solid biomass which is also promoted by the Directive. With regard to the energy use of all biomass forms, Article 17, paragraph 9 of the Directive requires the Commission to report on "*requirements for a sustainability scheme for energy uses of biomass, other than biofuels and bioliquids, by 31 December 2009.*"

**In 2010, the Commission adopted a report on sustainability requirements for the use of solid biomass and biogas in electricity, heating and cooling together with an impact assessment. The report makes recommendations on sustainability criteria to be used by those Member States that wish to introduce a scheme at national level, in order to avoid obstacles for the functioning of the internal market for biomass.**

The Commission will also report on biofuels' potential indirect land use change effect and the positive and negative impact on social sustainability in the Union and in third countries, including the availability of foodstuffs at affordable prices, in particular for people living in developing countries, and wider development issues. Reports shall address the respect of land-use rights. The first reports will be submitted in 2012.

The EU's biofuel sustainability criteria form the first global initiative to address the climate change and sustainability issues surrounding crop production.

The biofuels scheme, by imposing environmental standards and requiring high greenhouse gas savings (35% rising to 60%), put also pressure on the production of the raw materials used for other purposes. Some examples of voluntary sustainability scheme out of the biofuels field are in the pipeline.

Any negative economic aspects will also be monitored by the Commission. In addition, Article 18(4) of the Directive provides that the Community shall endeavour to conclude bilateral or multilateral agreements with third countries containing provisions on sustainability criteria that correspond to those of this Directive. Where the Community has concluded agreements containing provisions relating to matters covered by the sustainability criteria set out in Article 17(2) to (5), the Commission may decide that those agreements demonstrate that biofuels and bioliquids produced from raw materials cultivated in those countries comply with the sustainability criteria in question.

**The recent Communication from the Commission on voluntary schemes and default values in the EU biofuels and bioliquids sustainability scheme (2010/C 160/01)[40] sets up a system for certifying sustainable biofuels, including those imported into the EU. It lays down rules that such schemes must adeher to if they are to be recognized by the Commission. This will ensure that the EU's requirements that biofuels deliver substantial reductions in greenhouse gas emissions and that biofuels do not result from forests, wetlands and nature protection areas.**

**In line with Article 19(4) of Directive 2009/28/EC on the promotion of the use of energy from renewable sources[41] the Commission published in 2010 a report on the feasibility of drawing up lists of areas in third countries with low greenhouse gas emissions from cultivation (COM(2010) 427 final) concluding that, "while desirable, it is not yet feasible to set up legally binding lists of areas for third countries where a major component of the underlying calculation is uncertain and can easily be questioned, and where third countries have had no possibility to contribute on the methodology and data used. It is therefore not appropriate, at least at this stage to produce legislative lists for third countries based on the current modelling of $N_2O$ emissions from agriculture. However, it is important to enhance the understanding of the topic and survey the data used in view of a new assessment in 2012. The Commission has thus published the preliminary results of the JRC work together with all necessary data and description of methodology to support such a process on the webpage of the JRC. It will use this as the basis for a discussion with third countries in the framework of its dialogue and exchange with them under Article 23(2) of the Renewable Energy Directive."**

In addition to the sustainability criteria, several initiatives have been taken to better channel and control biofuel and biomass expansion and thereby mitigate the most serious effects. With respect to palm oil production, the Roundtable on Sustainable Palm Oil (RPSO), an initiative by WWF, producers, traders and other NGOs, adopted of a set of criteria for the responsible production of palm oil, which would allow palm oil production without affecting the sustainability of tropical forests and endangered species. Other similar private and public initiatives will follow for other sectors and regions.

40 OJ C160, 19.6.2010, p.1

41 OJ L 140, 5.6.2009, p. 16

Another way the EU will strive to minimize potential adverse impacts of biomass use is to promote second generation biomass technologies. Within the renewable energy Directive, second generation biofuels are promoted through Article 21, paragraph 2 which establishes that the contribution made by biofuels produced from wastes, residues, non-food cellulosic material, and ligno-cellulosic material shall be considered to be twice that made by other biofuels for the purposes of demonstrating compliance with national renewable energy targets; and EU research also has a major focus on bioenergy technologies. The goal of second generation biofuel processes is to extend the amount of biofuel that can be produced sustainably by using biomass consisting of the residual non-food parts of current crops, such as stems, leaves and husks that are left behind once the food crop has been extracted, as well as other crops that are not used for food purposes (non food crops) and also industry waste such as woodchips, skins and pulp from fruit pressing. Second generation biofuels are expected to expand the biomass feedstock available for biofuel production. Further research and impact assessments in this area are necessary to assess e.g. the long-term effects of the energy use of non-food parts of crops compared to their existing use.

### 15.1.3 Inclusion of aviation in the EU emission trading scheme

In 2005 the Commission adopted a Communication entitled "Reducing the Climate Change Impact of Aviation", which evaluated the policy options available to this end and was accompanied by an impact assessment. The impact assessment concluded that, in view of the likely strong future growth in air traffic emissions, further measures are urgently needed. Therefore, the Commission decided to pursue a new market-based approach at EU level and included aviation activities in the EU's scheme for greenhouse gas emission allowance trading. The finally adopted legislation was the result of an extensive stakeholder consultation including an internet consultation and an Aviation Working Group of experts set up as part of the European Climate Change Programme that identified the integration of aviation in the EU ETS as the lowest cost option to address the challenge of reducing emissions from this sector. The impact assessment also specifically addressed the effects on developing countries (European Commission 2006).

Aircraft operators from developing countries will be affected to the extent they operate on routes covered by the scheme. Data from Eurocontrol on the nationality of operators has been used to make an estimate of the aggregated costs for third country airlines from regions that include developing countries. As operators from third countries generally represent a limited share of emissions covered, the impact is also modest. For example, the total additional operating costs for all operators based in Africa would, at current activity levels, vary from €2 to €35 million per year depending on allowance prices and the share of allowances auctioned. In terms of the economic impacts, a larger proportion of the compliance costs would naturally be borne by carriers from Annex I countries as they generally have a higher market share on the routes covered. However, carriers from developing countries that are able to operate in competition with Annex I carriers on such routes would need to be covered in order to avoid a) distortions of competition and b) discrimination as to nationality in line with the Chicago Convention.

For carriers with relatively old and inefficient fleets the impact may be higher as the effective proportion of allowances acquired for free through benchmarking is lower. However, as third country airlines would generally only have a fraction of their fleet operating in Europe, they may in some cases be able to reduce any negative effects by shifting their most efficient aircraft to operate on routes covered by the scheme.

To the extent that aviation's inclusion in the EU ETS creates additional demand for credits from JI and CDM projects, there will also be indirect positive effects as such projects imply additional investments in clean technologies in developing countries.

Similarly, additional finance for climate change mitigation and adaptation in developing countries should be raised through the auction of emissions allowances by EU Member States. The legislation provides a list of such areas by which the Member State should use the monies raised, and specifically mentions use for adaptation in developing countries.

There are further opportunities for developing countries to increase the demand for both CDM credits and future forms of sectoral mechanisms. The EU ETS legislation anticipates that third countries will take equivalent measures covering all flights departing their territory for the EU. In such circumstances, when equivalent measures are taken, the scope of the EU scheme can be reduced with the exclusion of these flights. Developing countries can thus benefit from additional demand for credits over and above the quantity that is allowed already for compliance by participants in the EU ETS.

## 15.2 Information on how the EU gives priority, in implementing the commitments under Article 3, paragraph 14, to specific actions

The EU reports activities that are related to the actions specified in the subparagraphs (a) to (f) of paragraph 24 of the reporting requirements in the Annex to decision 15/CMP.1. However, no decision was agreed yet that these actions form part of the commitment under Article 3, paragraph 14. For some of the actions specified in the reporting requirements, it seems rather unclear how they relate to the minimization of adverse social, environmental and economic impacts resulting from policies and measures to mitigate GHG emissions, e.g. information related to the cooperation activities requested are activities that help both Annex I and Non-Annex I Parties in reducing emissions from fossil fuel technologies, but they do not directly address the minimization of potential adverse impacts in Annex I Parties.

For the purposes of completeness in reporting, the EU addresses all subparagraphs specified in the reporting requirements, however the main ways how the EU is striving to minimize adverse impacts are described in the previous section.

**a) The progressive reduction or phasing out of market imperfections, fiscal incentives, tax and duty exemptions and subsidies in all greenhouse-gas-emitting sectors, taking into account the need for energy price reforms to reflect market prices and externalities**

The actions addressed in subparagraph a) also form part of the commitment to implement policies and measures requested under Article 2, paragraph 1(a) (v), however Article 2 specifies that Annex I Parties shall "implement and/or further elaborate policies and measures in accordance with national circumstances, such as progressive reduction or phasing out of market imperfections, fiscal incentives, tax and duty exemptions and subsidies in all greenhouse gas emitting sectors **that run counter to the objective of the Convention and application of market instruments**." Subparagraph a) in the reporting requirements lacks such objective and therefore seems somewhat inconsistent with the commitment under Article 2. The promotion of research, demonstration projects, fiscal incentives or carbon taxes is important instrument to advance the objectives of the Convention, e.g. the use of renewable energies. A progressive reduction of **all** fical incentives or subsidies in all GHG emitting sectors would run counter the objective of the Convention and counter the ability of the EU to meet its commitment under Article 3, paragraph 1 of the Kyoto Protocol. Therfore the EU interprets this reporting requirement in a way consistent with Article 2 paragraph 1(a)(v) that the EU should focus on the progressive reduction or phasing out of market imperfections, fiscal incentives, tax and duty exemptions and subsidies that run counter the objectives of the Convention and application of market instruments.

The 2009 Review of the EU Sustainable Development Strategy assesses that *"the Commission has been mainstreaming the progressive reform of environmentally harmful subsidies into its sectoral policies"*. For instance, environmental concerns have been gradually incorporated into the EU Common Agricultural Policy, including "decoupled" direct payments which have replaced price support; environmental cross compliance; a substantial increase in budget for rural development. As part of 2008 Common Agriculture Policy Health Check, additional part of direct aid has been shifted to climate change, renewable energy, water management, biodiversity, innovation; - transparency of agricultural subsidies has improved. It is important to note that in the other areas most subsidies are within the competence of the Member States and not of the EU, within the limits established by EU state aid rules.

EU policies aim to address market imperfections and to reflect externalities. For example the EU has made significant efforts to liberalise the internal energy market and to create a genuine internal market for energy as one of its priority objectives. The existence of a competitive internal energy market is a strategic instrument both in terms of giving European consumers a choice between different companies supplying gas and electricity at reasonable prices, but also in terms of making the market accessible for all suppliers, especially the smallest and those investing in renewable forms of energy.

With the implementation of the EU Emissions Trading Scheme, the EU uses a market instrument to implement the objective of the Convention and its commitment under Article 3, paragraph 1 of the Kyoto Protocol which aims at creating the right incentives for forward looking low carbon investment decisions by reinforcing a clear, undistorted and long-term carbon price signal.

With respect to financial support provided by the Member States to undertakings, the EU Treaty pronounces a general prohibition of "State aid". This concept encompasses a broad range of financial support measures adopted at national or sub-national level (i.e. not at EU level), and which can take various forms (subsidies, tax relieves, soft loans…). The Treaty provides for exceptions to this general prohibition. When State aid measures can contribute in an appropriate manner to the furtherance of objectives of common interest for the EU, and provided that they comply with certain strict conditions, they may be authorised by the Commission. By complementing the fundamental rules through a series of legislative acts and guidelines, the EU has established a worldwide unique system of rules under which State aid is monitored and assessed in the European Union. This legal framework is regularly reviewed to improve its efficiency. EU State aid control is an essential component of competition policy and a necessary safeguard for effective competition and free trade.

State aid reform in the EU aims to redirect aid to objectives of common interest which are related to the EU Lisbon Treaty, such as R&D&I, risk capital measures, training, and environmental protection. Environmental protection, and in particular, the promotion of renewable energy and the fight against climate change, is considered one of the objectives of common interest for the EU which may, under certain circumstances, justify the granting of State aid.

Specific “Community Guidelines on State aid for Environmental Protection”[42] have been established. The Guidelines foresee in particular the possibility to authorise the following types of State aid under certain conditions:

- Aid for undertakings which go beyond EU environmental standards or which increase the level of environmental protection in the absence of EU standards
- Aid for early adaptation to future EU standards
- Aid for energy saving
- Aid for renewable energy sources
- Aid for high-efficient cogeneration

[42] Official Journal No C 82, 1.4.2008, p.1

- Aid for energy-efficient district heating (DH).

Directive 2003/96/EC on the taxation of energy products and electricity establishes EU-wide rules for the taxation of energy products used as motor or heating fuel, taxes on energy consumption, and common minimum levels of taxation. Under certain conditions the Directive allows for exemptions or reductions to promote renewable sources of energy. Thus, the tax exemptions allowed under this directive further promote the objectives of the Kyoto Protocol.

**b) Removing subsidies associated with the use of environmentally unsound and unsafe technologies**

There is no clear definition of environmentally unsound and unsafe technologies, therefore the EU interprets this provision in the context of the KyotoProtocol that unsound and unsafe technologies would be those increasing GHG emissions.

The phase-out of subsidies to fossil fuel production and consumption by 2010 was one of the objectives in the Communication from the Commission "A Sustainable Europe for a Better World: A European Union Strategy for Sustainable Development (Commission's proposal to the Gothenburg European Council, 2001)".[43]

**Council Decision 2010/787/EU of 10 December 2010 on State aid to facilitate the closure of uncompetitive coal mines adopted a new coal regulation enabling Member States to grant State aid to facilitate the closure of uncompetitive mines until 2018, following the expiry of the current Coal Regulation (Council Regulation (EC) N° 1407/2002 of 23 July 2002) on 31 December 2010. The decision includes the following main elements:**

- **the possibility of continuing to grant, under certain conditions, public aid to the coal industry with a view to facilitating the closure of uncompetitive hard coal mines until December 2018;**
- **the modalities for the phasing-out of the aid, under which the overall amount of aid granted by a member state must follow a downward trend, in order to prevent undesirable effects of distortion of competition in the internal market. Subsidies will have to be lowered by at least 25% until 2013, by 40% until 2015, by 60% by 2016 and by 75% by 2017;**
- **the obligation for member states granting aid to provide a plan on intended measures to mitigate the environmental impact of the production of coal; and**
- **the possibility of allowing subsidies, until December 2027, in order to cover exceptional expenditure in connection with the closure of mines that are not related to production, such as social welfare benefits and rehabilitation of sites.**

**c) Cooperating in the technological development of non-energy uses of fossil fuels, and supporting developing country Parties to this end;**

The technological development of non-energy uses of fossil fuels is not a current research priority in the EU, nor a priority of cooperation with developing countries because the EU is not a major producer of oil and gas. Given the long-term depletion of fossil fuel resources and the decline in coal production, the EU's priority in general is the replacement of the use of fossil fuels by renewable resources.

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[43] See http://eur-lex.europa.eu/LexUriServ/site/en/com/2001/com2001_0264en01.pdf

**d) Cooperating in the development, diffusion, and transfer of less-greenhouse-gas-emitting advanced fossil-fuel technologies, and/or technologies, relating to fossil fuels, that capture and store greenhouse gases, and encouraging their wider use; and facilitating the participation of the least developed countries and other non-Annex I Parties in this effort;**

In March 2005, the EU and China signed an Action Plan on Clean Coal, which included cooperation on carbon capture and storage. The subsequent 2005 EU-China Summit established the EU-China Climate Change Partnership, which includes a political commitment to develop and demonstrate in China and the EU advanced, near-zero emissions coal (NZEC) technology through carbon capture and storage (CCS) by 2020. Phase I of this cooperation will be completed in 2009. Phase II of NZEC will run from 2010-2012. It will examine the site-specific requirements for and define in detail a demonstration plant and accompanying measures. It will include the technical and cost analysis of different options. Based on this analysis, the site of the power plant as well as the combustion technology (pulverised coal or IGCC), the capture technology and the transport and storage concepts will be determined. Phase II shall also include a detailed roadmap for the construction and operation of the demonstration plant as well as an Environmental Impact Assessment of the demonstration power plant and the carbon storage site. Phase III should commence thereafter and will see the construction and operation of a commercial-scale demonstration plant in China.

The Communication from the Commission entitled "*Demonstrating Carbon Capture and Geological Storage (CCS) in emerging developing countries: financing the EU-China Near Zero Emissions Coal Plant project*" from June 2009 sets out the plan of the European Commission to establish an investment scheme to co-finance the construction and operation of a power plant to demonstrate carbon capture and storage (CCS) technology in China. This investment scheme could serve as a model for other technology cooperation activities between developed countries and emerging/developing countries in the context of a post-2012 climate change agreement.

The EU is also cooperating with other Annex I and Non-Annex I Parties (**Australia**, Brazil, **Canada**, China, Colombia, Denmark**, European Commission, France, Germany, Greece**, India, **Italy, Japan**, Korea, Mexico, **Netherlands, New Zealand, Norway, Poland, Russian Federation, Saudi Arabia**, South Africa, **United Arab Emirates, United Kingdom and USA**) in the "Carbon Sequestration Leadership Forum (CSLF)". The CSLF is a Ministerial-level international climate change initiative that is focused on the development of improved cost-effective technologies for the separation and capture of carbon dioxide ($CO_2$) for its transport and long-term safe storage. The mission of the CSLF is to facilitate the development and deployment of such technologies via collaborative efforts that address key technical, economic, and environmental obstacles. The CSLF will also promote awareness and champion legal, regulatory, financial, and institutional environments conducive to such technologies. **In 2010 a Technology Roadmap was released by the Carbon Sequestration Leadership Forum. This road map indicates that significant international progress has been made in the past year on advancing carbon capture and storage, but that a number of important challenges remain that must be addressed to achieve widespread commercial deployment of CCS. The 2011 Strategic Plan Implementation Report recognized five new CCS projects bringing the total number of CSLF recognized technology demonstrations to 32.** [44]

[44] See http://www.cslforum.org/ for more specific information

**e) Strengthening the capacity of developing country Parties identified in Article 4, paragraphs 8 and 9, of the Convention for improving efficiency in upstream and downstream activities relating to fossil fuels, taking into consideration the need to improve the environmental efficiency of these activities**

In the oil and gas industry the upstream sector is a term commonly used to refer to the exploration, drilling, recovery and production of crude oil and natural gas. The downstream sector includes the activities of refining, distillation, cracking, reforming, blending storage, mixing and shipping and distribution.

The EU contributes to strengethening of the capacities of fossil fuel exporting countries in the areas of energy efficiency via the work of the Energy Expert Group of the Gulf Cooperation Council (GCC)[45], in particular in the working sub-group on energy efficiency. As part of the EU's research programme, a project called "EUROGULF" was launched with the objective of to analyse EU-GCC relations with respect to oil and gas issues and propose new policy initiatives and approaches to enhance cooperation between the two regional groupings.

The European e-network on clean energy technologies, currently under development as part of the EU's research and development, is also aiming at the objective: promote research and technical development of clean energy technologies in the GCC countries. The Commission has recently started a project with the specific objective to create and facilitate the operation of an EU-GCC Clean Energy Network during the next three years. The network is to be set up to act as a catalyst and element of coordination for development of cooperation on clean energy. **A website was created at** http://www.eugcc-cleanergy.net **where further information on the EU-GCC Clean Energy Network and its recent activities can be found. The Masdar Institute of Science and Technology in Abu Dhabi has been selected as the lead research institution to represent the Gulf Cooperation Council (GCC) in the European Union-GCC Clean Energy Network. A number of discussion groups and training seminars took place, e.g. on solar resource assessment.**

Energy efficiency activities in the upstream or downstream sector are also candidates for CDM projects. Thus, the development of the CDM under the Kyoto Protocol and the demand of CERs by Annex I Parties under the Kyoto Protocol as well as by operators under the EU ETS have fostered such activities performed by the private sector. Related CDM projects are for example:

- Rang Dong Oil Field Associated Gas Recovery and Utilization Project in Vietnam: The purpose of this project activity is the recovery and utilization of gases produced as a by-product of oil production activities at the Rang Dong oil field in Vietnam with the involvement of Conoco-Phillips (UK).
- Recovery of associated gas that would otherwise be flared at Kwale oil-gas processing plant in Nigeria involves the capture and utilisation of the majority of associated gas previously sent to flaring at Kwale OGPP plant. The Kwale OGPP plant receives oil with associated gas from oil fields operated by Eni Nigeria Agip Oil Company.
- Recovery and utilization of associated gas produced as by-product of oil recovery activities at the Al-Shaheen oil field in Qatar
- Flare gas recovery and utilisation project at Uran oil and gas processing plant in India which is handleing the oil and gas produced in the Mumbai High offshore oil field.
- Flare gas recovery and utilisation project at Hazira gas and condensate processing plant in India.
- Flare gas recovery and utilisation project from Kumchai oil field in India
- Flare gas recovery and utilisation project at the Ovade-Ogharefe oil field operated by Pan Ocean Oil Corporation in Nigeria
- Flare gas recovery and utilisation project at Soroosh and Nowrooz offshore oil fields in Iran.

[45] The Gulf Cooperation Council covers Bahrain, Kuwait, Oman, Qatar, Saudi Arabia and the United Arab Emirates.

- Leak reduction in aboveground gas distribution equipment in the KazTransgaz-Tbilisi gas distribution system in Georgia where leakages at gate stations, pressure regulator stations, valves, fittings as well at conection points with consumers are reduced.
- There are currently 21 Coal Mine Methane Utilization Project in China which use coalmine methane previously released to the atmosphere.

Improved energy efficiency in the energy and the transport sector in a more general way is one of the priorities in the EU's development assistance as well as for the EIB (European Investment Bank) and the EBRD (European Bank for Reconstruction and Development). Related projects and specific activities can be found for example at http://www.eib.org/projects/topics/environment/renewable-energy/index.htm or http://www.ebrd.com/country/sector/energyef/.

**f) Assisting developing country Parties which are highly dependent on the export and consumption of fossil fuels in diversifying their economies.**

The EU actively undertakes a large number of activities aiming at reducing dependence on the consumption of fossil fuels, in particular the EU support activities for the promotion of renewable energies and energy efficiency in developing countries contribute to reduction of dependence on fossil fuels, meeting rural electricity needs, and the improvement of air quality. As explained in more detail in chapter 8 of the EU's 5th national communication, there exist several support programmes in this respect. These include:

- *Renewable energy cooperation with the Mediterranean and Gulf countries*

  The major objective of the cooperation between the EU and the Mediterranean and Gulf countries in the field of renewable energy is to contribute to sustainable energy and climate mitigation and to develop an integrated and interconnected 'Green Energy Market'.

  Several initiatives are already being developed by the European Union in cooperation with the partners in the Gulf region to boost energy as well as renewable energy development. This includes the EU-GCC (Gulf Coopration Council) Energy Expert Group, which started working at the beginning of 1990s' and the EU-GCC Climate Change Expert Group that has met on a regular basis since 2007. In 2009 EU and GCC partners agreed on extending energy cooperation and more specifically on establishing an EU-GCC clean energy network thus bringing together the relevant EU and GCC stakeholders. The European Commission will support the establishment of a network of key actors from public and private sectors in the EU and the GCC with a view to deepening cooperate on clean energy. This network will act as a facilitator and identify projects in fields of common interest, such as solar and other renewable energies.

  Given the importance of research to further development of renewable energy in the GCC region, the Commission is also contributing to the establishment of a specific large-scale platform to foster international R&D cooperation with partners of the Gulf region.

The expansion and deployment of renewable energy is currently a key element in cooperation between the EU and the Mediterranean countries. The most important initiative is the Mediterranean Solar Plan, endorsed in 2008. The objective is the creation of 20 GW of new generation capacity in solar and other renewable energy sources around the Mediterranean Sea by 2020. The Regional Centre of Excellence for Renewable Energy and Energy Efficiency (RCREEE) facilitates development of renewable energy sources and promotion of energy efficiency measures in the Southern Mediterranean partner countries. Since 2008, when the centre was established in Cairo, the European Union has provided a financial contribution to enable the launch and initial operation of the Centre. Bearing in mind the importance of the infrastructures necessary for deployment and exports of green energy, the EU is contributing to the Maghreb Electricity Market Integration Project (IMME). The objective is to create a sub-regional electricity market between Morocco, Tunisia and Algeria and its progressive integration with the EU's electricity market. The Commission has so far provided a support of €5.6 million. These are only some examples from the cooperation with the Mediterranean countries.

- *Africa, Caribbean and the Pacific (ACP-E) Energy Facility*

  The ACP-EU Energy Facility is a contribution under the EU Energy Initiative to increase access to energy services for the poor. The Facility was approved by the joint ACPEU Council of Ministers in June 2005, with an amount of € 220million. The main activity of the Facility is to co-finance projects that deliver energy services to poor rural areas.

  The Energy Facility was mainly implemented through a €198 million Call for Proposals which was launched in June 2006. Out of 307 proposals received, 74 projects have been contracted by the end of 2008 for a total amount of €196 million from the Energy Facility, with a total project cost of €430 million.

  The main activities performed through Energy Facility projects can be classified into three different groups: (1) energy production, transformation and distribution, (2) extension of existing electricity grids and (3) "soft" activities such as governance, capacity building or feasibility studies. The sources of energy used for electricity generation were mainly renewable energies (77 % of the projects). Only one project using exclusively fossil fuels was funded. In total, € 81 million of commitments have been marked as climate change related under the Energy Facility, covering support to enhance use of renewable energies or increase energy efficiency. A replenishment of the ACP-EU Energy Facility has been decided under the 10$^{th}$ European Development Fund for the period of 2009-2013. Endowed with € 200 Million, it will focus on improving access to safe and sustainable energy services in rural and peri-urban areas. The new Energy Facility will also contribute to the fight against climate change by emphasizing the use of renewable energy sources and energy efficiency measures and by taking into account impacts of climate change on energy systems. The new Facility started being implemented by the end of 2009 **and funding guidelines were approved in October 2010**.

- *Euro-Solar Programme in Latin America*

  The Euro-Solar Programme is aiming to reduce poverty, allowing remote rural communities currently without access to electricity, to benefit from renewable electric energy. Approved in May 2006 and extended in December 2008, the Programme's total budget amounts to € 35.8 million, of which € 6.9 million will be provided by the Programme's eight beneficiary countries.

- *Latin America Investment Facility (LAIF)*

The European Commission plans to establish the Latin America Investment Facility (LAIF). The LAIF will focus on energy, environment and transport investment, contributing to cleaner transport infrastructure, improved energy efficiency and energy savings, the use of renewable energy, low-carbon production and of climate change adaptation technologies. The LAIF will operate by providing financial non-refundable contributions to support loans to partner countries from the European Investment Bank (EIB) and other European, multilateral and national, development finance institutions and will encourage the beneficiary governments and public institutions to carry out essential investments in the relevant sectors. The contribution of the Commission to the LAIF will be decided annually. For the year 2009, the Commission will allocate a budget of €10.85 million.

- *Global Energy Efficiency and Renewable Energy Fund (GEEREF)*

The European Commission has launched an innovative pilot instrument to involve the private sector. The Global Energy Efficiency and Renewable Energy Fund (GEEREF), launched in 2007, is focused on energy efficiency and renewable energy projects in developing countries and economies in transition. GEEREF invests in regionally-orientated investment schemes and prioritises small investments below €10 million. In December 2008, the GEEREF Investment Committee approved two funds, and the first investments of a total value of € 22.5 million were carried out in 2009 focussing on projects in Sub-Saharan and Southern Africa and in Asia:

- €12.5 million investment in Berkeley Energy's Renewable Energy Asia Fund (REAF) for operationally and economically mature wind, hydro, solar, biomass, geothermal and methane recovery projects in India, Philippines, Bangladesh and Nepal.
- €10 million investment in the Evolution One Fund, dedicated to clean energy investment in Southern Africa (SADC countries).

In the regions where the two funds operate, there is a lack of equity investment available through the market for these types of projects. It is envisaged that GEEREF will invest in regional sub-funds for the African, Caribbean and Pacific (ACP) region, Neighbourhood, Latin America and Asia. Together the European Commission, Germany and Norway have committed about €108 million to the GEEREF over the period 2007-2011, the majority of which is provided by from the EU budget. It is envisaged that further financing from other public and private sources will be forthcoming. In 2007, the the EU budget contributed €5 million towards a support facility for the GEEREF and a further €25 million in form of grants.

The EU also supports developing countries in diversifying their economies, however these activities are not limited to fossil fuel exporting countries, but open to all developing countries based on partnership agreements such as the ACP-EU Partnership Agreement. Within this partnership agreement there are five areas of EU intervention for private sector development which are:

1. The creation of enabling environment
2. The promotion of investment and inter-enterprise co-operation
3. Investment financing and development of financial markets
4. Business Development Services
5. Support for micro-enterprises (especially through the development of an effective microfinance market)

More specific information related to these activities can be obtained at: http://ec.europa.eu/europeaid/where/acp/sector-cooperation/economic-growth/index_en.htm

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European Commission 2002 (Directorate General for Energy and transport): Inventory of public aid granted to different energy sources. Working document from the services of the Commission.

European Commission 2006: Commission staff working document, Accompanying document to the proposal for a Directive of the European Parliament and of the Council amending Directive 2003/87/EC so as to include aviation activities in the scheme for greenhouse gas emission allowance trading within the Community Impact Assessment of the inclusion of aviation activities in the scheme for greenhouse gas emission allowance trading within the Community SEC(2006) 1648, COM(2006) 818 final.

European Commission 2007a: Commission Report on the Application of Council Regulation (EC) No 1407/2002 on State Aid to the Coal Industry, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, 21.5.2007, SEC(2007) 602, COM(2007) 253 final.

European Commission 2007b: Commission staff working document, Annex to the Commission Report on the Application of Council Regulation (EC) No 1407/2002 on State Aid to the Coal Industry, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, 21.5.2007, SEC(2007) 602, COM(2007) 253 final

European Commission 2009: Impact Assessment Guidelines, 15 January 2009, (SEC(2009)92)

Luciani, G. 2005: EUROGULF: An EU-GCC Dialogue for energy stability and sustainability. Final research report as presented at the conclusing conference in Kuweit, 2-3 April 2005

# PART 3: ANNUAL INVENTORY SUBMISSION (EU-27)

# 16 INTRODUCTION

This part of the EU GHG inventory report includes data for the EU-27 Member States. The EU-27 Member States are (new MS are marked with n): Austria, Belgium, Bulgaria (n), Cyprus (n), the Czech Republic (n), Denmark, Estonia (n), Finland, France, Germany, Greece, Hungary (n), Ireland, Italy, Latvia (n), Lithuania (n), Luxembourg, Malta (n), the Netherlands, Poland (n), Portugal, Romania (n), Slovakia (n), Slovenia (n), Spain, Sweden and the United Kingdom. As the relevant information for the EU-15 Member States was given in part 1 of this report, this part provides information for the 12 new Member States. The relevant tables for the new Member States are included in this part as well as more detailed information on the the 20 largest key categories. The general description of institutional arrangements at EU level are also included in part 1.

## 16.1 Institutional arrangements and inventory preparation

Table 16.1 shows the main institutions and persons involved in the compilation and submission of the new Member States' inventories.

**Table 16.1 List of institutions and experts responsible for the compilation of new Member States' inventories and for the preparation of the EU inventory**

| Member State/EU institution | Contact address |
|---|---|
| Bulgaria | Detelina Petrova<br>Executive Environment Agency<br>136, Tzar Boris III Blvd.<br>1618 Sofia |
| Cyprus | Theodoulos Mesimeris<br>Head of Climate Action Unit<br>Department of Environment<br>Ministry of Agriculture, Natural Resources and Environment<br>1498, Nicosia, Cyprus |
| Czech Republic | Pavel Fott<br>Czech Hydrometeorological Institute (CHMI)<br>Na Sabatce 17, CZ 14306 Prague 4 |
| Estonia | Anne Mändmets<br>Ministry of the Environment<br>Narva mnt 7a 15172 Tallinn, Estonia |
| Hungary | László Gáspár<br>Ministry of Environment and Water, department of Climate Policy<br>Fõ u. 44-50, Budapest, 1011 Hungary |
| Latvia | Agita Gancone<br>Latvian Environment, Geology and Meteorology Centre<br>Maskavas street 165, Riga, LV-1019 |
| Lithuania | Vytautas Krusinskas<br>Lithuanian Ministry of Environment<br>A. Jaksto 4/9, LT 01105 Vilnius |
| Malta | Krista Rizzo<br>Malta Resources Authority – Climate Change Unit<br>Millennia, 2nd Floor, Aldo Moro Road, Marsa MRS 9065, Malta. |
| Poland | Krzysztof Olendrzynski<br>Institute of Environmental Protection, National Centre for Emission Management<br>Kolektorska 4, 01-692 Warszawa |
| Romania | Sorin Deaconu<br>National Environmental Protection Agency<br>Splaiul Independentei 294, Sector 6, Cod Postal 060841, Bucharest, Romania |
| Slovakia | Janka Szemesova<br>Department of Emissions, Slovak Hydrometeorological Institute<br>Jeseniova 17, 833 15 Bratislava, Slovak Republic |

| Member State/EU institution | Contact address |
|---|---|
| Slovenia | Tajda Mekinda Majaron<br>Environmental Agency of the Republic of Slovenia<br>Vojkova 1/b, SI-1000 Ljubljana |

Table 16.2 summarises the information on national systems/institutional arrangements in the new EU Member States.

**Table 16.2 Summaries of institutional arrangments/national systems of new Member States**

| MS | Institutional arrangments/national systems | Source |
|---|---|---|
| **Bulgaria** | The BGNIS is developed following the requirements of the provisions of Decision 19/CMP.1 Guidelines for national systems under Article 5, paragraph 1, of the Kyoto Protocol. The BGNIS has been enshrined in law through a special Regulation of the Council of Ministers 215/21.09.2010 SG 76/2010. The new regulation establishes and maintain the institutional, legal and procedural arrangements necessary to perform the general and specific functions of BGNIS, defined in Decision 19/CMP.1. The new regulation reinforces the existing institutional agreements by specifying the roles of all data providers.<br><br>Bulgaria's reporting obligations to the UNFCCC, UNECE and EC are being administered by the MoEW. All activities on preparation of GHG inventory in Bulgaria are coordinated and managed on the state level by MoEW. The Bulgarian Government by MoEW has the political responsibility for compliance with commitments under the Kyoto Protocol, including for functioning of BGNIS in accordance with the requirements of Decision 19/CMP.1 under Article 5, paragraph 1, of the Kyoto Protocol:<br>• National Focal Point;<br>• QA exeperts from Climate Change Policy Directorate and Air Protection Directorate;<br>• Approval of inventory;<br>• Submission of CRF / NIR / Kyoto Tables / SEF.<br><br>The ExEA has been identified as the responsible organization for preparation of Bulgaria's National GHG Inventory under the UNFCCC and the Kyoto Protocol and designated as single national entity. ExEA has the technical responsibility for the national inventory:<br>• acts as National Inventory Compiler (supervises inventory preparation process);<br>• manages BGNIS;<br>• compiles CRF tables and NIR;<br>• coordinates the work of engaged consultants for supporting inventory;<br>• coordinates and implements the activity of National QA/QC Plan;<br>• National Inventory Focal Point.<br><br>The ExEA coordinates all activities, related to collecting inventory data of GHG emissions by the following authorities:<br>• National Statistical Institute;<br>• Ministry of Economy and Energy (MEE);<br>• Statistics Department within Ministry of Agriculture and Food Supplies (MAF) and their relevant services;<br>• Ministry of Environment and Water;<br>• State Forestry Agency (SFA);<br>• Road Control Department (RCD/MIA) within the Ministry of Internal Affairs;<br>• Large industrial plants<br>• Branch Business Associations | Short NIR of GHG emissions in Republic Bulgaria 1988-2009<br><br>Jan 2011<br><br>pp. 4ff |
| **Cyprus** | The competent authority for Decision 280/2004/EC and the preparation and submission of the National Greenhouse Gases Inventory Report of Cyprus, is the Ministry of Agriculture, Natural Resources and Environment (MANRE).<br><br>The Department of Environment is responsible for the preparation of the GHG inventory, which consists of the preparation/compilation of the annual national inventory, i.e. the selection of methodologies, data collection (activity data and emission factors, provided by statistical services and other organizations), data processing and archiving, as well as the implementation of general quality control procedures; and the development of an inventory QA/QC plan, in accordance with the provisions of the IPCC Good Practice Guidance.<br><br>The NIR2011 has been developed through the co-operation of the Department of Environment with the departments and institutions presented in Table 1.5. | National GHG Inventory Report 1990-2009 2011 Submission<br><br>Jan 2011, pp. 2-3 |

<table>
<tr><th>MS</th><th>Institutional arrangments/national systems</th><th>Source</th></tr>
<tr><td>Czech Republic</td><td>
The arrangement of institutions co-operating in the national GHG inventory is given by National Inventory System - NIS, which was established in accord with Decision 280/2004/EC, Article 4.4. This system accepted the rules from Resolution 20/CP.7 (FCCC/CP/13/Add.3) that was approved by COP/MOP-1 in Montreal, December 2005. The relevant information is given in the Czech Republic's Initial Report under the Kyoto Protocol, which was sent to European Commission (June 2006) and to UNFCCC (October 2006)
In the Czech Republic, the Ministry of the Environment (MoE) is the national entity with overall responsibility for the NIS.
The Czech Hydrometeorological Institute (CHMI), founded by the MoE, is designated as the coordinating and managing organisation responsible for the compilation of the national greenhouse gas inventory and reporting its results. In addition, the MoE provides additional specific financial resources for the NIS performance to the CHMI. The representative of CHMI for the NIS is Mr. Pavel Fott (fott@chmi.cz).
The main roles and responsibilities of the CHMI are: inventory management, general and cross-cutting issues, QA/QC, reporting data (CRF), preparation of NIR, communication with the relevant UN FCCC and EU bodies, etc. Sectoral inventories are prepared by specialized institutions (sectoral compilers), which are coordinated and controlled by the CHMI. The responsibilities for the GHG inventory compilation from individual sectors are allocated as follows:
<ul>
<li>KONEKO marketing, Ltd. (KONEKO), with responsibility for the inventory compilation in the Energy sector, in particular for stationary sources and fugitive emissions;</li>
<li>The Transport Research Centre (CDV), with responsibility for the inventory compilation in the Energy sector, in particular for mobile sources;</li>
<li>The Czech Hydrometeorological Institute (CHMI), with responsibility for the inventory compilation in the Industrial Processes and Product Use sectors;</li>
<li>The Institute of Forest Ecosystem Research (IFER), with responsibility for the inventory compilation in the Agriculture and Land Use, Land Use Change and Forestry sectors;</li>
<li>Charles University Environment Centre (CUEC), with responsibility for the inventory compilation in the Waste sector.</li>
</ul>
The official submission of the National GHG Inventory is prepared by the CHMI and approved by the MoE. Moreover, the MoE secures contacts with other relevant governmental bodies, such as the Czech Statistical Office (CSO), the Ministry of Industry and Trade (MoIT) and the Ministry of Agriculture (MoA).
</td><td>
National GHG Inventory Report 2011 of the Czech Republik
Jan 2011 pp. 5-6
No change with regard to previous submission
</td></tr>
<tr><td>Estonia</td><td>
Single national entity with overall responsibility for the Estonian greenhouse gas inventory is the Estonian Ministry of the Environment (MoE). The inventory is produced in collaboration between the MoE, Estonian Environmental Research Centre (EERC), Estonian Environment Information Centre (EEIC) and Tallinn University of Technology (TUT).
The MoE is responsible for:
<ul>
<li>Coordinating the overall inventory preparation process;</li>
<li>Approving the inventory before official submission to the UNFCCC;</li>
<li>Reporting the greenhouse gas inventory to the UNFCCC, including the National Inventory Report and CRF tables;</li>
<li>Concluding the formal agreements with inventory compilers (TUT, EERC);</li>
<li>Coordinating the cooperative work between the inventory compilers and UNFCCC Secretariat;</li>
<li>Informing the inventory compilers about the requirements of the national system and ensuring that existing information in national institutions is considered and used in the inventory where appropriate;</li>
<li>Informing the inventory compilers about new or revised guidelines;</li>
<li>Coordinating the UNFCCC inventory reviews.</li>
</ul>
Climate Department in EERC is responsible for:
<ul>
<li>Compiling the National Inventory Report according to the parts submitted by the inventory compilers;</li>
<li>Coordinating of the implementation of the QA/QC plan;</li>
<li>Coordinating the inventory process;</li>
<li>Preparation of the UNFCCC inventory reviews and coordinating the communication with the expert review team, including responses to the review findings;</li>
<li>Overall archiving system.</li>
</ul>
Department of Thermal Engineering and Department of Chemistry at TUT prepare the estimates for the Energy and Agriculture sectors. The EERC is responsible for the Industrial Processes, Solvents and Other Product Use and Waste sectors. Department of the National Forest Inventory at EEIC is responsible for the LULUCF and KP LULUCF sectors. All experts collect activity data, prepare relevant QC, fill in the sectoral data to the CRF Reporter and prepare sectoral parts of the NIR. They also have archiving system for the sectors that they are working with.
</td><td>
Greenhouse Gas Emissions in Estonia 1990-2009
Jan 2011
pp. 17ff
</td></tr>
</table>

| MS | Institutional arrangments/national systems | Source |
|---|---|---|
| Hungary | The designated single national entity is the Ministry of Environment and Water. Within the ministry, the Climate Change and Energy Department administers this responsibility by supervising the national system. At the end of 2006, a GHG division was established in the Hungarian Meteorological Service (OMSZ) for the preparation and development of the inventory. This division is responsible for all inventory related tasks, prepares the greenhouse gas inventories and other reports with the involvement of external institutions and experts on a contractual base and supervises the maintenance of the system.<br><br>The GHG division coordinates the work with other involved ministries, government agencies, consultants, universities and companies in order to be able to draw up the yearly inventory report and other reports to the UNFCCC and the European Commission. The GHG division can be regarded as a core expert team of four people. The division of labour and the sectoral responsibilities within the team are laid down in the QA/QC plan and other official documents of OMSZ. The Head of Division coordinates the teamwork and organizes the cooperation with other institutions involved in inventory preparations. He is responsible for compilation of CRF tables and NIR. Within the team there are coordinators of the different sectors and also a QA/QC co-ordinator and an archive manager were nominated.<br><br>Some parts of the inventory (mainly energy and waste) are prepared by the experts of the GHG division themselves.<br><br>In the industry and solvent sector the former inventory compiler acted as sectoral expert, so he collected the data and prepared the inventory. The agriculture sector of the inventory has been prepared by the Research Institute for Animal Breeding and Nutrition for several years. This institute collects the data, chooses the calculation method, prepares the inventory in CRF format and sends it to the inventory compiler.<br><br>At the very end of 2009, a new government decree on data provision relating to GHG emissions was put into force. As a new element, the participation of the Forestry Directorate of the Central Agricultural Office (CAO) together with the Forest Research Institute is now formalized by this decree. These two institutes are responsible for the forestry part of the LULUCF sector and for the supplementary reporting on LULUCF activities under Articles 3.3 and 3.4 of the Kyoto Protocol by way of making recommendations to HMS of the content of the inventory.<br><br>The annual inventory cycle is carried out in accordance with the principles and procedures set out in the IPCC (1996) Guidelines and the IPCC Good Practice Guidance.<br><br>Data are collected from the emitter if it is possible (especially in case of power stations, heating stations and industrial technologies) but statistical databases are also used as source of information. The most important statistical publications are the Statistical Yearbook of Hungary, the Environmental Statistical Yearbook of Hungary both published by the Hungarian Central Statistical Office (HCSO) and the Energy Statistical Yearbook published by the Energy Efficiency, Environment and Energy Information Agency. Since the use of ETS data has several advantages, the inventory team was granted access to the verified emissions database held by the National Inspectorate for Environment, Nature and Water.<br><br>Basically, the sectoral experts are responsible for the choice of methods and emission factors. The calculation method – allowing for a few exceptions – was chosen by taking into account the technologies available in Hungary and according to the recommendations of the IPCC Guidelines. | National Inventory Report for 1985-2008,<br><br>Hungary (Draft Excerpts) Jan 2010<br><br>pp. 9-13 |

| MS | Institutional arrangments/national systems | Source |
|---|---|---|
| **Latvia** | Latvian  national GHG inventory system is designed and operated according to the guidelines for national system under article 5, paragraph 1, of the Kyoto Protocol (Decision 20/CP7) to ensure the transparency, consistency, comparability, completeness and accuracy of inventories.<br><br>The new legislation act No. 157 was approved and adopted by the Cabinet of Ministers on17 February 2009. Detailed functions (roles) and responsibilities of institutions that are involved in the preparation of the National inventory are prescribed in the act, including the designation of an institution controlling the QA/QC procedures.<br><br>The single national entity with overall responsibility for the Latvian GHG inventory is the Latvian Ministry of the Environment (MoE). The MoE is responsible for:<br>• Informing the inventory compilers about the requirements of the national system;<br>• Final checking and approving the inventory before official submission to the EU and UNFCCC;<br>• Formal agreements with inventory experts regarding Transport sector and for experts that evaluate quality assurance process;<br>• Coordinating the work between the inventory compilers, EU and UNFCCC (including coordination the UNFCCC inventory reviews).<br><br>Latvian Environment, Geology and Meteorology Centre (LEGMC) is a governmental limited liability company and is responsible for preparing the GHG inventory:<br>• Together with MoE coordinates the overall inventory preparation process, including the compilation of national inventory;<br>• Collects activity data - activity data are mainly collected from other institutions and LEGMC uses them to calculate emissions;<br>• Prepares the emission estimates for the Energy, Industrial Processes, Solvent and Other Product use, Agriculture and Waste sectors;<br>• Prepares sectoral parts of the NIR and compiles the final NIR;<br>• Fills in the sectoral data to the CRF Reporter (for relevant sectors);<br>• Prepares QC procedures;<br>• Documents and archives the prepared inventory and used materials.<br><br>The main data supplier for the Latvian GHG inventory is the Central Statistical Bureau of Latvia (CSB). LEGMC has signed additional agreement for the supply of the necessary data too. Mainly LEGMC contacted with five CSB experts. Since submission 2009, removals and emission calculations for the LULUCF sector were done by Latvian State Forest Research Institute "Silava" in collaboration with MoA. Since submission 2009, Institute of Physical Energetic (IPE) calculates emissions for Transport sector according to agreement with MoE. Before GHG inventory are reported to European Commission and UNFCCC secretariat it is forwarded to the involved ministries for review, checking and approving. One general meeting was held in the June to discuss and agree on the methodological issues, problems that have arisen and improvements that need to be implemented. There was discussion on the different problems that came up during the last inventory preparation to find solutions how to improve the overall system. | Latvia's Short National Inventory Report 1990-2009<br><br>Jan 2011<br><br>pp.16-17 |

<table>
<tr><th>MS</th><th>Institutional arrangments/national systems</th><th>Source</th></tr>
<tr><td>Lithuania</td><td>The final responsibility for the preparation of the annual GHG inventory report and its submission to the European Commission and the Secretariat of the UNFCCC is placed on the Ministry of Environment within which the inventory is coordinated by the Climate Change Division of the Environmental Quality Department.<br><br>The Ministry of Environment is responsible for:<br>• Overall coordination of GHG inventory process;<br>• Final checking and approval of GHG inventory procedures;<br>• Approval of QA/QC plan and procedures;<br>• Checking of consistency of data, documenting, processing, archiving;<br>• Preparation of legal basis necessary for National system functioning;<br>• Timely submission of GHG inventory to the UNFCCC Secretariat and the European Commission;<br>• Coordination of the UNFCCC inventory reviews in Lithuania;<br>• Keeping of archive of official submissions to the UNFCCC and the European Commission;<br>• Informing the inventory compilers about relevant requirements for the National system<br><br>Before submission, reports are forwarded to the National Climate Change Committee for final approval. The National Committee on Climate Change was set up in 2001 in the first instance and renewed in April 2010. It consists of experts from, government institutions, academia and nongovernmental organizations (NGOs) and has an advisory role. The main objective of the Committee is to ensure attainment of the goals related to the restriction of GHG emissions as set in the National Sustainable Development Strategy and implementation of the measures for attaining such goals. Also, the Committee has to coordinate the issues related to formulation and implementation of the national policy on climate change management, to advise on the implementation of the provisions of the UNFCCC and coordinate compliance with the requirements of the Kyoto Protocol and the EU legal acts related to the UNFCCC.<br><br>The Center of Environmental Policy is contracted by the Ministry of Environment as the coordinator of the GHG inventory from 2008. It has the following functions and responsibilities:<br>• Forming of GHG inventory experts team;<br>• Participation in the identification of data providers for specific information and in the selection of methods (complying with IPCC Good Practice Guidance) for calculation of emissions;<br>• Checking and archiving of supplied input data, prepared inventory and used materials;<br>• Key categories analysis;<br>• Uncertainty assessment;<br>• Preparation of Common Reporting Format (CRF) tables and compilation of National Inventory Report (NIR);<br>• Development and implementation of QA/QC plan and specific QA/QC procedures;<br>• Providing the final inventory (CRF tables and NIR) for the Ministry of Environment;<br>• Evaluating requirements for new data, based on internal and external reviews.<br><br>The State Forest Service (SFS) compiles the National Forest Inventory and the forest information system, carries out monitoring of the status of the Lithuanian forests, collects and manages statistical data etc. The Service functions under the Ministry of Environment. Since year 2010 State Forest Service in the GHG inventory preparation process is responsible for LULUCF (forestry part) sector and Kyoto protocol 3.3 and 3.4 removals and emission calculations for the LULUCF sector.</td><td>Draft National GHG Emission Inventory Report 2011 of the Republic of Lithuania,<br><br>Reported inventory 1990-2009<br><br>Jan 2011<br><br>pp. 12-13</td></tr>
<tr><td>Malta</td><td>From 2010 (monitoring year 2009) the Malta Resources Authority (MRA) is the authority entrusted with the role of compiling national greenhouse gas emission inventories, with the National Emissions Inventory Team within the Climate Change Unit at MRA being delegated the main responsibility for managing the inventory compilation system and for preparing the relevant submissions.<br><br>The National Emissions Inventory System Team is responsible for all functions of the inventory system, from data collection, through data management, to the preparation and submission of reports.<br><br>Activity data used for the preparation of this inventory was obtained from Malta’s past GHG inventory compilation, the National Statistics Office, government entities (ministries, departments), other public bodies such as regulatory authorities, private establishments and published reports.</td><td>National Greenhouse Gas Emissions Inventory Report for Malta<br><br>1990 - 2009<br><br>Jan 2011<br>p. 5-7</td></tr>
</table>

| MS | Institutional arrangments/national systems | Source |
|---|---|---|
| **Poland** | Since 2000 until September 2009, elaboration of the national GHG emission inventory as well as the national inventory for other air pollutant emissions for the needs of UNFCCC and LRTAP convention respectively, had been the task performed by the National Emission Centre (NEC) located in the Institute of Environmental Protection in Warsaw. Since 2006, NEC has performed its duties within the National Administration of the Emission Trading Scheme (KASHUE) established also in the Institute of Environmental Protection based on Ordinance of 13 September 2005 to the Act of 22 December 2004 on emission allowance trading system for greenhouse gases and other substances. Since October 2009, the National Centre for Emission Management (KOBiZE) replaced KASHUE based on Act of 17 July 2009 on the System to Manage the Emissions of Greenhouse gases and Other Substances and the Emission Balancing and Reporting Unit (ZBiRE) within the Centre has taken over the responsibilities of NEC. KOBiZE is also located in the Institute of Environmental Protection. The Minister responsible for issues related to the environment, supervises the carrying out of tasks by KOBiZE.<br><br>The emission calculation, choices of activity data, emission factors and methodology are performed by KOBiZE. KOBiZE is collaborating with a number of individual experts as well as institutions when compiling inventories. Among the latter are: Central Statistical Office (GUS), Agency of Energy Market (ARE), Institute of Ecology of Industrial Areas in Katowice (IETU), Motor Transport Institute (ITS) as well as Office for Forest Planning and Management (BULGiL). These institutions are mainly involved in providing activity data for inventory estimates. The KOBIZE experts have access to the individual data of entities participating in the European Union Emission Trading Scheme (EU-ETS). This ensures availability of data for major sources in emissions from stationary combustion sectors (1.A.1, 1.A.2) as well as from specific industrial processes. Such data are successively included into GHG inventory where possible after verification.<br><br>Prior to submission the elaborated inventories undergo internal process for the official consideration and approval. The responsibility for approval GHG inventories lies on the Ministry of Environment. | Information based on Poland,s National Inventory Report 2010 Mar and NIR 2011 of March 2011 |
| **Romania** | The Governmental Decision no. 1570 for establishing the National System for the estimation of anthropogenic greenhouse gas emissions levels from sources and removals by sinks, adopted in 2007, and the subsequent relevant procedures (procedure on processing, archiving and storage of the Greenhouse Gas Inventory (GHGI) data, procedure on reporting the GHGI and the responses to the observations/questions following the GHGI review, GHGI quality assurance and quality control plan and the procedure on the selection of the methods and emission factors needed for the estimation of the GHG emissions level) are regulating all the institutional, legal and procedural aspects for supporting the Romanian authorities to estimate the greenhouse gas emissions levels, to report and to archive the National GHGI information.<br><br>The main objective of the Governmental Decision is to ensure the fulfillment of the provisions and the obligations of Romania under the UNFCCC, the Kyoto Protocol and the European Community legislation.<br><br>The competent authority, which is responsible for administrating the National System, is the National Environmental Protection Agency (NEPA), under the subordination of the Ministry of Environment and Forests. NEPA has also the obligation of the preparation of the National GHGI; in this sense, the Governmental Decision no. 1570/2007 and the subsequent relevant procedures supports NEPA by defining a legal, institutional and procedural framework to involve actively all the relevant responsible public authorities, different research institutes, economic operators, and professional associations.<br><br>Central public authorities and the institutions under their authority, in their coordination or subordination, different research institutes, and the economic operators have the responsibility for submitting activity data needed for the GHG emissions calculation.<br><br>The main activity data supplier is the National Institute for Statistics (NIS) through the yearly-published documents like the National Statistical Yearbook and the Energy Balance. In 2002, the Ministry of Environment and NIS signed a protocol of co-operation. Under this protocol, NIS agreed to provide, besides its yearly publication, additional data, necessary for the inventory preparation.<br><br>The Ministry of Environment and Forests submits officially the National GHGI to the UNFCCC Secretariat, the European Commission and the European Environment Agency taking into account the specific deadlines. | Information pursuant Article 4.1 (a) of Decision 166/2005/EC<br><br>National Environmental Protection Agency<br><br>Jan 2011 |

| MS | Institutional arrangments/national systems | Source |
|---|---|---|
| **Slovakia** | The Ministry of Environment of the Slovak Republic (MŽP) (www.enviro.gov.sk) is responsible for national environmental policy including climate change and air protection issues as the National Focal Point. It has the responsibility to develop acts and amendments to existing legislation.<br><br>The Slovak Hydrometeorological Institute (SHMÚ) www.shmu.sk is authorised by the Ministry of Environment of the Slovak Republic to provide environmental services, including annual GHG inventories according to the approved statute (http://www.shmu.sk/File/statut.pdf). The range of services, competencies, time schedule and financial budget are updated and agreed annually. All details of the SHMÚ activities are described in the Plan of Main Projects. The plan, commented by all stakeholders and after the approval it is published at the website of the SHMÚ http://www.shmu.sk/File/ kontrakt_2008.pdf. Deadline for the approval of this plan by the ministry is 31st December each year.<br><br>Structural changes occurred after the 1st of January 2008 at the SHMÚ established the Department of Emissions (OE) as the Single National Entity with delegated responsibilities. The process of preparing and management of emission inventories is the main workload of the OE. Permanent staff of emission experts working at the Department is complemented by several external experts working on annual contracts renewed each year. Emission experts cooperate also with the other units of the SHMÚ (the Department of Climatology, the Department of Meteorology and Water Management) and other institutions and the state administration.<br><br>The SHMÚ is responsible for developing and maintaining the National Emission Inventory System (NEIS) – the database of stationary sources to monitor the development of SO2, NOx, CO emissions at regional level and to fulfil reporting commitments under the national regulations and EU Directives. The NEIS software product is constructed as a multi-module system, corresponding fully to the requirements of current legislation. The NEIS database contains also some technical information about the sources like fuel consumption and use for the estimation of sectoral approach.<br><br>The SHMÚ updates annually the incoming information and activity data using the corresponding statistical information from the Statistical Office of the Slovak Republic and other national statistics. | National inventory report 2010<br><br>GHG emission inventory 1990-2008<br><br>Apr 2010<br><br>pp.22ff |
| **Slovenia** | In Slovenia, the institution responsible for GHG inventories is the Environmental Agency of the Republic of Slovenia. In accordance with its tasks and obligations to international institutions, the Environmental Agency is charged with making inventories of GHG emissions, as well as emissions that are defined in the Convention on Long Range Transboundary Air Pollution within the specified time limit. In making the inventories, the Environmental Agency cooperates with numerous other institutions and administrative bodies which relay the necessary activity data and other necessary data for the inventories.<br><br>The chief sources of data are the Statistical Office of the Republic of Slovenia (SORS) and the Ministry of Environment and Spatial Planning; however, the Environmental Agency obtains much of its data through other activities which it performs under the Environmental Protection Act. Emissions from Agriculture are calculated in cooperation with the Slovenian Agriculture Institute (KIS), and sinks in the LULUCF sector are calculated by the Slovenian Forestry Institute (GIS).<br><br>A Memorandum of Understanding has been concluded with institutions that participate in inventory preparation, binding these institutions to submit quality and verified data to the Environmental Agency in due time. At the beginning of 2007, the agreement between Statistical Office of the Republic of Slovenia and the Environmental Agency came into force. Accordingly, all statistical data which are necessary for preparing GHG inventories are available each year by October 30 at the latest. In exchange, ETS data and emission estimates are reported to the Statistical Office within a defined time frame.<br><br>Experts from the Slovenian Forestry Institute and the Agricultural Institute of Slovenia work on GHG inventories according to the standing rules of institutes (ordinance). Financing is assured by governmental institutions according to the yearly work plan. All data from external institutions are submitted to the Environmental Agency, where they are archived. The detailed process from gathering data to emissions calculation and reporting is described in our Manual of Procedures, which was prepared in 2005 and updated in 2008. In 2009, the QA/QC plan as part of the Manual was developed and mostly implemented. | Slovenia's National Inventory Report 2011 (selected chapters)<br><br>Jan 2011<br><br>pp.6-8 |

## 16.2 General description of methodologies and data sources used

### *16.2.1 The compilation of the EU GHG inventory*

The EU inventory is compiled in accordance with the recommendations for inventories set out in the *'UNFCCC guidelines for the preparation of national communications by parties included in Annex 1 to the Convention, Part 1: UNFCCC reporting guidelines on annual inventories'* (FCCC/SBSTA/2004/8), to the extent possible. In addition, the *Revised IPCC 1996 guidelines for national greenhouse gas inventories* have been applied as well as the *IPCC Good practice guidance and uncertainty management in national greenhouse gas inventories*, where appropriate and feasible. In addition, for the compilation of the EU GHG inventory, Council Decision No 280/2004/EC and the Commission Decision 2005/166/EC.

The EU-27 GHG gas inventory is compiled on the basis of the inventories of the 27 Member States. The emissions of each source category are the sum of the emissions of the respective source and sink categories of the 27 Member States. This is also valid for the base year estimate of the EU-15 as fixed in the initial review report (which is included in part 1). Table 16.3 shows the base year emissions for the new EU Member States.

All EU Member States are Annex I parties to the UNFCCC except Cyprus. Malta acceded to Annex I status under the UNFCCC in October 2010; however, no quantified emissions limitation or reduction target is inscribed for Malta in Annex B to the Kyoto Protocol. Therefore, all Member States except Cyprus have committed themselves to prepare individual GHG inventories in accordance with UNFCCC reporting guidelines and to submit those inventories to the UNFCCC secretariat by 15 April. In addition, all Member States (including Cyprus) are required to report individual GHG inventories prepared in accordance with UNFCCC reporting guidelines to the Commission by 15 January every year under Council Decision 280/2004/EC.

**Table 16.3 Base year emissions for the new Member States**

| New MS | $CO_2$, $CH_4$, $N_2O$ | HFC, PFC, $SF_6$ | Base year emissions 1) (Tonnes $CO_2$ equivalents) |
|---|---|---|---|
| Bulgaria | 1988 | 1995 | 132,618,658 |
| Cyprus | Not relevant | Not relevant | |
| Czech Republic | 1990 | 1995 | 194,248,218 |
| Estonia | 1990 | 1995 | 42,622,310 |
| Hungary | 1985-87 | 1995 | 115,397,149 |
| Latvia | 1990 | 1995 | 25,909,160 |
| Lithuania | 1990 | 1995 | 49,414,386 |
| Malta | Not relevant | Not relevant | |
| Poland | 1988 | 1995 | 563,442,774 |
| Romania | 1989 | 1989 | 278,225,022 |
| Slovakia | 1990 | 1990 | 72,050,764 |
| Slovenia | 1986 | 1995 | 20,354,042 |

*1) Base-year emissions exclude emissions and removals from the LULUCF sector but include emissions due to deforestation in the case of Member States for which LULUCF constituted a net source of emissions in 1990.*
*Source: Initial review reports of the new Member States (www.unfccc.int)*

### 16.2.2 Use of data from EU ETS for the purposes of the national GHG inventories in EU Member States

For a general overview see section 1.3.2.1.

#### 16.2.2.1 Bulgaria

**General**

A total of 153 operators have provided their verified $CO_2$ emissions required under the EU ETS for the years 2007-2009. These emissions have been incorporated in the inventory as far as possible. Furthermore the background data for the emission calculations under the ETS were used for further QA/QC checks.

**Energy**

Data from the verified ETS reports was analyzed in order to use a Tier 2 methodology for emission calculations. For Anthracite, Other Bituminous Coal and Sub-bituminous Coal, Lignite and Petroleum Coke country-specific emission factors for $CO_2$ were applied in the calculations. These emission factors are derived from verified ETS reports as a weighted average from all operators which have declared that they have used plant-specific emission factors (Tiers 2b or 3 according to the Methodology for monitoring GHG emissions of operators participating in the ETS). Since only limited number of plants use Tiers 2b or 3, it was possible to derive country specific EFs for the major solid fuels only. The EFs are calculated as the total sum of the verified $CO_2$ emissions divided by the total amount of the respective fuel as reported by the operators. These emission factors are used for all subsectors in CRF 1.A except CRF 1.A.3.

For the 2010 submission, the country specific emission factors were calculated as a weighted average from the ETS reports for 2008 and applied to all the years. For the 2011 submission, the country specific factors were recalculated as a weighted average from all reports for 2007, 2008 and 2009.

- 1A2 Manufacturing industries and production: There is a specific case for other fuels used in the cement industry, for which a separate calculation model was developed. Due to the fact that all cement plant participate in the ETS, their verified reports were used in order to calculate the country-specific EFs for the following fuels:
    - SRF/RDF
    - Waste oils
    - Tyres
    - Filters
    - Biomass

**Industrial Processes**

In some categories emission and production data were reported directly by industry or ETS, IPPC and/or E-PRTR reports thus represent plant and country specific data. Verified $CO_2$ emissions reported under the EU ETS were available for the years 2007-2009. These emissions have been incorporated in the inventory as far as possible (see respective subchapters for more information). Furthermore the background data for the emission calculations under the ETS were used for further QA/QC checks.

Emission estimations as well as activity data and emission factors are compared with EU ETS verified emission reports, IPPC reports as well as E-PRTR reports where available.

- 2A1 Cement Production: All 5 plants are covered by the EU ETS and the IPPC Directive and have been modernized accordingly during the last 10 years. The 2009 $CO_2$ emissions are taken from the operators EU ETS reports. As a part from the QA activities the aggregated national clinker production data provided by the NSI were compared with the production data reported by the cement plants in the annual reports for compliance with their IPPC permits (EPRTR data), as well as in their verified emission reports within the EU ETS.

- 2A2 Lime Production: Currently there are 4 lime producing plants in Bulgaria which fall under IPPC and EU ETS. They produce quicklime and dolomitic lime.
- 2A4 Soda Ash use: EU ETS reports - emission from soda ash used in glass production (calculated by plants in the reports) and using the mass balance approach are compared. Activity data for Soda ash use has been revised for the entire time series by using soda ash mass balance based on plant specific (EU ETS reports) and statistical data.
- 2A7 Glass Production: Currently there are six glass plants in Bulgaria mainly producing flat, container and domestic glass. All of them fall under IPPC and EU ETS. For the period 2007 - 2009 plant specific emissions, activity data and emission factors were used based on the data reported by operators under EU ETS (except one plant) and IPPC. Activity data has been revised by using IPPC permits reports and EU ETS data as well as statistical data for cross-check.
- 2A7 Others (Ceramics Production): The $CO_2$ emissions from the verified ETS reports are used. These emissions are estimated taking into account the CaO and MgO content in the products. Country specific emission factor was calculated on the basis of data from ETS and IPPC reports of the operators. The ETS data used to estimate the EF take into account the CaCO3, MgCO3 in the used in the raw materials (clay).
- 2A7 Others Non-Specified (Wet Scrubbers): Currently there are three large combustion plants (LCP)in Bulgaria applying desulphurization for the flue gas cleaning. Tier 2 method for the $CO_2$ emissions estimation is used. The $CO_2$ emissions estimated using the above equation are taken from the LCP operators EU ETS reports. The quantities of calcium carbonate (CaCO3) and magnesium carbonate (MgCO3) used for the estimations are also taken form the EU ETS reports thus allowing to take into account the pure carbonates used in the process. Plant specific activity data on the amount of carbonates use are obtained from EU ETS reports.
- 2B1 Ammonia Production: Currently ammonia is produced in two plants in Bulgaria. Both plants are falling under the IPPC Directive and EU ETS.
- 2B2 Nitric acid Production: Currently nitric acid is produced in two plants in Bulgaria. Both plants are falling under the IPPC Directive and ETS.
- 2B42 Carbide Production and Use: There is one carbide producing plant in Bulgaria. It reports under EU ETS and has IPPC permit.
- 2C1 Iron and Steel Production: The $CO_2$ emissions from the sector are calculated using country specific data from EU ETS reports. Country specific emission factor was developed for the EAF steel based on data from EU ETS reports for the period 2007 - 2009. In the calculation of ETS emissions the operators performed a mass balance of the Carbon content in the raw materials used and the produced end product. Country specific data from EU ETS reports as well as from BAMI and WSA on total crude steel production were received.

#### 16.2.2.2 Cyprus

**Energy**

The main source of the emission factors is the 2006 IPCC Guidelines for National Greenhouse Gas Inventories. For electricity, cement and ceramics production, the EF were estimated according to the information provided to the Department of Environment for the ETS installations for 2005-2008. The average EF reported in ETS reports 2005-2007 is used.

**Industrial Processes**

- 2A Mineral Products: Emissions factors used for the estimation of $CO_2$ from cement and ceramics have been obtained by the ETS reports submitted by the industries for 2005-2009, whereas the emission factor for lime production is the same as used in previous submissions.

### 16.2.2.3 Czech Republic

**General**

So far, data from the emission trading system has been used to only a limited degree in the Czech national greenhouse gas inventory (e.g. in the sector of Industrial processes - mineral products). It was recommended to the Czech inventory team during the recent "in-country review" that the data from EU ETS be used to a greater degree. For this purpose, the team began to prepare an "improvement plan" to provide for gradual inclusion of the relevant EU ETS data in the national inventory. The next part of this "improvement plan" will consist in gradual introduction of higher tiers into the national inventory. At the present time, CHMI, in cooperation with MoE, is preparing a database of activities and emission data from the EU ETS system, which could be used in preparation of the national inventory. Consequently, it can be expected that these data will be employed more extensively only in future inventories.

**Energy**

- 1A Fuel combustion: The fuel consumption is taken from the energy balance of the Czech Republic and is transformed to the IPCC structure. Consumption of the other kinds of fuels (Other fuels) was taken from the national ETS system (ETS, 2009).
- 1A2f Other: In this year's submission, this subcategory also includes the combustion of other kinds of fuel (Other Fuels). Activity data and data on $CO_2$ production were taken from the national ETS system (ETS, 2009), while $CH_4$ and $N_2O$ emissions were calculated using the default emission factors for solid and liquid fuels.

QA/QC: QC procedures at the Tier 2 are included upon the suggestion of the QA/QC sectoral guarantor after the consultation with the NIS coordinator. They are aimed mainly at the comparison with independent data sources that are not based on data processing from the CSO energy balance. The relevant independent sources in the Czech Republic are represented by data published and verified within the EU Emission Trading Scheme (ETS), from the national system REZZO, used for the registration of ambient air pollutants, and based mainly on data collection from individual plants

**Industrial Processes**

- 2A1 Cement Production: Since 2006 submission methodology equal to the Tier 3 has been employed. $CO_2$ emissions are based on data submitted by the cement kiln operators for preparation and standard operation of the EU ETS system, which includes all the cement kilns in Czech Republic. Information from individual kilns is reported to the competent authority. This data covers years 1990, 1996, 1998 - 2002 and 2005 - 2009. For other years the EF was extrapolated. All operating cement plants in the Czech Republic are equipped with dust control technology and the dust is then recycled to the kiln. Only in one cement plant is a small part of the CKD discarded, for technical reasons. Use of dolomite or amount of magnesium carbonate in the raw material, as well as fissile carbon (C) content is known, all above mentioned variables are used for emissions estimates in the EU ETS system.
- 2A2 Lime Production: A comparison of $CO_2$ emissions calculated according to IPCC methodology and process related emissions reported for EU ETS is made. ETS data closely corresponds to the IPCC methodology and national circumstances. The reports on EU ETS emissions from the individual installations have been verified by independent verifiers.
- 2A3 Limestone and Dolomite Use: In 2005 data was verified by comparison with data from the individual power plants, which were collected for EU ETS preparation and which cover the years 1999 – 2005. The EU ETS data form has been used since 2006. Emissions from limestone and dolomite use in sintering plants were new source, in 2006 submission, which was identified in the process of preparation of the EU Emission Trading Scheme. Only 2 sintering plants have existed in the CR in recent times. $CO_2$ emissions from this category are calculated on the basis of data from statistics (The Steel Federation, Inc - production of agglomerate / sinter) and the EF value, which was derived from EU ETS $CO_2$ emission data based on the limestone and dolomite compositions and consumptions (0.08 t $CO_2$ / t sinter).

- 2A4 Soda Ash Use: Activity data were taken from EU ETS and from consultations with the operator of the relevant plant.
- 2A7 Other: The EF value was derived from individual installation data collected for EU ETS (emissions) and from CSO (production). The calculation is based on the total production of ceramic products (fine ceramics, tiles, roofing tiles, and bricks) and the EF value.

It is planed to process all available information about uncertainty form the EU ETS and provide category and national specific uncertainty assessment.

#### 16.2.2.4 Estonia

**Energy**

In 2011inventory submission Energy Sector $CO_2$ emission factors were compared also with EFs used by Emission Trading System (ETS) enterprises.

**Industrial Processes**

- 2A1 Cement Production: The emissions of last five years (including 2009 emissions) have been compared with ETS data (as recommended by the UNFCCC review team). Differences between those two figures have been less than 1%.

#### 16.2.2.5 Hungary

**Energy**

- 1A1 Energy Industries: Energy consumption data were taken from the energy balance (1985-2009) of the Energy Statistics Yearbooks prepared by the Energy Centre. Besides, waste statistics and ETS data were taken into account. Some $CO_2$ emission factors have been taken from the EU ETS. It should be noted that only those measured factors were applied where the EU ETS covers all or most of the installation of the sector. For waste incineration also EU ETS data is used. The biggest co-incinerator plant is Mátra Power Plant. Since this plant reports its verified emissions in the framework of the European emission trading, direct ETS data relating its fuel use and $CO_2$ emissions were taken over. Verified energy use from EU ETS was compared to statistical data. It was noticed that data in metric tonnes are similar in the ETS to those in the statistics, but there are some differences in energy values due to different NCVs. For the main power plants the total fuel consumption’s difference between the ETS and this dataset was around 1% in 2009.
- 1A2 Manufacturing Industries and Construction: Part of the emissions from waste incineration for energy purposes was allocated to this source category. Special attention was given to the four big cement factories, as they incinerate large amount of waste of fossil origin (plastics, rubber etc.). Their verified ETS data (emissions and fuel use) were analyzed, from which a specific emission factor was derived: 2.2 tonne $CO_2$/tonne fossil waste. From 2006 on, ETS data (fuel consumption and emission) of the cement factories were used directly. $CO_2$ emission in the process of manufacturing bricks and ceramics is calculated using the verified emission reports (EU ETS) in the Industrial Processes Sector. Carbon emission factors for coke oven coke and coke oven gas combusted by the iron and steel industry, where measured (by accredited laboratory) carbon content of fuels were available from the EU ETS. For all other fuels default emission factors have been used.

QA/QC: Energy consumption data were subject of several rounds of verification before use. Verified energy use from EU ETS was compared to the statistical data. It was noticed that data in metric tonnes are similar in the ETS to those in the statistics, but there are some differences in energy values due to different NCVs.

**Industrial Processes**

- 2A1 Cement Production: In 2009 four factories were operating in Hungary. Production data for the whole time series were obtained directly from the factories and from the EU Emission Trading System (ETS) According to the ETS introduced by the European Union from 2005 on, the factories report their $CO_2$ emission. We have compared the $CO_2$ emission from ETS data with the emissions calculated with our country-specific factor. $CO_2$ emission from ETS was higher in 2006 and 2007 by 10.62% and 6.08%, respectively but lower in 2008 and by 14.42%and 18.21%. The lower value was due to the new data logging methodology of the HCSO, i.e. estimations were made from salesmanship.
- 2A7 Glass Production: A specific emission factor was created from the emission trading data of 2005, and emissions were calculated retrospectively using this EF with the known production data.

QA/QC: There are several actions with regard to QA/QC which include the use of ETS data:

- Checking the differences in activity data to increase the consistency between different emission databases, especially the GHG inventory, LRTAP inventory, ETS data, NAMEA data, and the E-PRTR data.
- Incorporation of ETS data in broader extent for revision of the used EFs and for better sectoral allocation of emissions

### 16.2.2.6 Latvia

**General**

As all Latvia's industrial processes sector's companies are participating in ETS then data from these companies can be obtained from their annual GHG report within compliance obligations within ETS. These activity data used emission factors and used emission estimation methodologies can be reported in NIR and in CRF Tables as the data of ETS can't be confidential and all companies' annual GHG reports are published in LEGMC webpage.

**Energy**

- 1A: Carbon emission factor for industrial wastes (used tires) was estimated based on $CO_2$ emission factor reported by cement production plant within ETS.
- 1A2f Others: EF for $CO_2$ emission estimation for other fuels – used tires, combusted in CRF 1.A.2.f Other Manufacturing Industries – cement production, category for years 1999–2009 is taken from GHG emission reports that plant submitted under ETS. This $CO_2$ emission factor is estimated at the plant by using plant specific data about combustion installation, as well as net calorific value and carbon content measured and obtained in the plant laboratory.
- 1A2: $CO_2$ emission factor of municipal wastes combusted in cement production plants is taken from plant's annual GHG report within EU ETS for 2008-2009 IPCC 2006 as there is no information available of such fuel type. This $CO_2$ emission factor is estimated at the plant by using plant specific data about combustion installation, as well as net calorific value and carbon content measured and obtained in the plant laboratory.

**Industrial Processes**

All industrial production data used in emission estimation from 2.A Mineral Products sector is taken from the annual GHG reports that industrial producers submit within EU ETS. According to EU ETS legislation all GHG reports have to be verified by the ISO accredited verifiers that checks that all reported information – activity data, $CO_2$ emission factors, estimated emissions as well as estimation methodology, is correct and corresponds to certain requirements from the legislation.

- 2A1 Cement Production: According to IPCC GPG alternative of activity data if clinker production data is not available is to use cement clinker data and the estimate this amount back to clinker production data. In the cement production plant it is done for the EU ETS annual reporting by taking into account clinker and cement ratio for the particular types of cement produced. According to cement production plant the CKD amount is weighted before it is sent to disposal site. The amount of weighted CKD as well as procedures of all data obtaining is verified by the accredited verifier within EU ETS. Cement, cement kiln dust production data and estimated clinker production data is taken from plant's annual GHG reports within EU ETS.

- 2A2 Lime Production: In iron & steel production facility lime necessary for steel smelting in open heart furnaces is produced only from limestone in vertical shaft kiln. The plant is reporting their non-marketed quicklime production data for 2005-2009 within ETS so the estimated emissions as well as used activity data and emission factor are taken from plant's annual GHG report within GHG.
- 2A3, 2A4 Limestone, Dolomite and Soda Ash Use: Limestone, dolomite and soda ash are used in glass production plants, steel production plant and lime production plants. All these plants are participants of EU ETS so the detailed information of used technologies, raw materials as well as emission factors are available as plants report their annual GHG reports to LEGMC. Activity data were taken from industrial production plants. Industrial producers are participants of the ETS the GHG reports of these enterprises have to be freely available according to EU ETS regulations. The GHG reports of ETS operators are published on LEGMC home page.
- 2A7 Glass Production: $CO_2$ emission factors used to estimate emissions from raw materials use in glass production are plant specific and taken from plants' annual GHG reports within ETS. Activity data, $CO_2$ emission factors and estimated emissions from glass production plants are taken from the annual GHG reports that plants submit within EU ETS. All GHG reports are verified by the ISO accredited verifiers that checks that all reported information is correct and corresponds to certain requirements from the legislation.
- 2A7 Bricks Production: There are five bricks production plants in Latvia. Some plants used 2004 in its application for GHG permit during the implementation of ETS in Latvia a methodology that is not in line with IPCC Guidelines. $CO_2$ emission factors used in emission calculation from bricks and tile production are the default from Monitoring and Reporting Guidelines within ETS so the uncertainty of emission factors is assumed as 50%. Activity data is taken from plants reported annual GHG reports within EU ETS. As bricks production plant is constantly changing used methodology to estimate their annual $CO_2$ emissions within ETS requirements, the emissions were recalculated using the most appropriate approach for the best result.
- 2A7 Tiles Production: There is only one tiles production plant in Latvia and $CO_2$ emissions from use of clay in tile production process in 1995-2009 are reported in this sector. The tiles production plant is participant of ETS so the data from plant's annual GHG reports is available for inventory. Activity data, $CO_2$ emission factor and estimated emissions are taken from the annual GHG reports that steel production plant submit within EU ETS.
- 2C Metal Production: There is only one Iron & Steel production plant in Latvia that produces crude steel by melting crude iron not only by melting scrap metals. The plant is participant of ETS and submits their annual GHG reports to LEGMC. It is possible to obtain more accurate and complete activity data and emission factors from enterprise that is involved in the emission trading system.

#### 16.2.2.7 Lithuania

Not indicated.

#### 16.2.2.8 Malta

The total allocation for the period 2008 to 2012 amounts to 10.715 million allowances and has been allocated in its entirety to the two incumbent electricity generation plants that remain, to date, the only local participants in the scheme.

**Energy**

1A1a: These are two power plants that are currently run on liquid fossil fuels, namely residual fuel oil (RFO) and gas oil (GO).It is important to note that for the years 2005 to 2009, fuel consumption data reported in verified emission reports as submitted by the operator under Directive 2003/87/EC [15] have been used.

#### 16.2.2.9 Poland

**General**

The experts of the National Centre have access to the individual data of entities participating in the European Union Emission Trading Scheme (EU-ETS). This ensures availability of data for major sources in emissions from stationary combustion sectors (1.A.1, 1.A.2) as well as from specific industrial processes. Such data are successively included into GHG inventory where possible after verification.

**Energy**

- 1A3e Pipelines transport: Since 2008, data from the transport via pipelines covered by the Community Emission Trading Scheme (EU ETS) were taken directly into GHG inventory.

**Industrial Processes**

For estimation of the 2009 emission, in sector 2. Industrial Processes, $CO_2$ process emission data were used from installations which take part in the EU ETS. Emissions based on such data were estimated in the following subcategories:

1. subcategory 2.A. Mineral Products: 2.A.1. Clinker Production, 2.A.3. Limestone and Dolomite Use and from subcategory 2.A.7. Other: Glass Production, Ceramics materials production
2. subcategory 2.C. Metal Production: processes included into Iron and Steel Production (2.C.1) such as: sinter production, pig iron production, steel production in basic oxygen process, steel production in electric arc furnace process
3. subcategory 2.D. Other Production: 2.D.1. Pulp and Paper
4. subcategory 2.G. Other – this subcategory includes data containing $CO_2$ process emissions from installations which take part in emission trading scheme that cannot be included in subcategory 2.A-2.F; for example emissions from refineries (process emissions, discharges and flaring)

- 2A1 Cement Production: $CO_2$ emission from clinker production is the sum of the process emissions given in the verified reports for 2009 for installation of clinker production, which participate in the EU ETS [KASHUE 2010]. $CO_2$ emission from clinker production was taken from the verified reports for the years: 2005-2009 for installations which participate in EU ETS.
- 2A3 Limestone and Dolomite Use: In this subcategory there were used only emissions from limestone and dolomite use in sulphur removal installations in power industry installation that participate in EU ETS. Emissions for this subcategory in GHG inventory correspond to emissions from the EU ETS verified reports. $CO_2$ emissions concerning limestone and dolomite use in production of glass, ceramics and paper includes only the emission from installations covered by EU ETS.
- 2A7 Other (Ceramics material production): $CO_2$ emission from production of ceramics materials was calculated based on the verified reports for 2009 for installation of ceramics production, which participate in EU ETS [KASHUE 2010].
- 2C1 Iron and Steel Production: Carbon dioxide process emissions from iron and steel production for 2009 come from the verified reports on annual emissions of $CO_2$ from iron and steel installations in EU ETS [KASHUE 2010].

- 2D Other Production: $CO_2$ process emissions from pulp and paper production for 2009 and for 2005-2008 were taken from the verified reports for installations of paper and cardboard production, which participate in EU ETS [KASHUE 2010].
- 2G Other Processes: $CO_2$ emission value estimated as process emission of $CO_2$ from the verified reports for refineries, which participate in EU ETS was included in this sub-category [KASHUE 2010].

QA/QC: Activity data used in the GHG inventory concerning industry sector come from yearbooks published by the Central Statistical Office (GUS). GUS is responsible for QA/QC of collected and published data. Data on selected production is compared to data collected from installations/entities covered by the EU ETS. Data relating to EUETS installations are verified by independent reviewers and by verification unit established in the National Centre for Emissions Management (KOBiZE). Additionally data on industrial production is compared with public statistics in case where entire sector is covered by EU ETS.

#### 16.2.2.10 Romania

**Energy**

- 1A1 Energy Industries: Based on data collected from the EU-ETS operators, NEPA performed a specific analysis and EF values have been calculated for 2008 and 2009
- 1A2 Manufacturing Industries and Construction: In the autumn of 2010 questionnaires were sent to operators for collecting activity data, in order to allow use Tier 2 method. After validating activity data (including tests for differences between the collected data and data EU-ETS) was calculated EF and EF national will be used in 2010 after completing a comparative analysis of data for three years (2008,2009 and 2010).
- 1A4: We will try to obtain more detailed data, in respect to the IPCC GPG 2000 provisions. A study on developing national EF, by each fuel type, was proposed; in parallel we try to obtain (through calculation) an EF specific to each fuel type, using the ETS data.

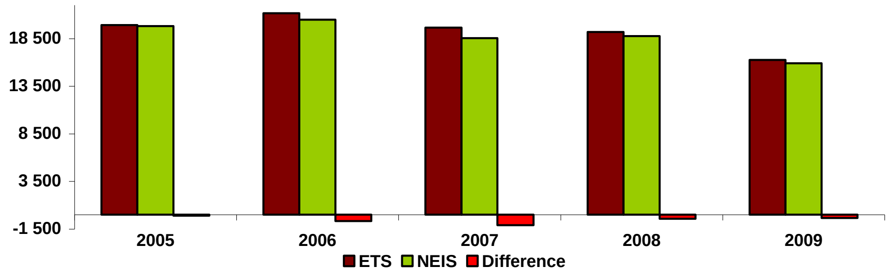
**Industrial Processes**

- 2A1 Cement Production: Starting with 2008 the figures related with clinker production, plant specific $CO_2$ EF for clinker production and $CO_2$ emissions from clinker production were compared with the data reported in monitoring plan of GHG emissions for the EU-ETS cement production installations. The data are similar.

#### 16.2.2.11 Slovakia

QA/QC: In order to comply with the quality management criteria and data harmonization between ETS and the national emission balance at sectoral level, emission factors of the most important fuels have been re-evaluated and new methods have been implemented at the level of source operators. By comparison and correct allocation of $CO_2$ emissions in sector energy, it can be concluded that the balance is in a good compliance with the emissions verified within ETS. The comparison was provided for most important sources (energy and technology) (Table 3.27), but also only for energy sources (Figure 3.21). For the comparison study, 26 biggest emitters were taken, which represent more than 90% of all allocated emissions in the Slovak Republic.

**Figure 16.1** **Comparison of $CO_2$ emissions from energy sources (in Gg) allocated in ETS and estimated by sectoral approach from the dbase NEIS for 2005 – 2009**




*Source: NIR of Slovakia, submission 2011, p. 54, Figure 3.21*

## Industrial Processes

- 2A1 Cement Production: The cement plants in the Slovak Republic (4 plants), where cement clink is produced, are included into the ETS and the verification reports from the ETS were used for $CO_2$ emission inventory. On the basis of the information provided into the verified ETS reports, Tier 3 methodology according to the IPCC 2006 Guidelines has been applied since 2002 based on plant specific information. The calculations provided by the cement clinker producers in the ETS reports balanced $CO_2$ emissions on the basis of cement clink production and CaO and MgO contents.
- 2A2 Lime Production: Tier 3 according to the IPCC 2006 GL has been applied since 2003 with the combination of plant specific activity data and emission factors estimated for each plant. The calculations provided by the lime producers in the ETS reports balanced $CO_2$ emissions on the basis of raw material used for production (Calmit lime plant) or produced lime (other lime plants) and CaCO3 and MgCO3 contents (Calmit lime plant) and CaO and MgO contents (other lime plants).
- 2B1 Ammonia Production: The Tier 2 methodology according to the IPCC 2000 GPG was applied to category 2B1 ammonia production and the plant specific emission factors were used. The information on ammonia production, provided directly by the company, was used based on ETS information in 2009. The data on the consumption of natural gas are available from ETS reports.
- 2C1 Iron and Steel Production: According to the information provided in the ETS reports, several plants produced steel in electric arc furnaces. The emissions from these plants were not reported in previous submission (2010). According to the ERT recommendation during centralized review 2010, the thorough survey of the $CO_2$ emissions from these plants was done. The information are summarized in Table 4.26. The emission calculation was based on the available data and assumptions:
    - Železiarne Podbrezová: EU ETS reports are available for the period 2005 – 2009. According to the questionnaires concerning the period 2000 – 2004; it was used approximately 13.4 kg of carbon (in all material inputs) for production of 1 tone of steel.
    - Metalurg Steel: EU ETS reports are available for the period 2007 – 2009. According to the questionnaires concerning the period 2000 – 2006; the emission factor of $CO_2$ was 0.165 t per 1 tone of steel.
    - UNEX Prakovce: The plant is not included in the EU ETS. The default emission factor of $CO_2$ was used (0.08 t $CO_2$ / 1 t of steel).
- 2C2 Ferroalloys Production: Information about activity data were taken from the ETS reports and directly from the producers of ferroalloys in the Slovak Republic based on questionnaires.

QA/QC: For 2A1, 2A2 and 2B1, 2B4 (Carbide Production) and 2C1: Information used for GHG emission inventories of IP sector are directly from the questionnaires sent to operators and producers in the Slovak Republic. First preliminary data related to the production and the quality of products in the Slovak Republic from the previous year is available at the beginning of October. This data are used for the estimation and verified by Mr. Vladimir Danielik – the sectoral expert for IP sector in the cooperation of the Slovak Technical University in Bratislava, the Faculty of Chemical and Food Technology. The data are compared with the information from the Statistical Office of the Slovak Republic and available ETS reports.

#### 16.2.2.12 Slovenia

**General**

In 2006, an additional quality control check point was introduced by forwarding the assessment of verified emission reports from installations included in the National Allocation Plan to the Statistical Office of the Republic of Slovenia (SORS). The role of SORS is to compare data from installations included in the EU-ETS with data from their reporting system and to propose corrective measures, if necessary.

The quantities of fuels and consumed fuel energy values were taken from the Statistical Office of the Republic of Slovenia. Additional data on the energy use of some types of waste (waste tyres, oils and solvents) were acquired from verified ETS reports.

**Energy**

- 1A1a Public Electricity and Heat Production: From 2005 the activity data from the verified reports from ETS have been used for four power plants. For four thermal power plants the aggregated fuel from SORS data are compared with the sum of fuel used from verified ETS reports. The NCV values are also checked. If case these numbers are not the same the ETS data are taken in account for GHG inventory and notification to SORS is made to correct their data. In other cases where connection between both set of data is uniform, the data from Statistical office are substitute with data from verified reports from installations included in ETS, if necessary. ETS data are also used for different types of waste used as a fuel. The list of waste types is not always complete in the SORS data.

QA/QC: The main source specific QA/QC activity is comparison of the ETS data with statistical data.

$CO_2$ emissions from solid fuel combustion in Electricity and Heat production have been estimated on the basis of data (AD, NCV and EFs) from EU-ETS and for this reason no more improvements are needed and planned for the future.

**Industrial Processes**

As Slovenia is small country only 12 installations from EU ETS report process emissions (2 cement, 3 lime, 3 steel and 4 glass producers), this QC can be performed manually. After entering this data to the calculation spreadsheet the QC is performed.

- 2A1 Cement Production: For the period 2005 - 2008, the EFs reported by the plants to the Ministry of Environment and Spatial Planning, as a competent authority in the European Union Greenhouse Gas Emission Trading System (EU ETS), are used to calculate emissions. To calculate emissions from cement production after 2005 we have been using data obtained by EU ETS. Data on clinker production and plant specific emission factors for both cement factories have been annually verified by independent verifiers. ETR recommended showing that the estimated $CO_2$ process emissions from cement production are comparable and consistent with the emissions reported under the EU ETS. EU ETS reports can not be publicly revealed due to sensitivity of information.

- 2A2 Lime Production: $CO_2$ emission was calculated according to IPCC methodology. The EFs for lime production for the period 2005-2009 are based on EU ETS data, whereas for the period 1986 -1989 the average EF for 1999-2004 was applied. Upon ERT recommendation year-specific EFs were used for the period 1999 -2004 instead of average EF. The EFs for the years 2005-2009 were derived from emissions and activity data on annual production of quicklime reported under EU ETS scheme.
- 2C1 Iron and Steel production: Data on CaCO3 and MgCO for the period 2005–2008 have been obtained from verified ETS reports. For the period 2005-2009 we have used precise and verified data obtained from EU ETS.

QA/QC: QC procedures for the plant data included in the inventory that are collected under the European Union Emissions Trading Scheme (EU ETS) have been performed. ETS emissions data from verified printed reports have been compared with data obtained in electronic form. ETS emissions data are collected by EU ETS experts from Environmental Agency of Republic of Slovenia. As national inventory team and EU ETS experts work together in the same institution, even in the same unit, it is very easy to access these hard copy reports for each company. Besides the data, reports include also the description of monitoring of this data, eventual stops and changes of production.

## 16.3 Key categories

A key category analysis has been carried out according to the Tier 1 method (quantitative approach) described in IPCC (2000) for the EU-27. The tables are included in Annex 2.1.

## 16.4 Information on the quality assurance and quality control plan

Table 16.4 gives an overview of QA/QC procedures in place for the new EU Member States.

**Table 16.4 Overview of quality assurance and quality control procedures for the new MS (NIR descriptions)**

| MS | Description of the national QA/QC activities | Source |
|---|---|---|
| **Bulgaria** | The ExEA is also responsible for coordination and implementation of QA/QC activities for the national inventory. A quality manger is in place. The Bulgarian Quality Management System was established in the frame of project with Bulgarian Academy of Science, Geophysical Institute. The project was carried out and finished in 2008. The QA/QC plan is an internal document to organise, plan and implement QA/QC activities. Once developed for the next submission, it is referenced and used in subsequent inventory preparation, or modified as appropriate. The QA/QC plan has been updated in August 2010 in order to implement the new established legal, institutional and procedural arrangements within the BGNIS. The updated National QA/QC Plan was approved by the Ministry of Environment and Water in September 2010.<br>National QA/QC Plan includes following elements:<br>• Responsible institutions;<br>• Data collection;<br>• Preparation of inventory;<br>• QC Procedures;<br>• QA Procedures;<br>• Uncertainty evaluation;<br>• Organisation of the activities in quality mamagement system;<br>• Documentation and archiving.<br>The legal and institutional arrangements within the BGNIS regulate the responsibilities of all engaged institutions for implementation of the requirements of the National QA/QC Plan. The QC procedures are performed by the sectors, who are directly involved in the process of preparation of inventory with their specific responsibilities. The QC procedures are implemented by all activity data provider and ExEA's sector experts (Order N 202/29.09.2010 by the Executive Director of ExEA) and/or external consultants.<br>For 2011 submission the QA procedures are implemented by sector experts within the MoEW and experts from the ExEA, who are not directly involved in the preparation of inventory (Order № RD-218/05.03.2010 by the minister) or external reviwers. | Short NIR of GHG emissions in Republic Bulgaria 1988-2009<br>Jan 2011<br>pp. 19ff |
| **Cyprus** | The QA/QC system has been developed on the basis of the IPCC guidelines. The quality objectives used are the following:<br>• Compliance with the IPCC guidelines and the UNFCCC reporting guidelines while estimating and reporting emissions/removals;<br>• Continuous improvement of GHG emissions/removals estimates;<br>• Timely submission of necessary information in compliance with relevant requirements defined in international conventions, protocols and agreements. The QA/QC system developed covers the following processes:<br>The QA/QC system developed covers the following processes:<br>• QA/QC system management, comprising all activities that are necessary for the management and control of the inventory agency in order to ensure the accomplishment of the above-mentioned quality objectives.<br>• Quality control that is directly related to the estimation of emissions. The process includes activities related to (a) data inquiry, collection and documentation, (b) methodological choices in accordance with IPCC Good Practice Guidance, (c) quality control checks for data from secondary sources and (d) record keeping.<br>• Archiving of inventory information, comprising activities related to centralized archiving of inventory information and the compilation of the national inventory report.<br>• Quality assurance, comprising activities related to the different levels of review processes including the review of input data from experts if necessary, and comments from the public.<br>• Estimation of uncertainties, defining procedures for estimating and documenting uncertainty estimates per source / sink category and for the whole inventory.<br>Inventory improvement, that is related to the preparation and the justification of any recalculations made. | National GHG Inventory Report 1990-2009<br>2011 Submission<br>Jan 2011<br>pp. 2-3 |

| MS | Description of the national QA/QC activities | Source |
|---|---|---|
| Czech Republic | The objective of the national inventory system (NIS) is to produce high-quality GHG inventories. In the context of GHG inventories, high quality provides that both the structures of the national system (i.e. all institutional, legal and procedural arrangements) for estimating GHG emissions and removals and the inventory submissions (i.e. outputs, products) comply with the requirements, principles and elements rising from the UNFCCC, Kyoto Protocol, IPCC guidelines and EU GHG monitoring mechanism (Decision of the European Parliament and of the Council No 280/2004/EC).<br>**Quality control procedures (QC)**<br>The QC procedures used in the Czech GHG inventory comply with the IPCC good practice guidance. General inventory QC checks (IPCC GPG 2000, Table 8.1 and IPCC GPG LULUCF 2003, Table 5.5.1) include routine checks of the integrity, correctness and completeness of data, identification of errors and deficiencies and documentation and archiving of inventory data and quality control actions. In addition to general QC checks, category-specific QC checks including technical reviews of the source categories, activity data, emission factors and methods are applied on a case-by-case basis focusing on key categories and on categories where significant methodological and data revisions have taken place.<br>Once the experts have implemented the QC procedures, they complete the QA/QC form for each source/sink category, which provides a record of the procedures performed. Results of the completed QC checks are recorded in the internal documents for the calculation and archived in the expert organisations and at the CHMI. Key findings are summarised in the sector-specific chapters of the NIR.<br>**Quality assurance procedures (QA)**<br>Quality assurance comprises a planned system of review procedures. The QA reviews are performed after the implementation of QC procedures to the finalised inventory. The inventory QA system comprises reviews and audits to assess the quality of the inventory and the inventory preparation and reporting process, to determine the conformity of the procedures taken and to identify areas where improvements could be made. While QC procedures are carried out annually and for all sectors, QA activities are expected to be performed by individual sectors and not so frequently. Each sector should be reviewed by the QA audit approx. once in three years as far as possible. Besides, QA activities should be focused mainly on key categories. | National GHG Inventory Report 2010 of the Czech Republic,<br>Jan 2010<br>pp. 7-11 |
| Estonia | This section presents the general QA/QC programme including the quality objectives and the QA/QC plan for the Estonian greenhouse gas inventory at the national inventory level. Source specific QA/QC details are discussed in the relevant sections of this NIR.<br>All institutions involved in the inventory process (MoE, EERC; TUT and EEIC) are responsible for implementing QC procedures to meet the data quality objectives. MoE as the national entity is responsible for overall QC and is in charge of checking on an annual basis that the appropriate QC procedures are implemented internally in TUT; EERC and EEIC. The EERC as a coordinator has an overall responsibility for QC of the data of the emission inventory. EERC checks the QC reports of TUT, EERC and EEIC. When EERC disagrees with the report then the errors are discussed and changes are made if necessary. Each institution is responsible for reporting on their completion of the QC procedures on an annual basis. This reporting is based on a checklist of general and source-specific QC checks and a textual description of possible recalculations, issues to be followed up before the next submissions, and other relevant information. MoE as the national entity is responsible for the overall QA of the national system, including the UNFCCC reviews and any national reviews undertaken.<br>During the Twinning Light project "Improving the quality of Estonia's National Greenhouse Gas Inventory" with Finland in 2009 Estonia updated its QA/QC plan. The Estonia's QA/QC plan consist of six parts: (1) production plan (see Table 1.1); (2) annual meetings; (3) QA/QC checks; (4) archiving structure; (5) response tables to the review process and (6) a list of planned activities and improvements. | Greenhouse Gas Emissions in Estonia 1990-2009<br>Jan 2011<br>pp. 33 |

| MS | Description of the national QA/QC activities | Source |
|---|---|---|
| Hungary | QA/QC activities are performed in two levels: based on the ISO 9001 standards and following the IPCC recommendations.<br><br>ISO activities: The Hungarian Meteorological Service introduced the quality management system ISO 9001:2000 in 2002 for the whole range of its activities. However, GHG inventory preparation was not among its activities in that time. Therefore, the scope of our ISO accreditation had to be modified and lots of efforts have been made to bring also the national system under the umbrella of the ISO QM system. Several regulatory ISO documents were created. The basic document is the Procedure on the activities of the GHG Division. It contains the basic principles of the inventory preparation and reporting processes, prescribes the obligation of making a QA/QC plan, and regulates the documentation and archiving activities. The QA/QC plan, which is an audited ISO document, consists of the following elements:<br>• Specification of the sectoral responsibilities of the core team<br>• Nomination of an officer responsible for the QA/QC system: the QA/QC coordinator<br>• Documentation<br>• Data quality check<br>• Reviews<br>• Development plan<br><br>The Hungarian Meteorological Service funds two research projects for the improvement of the inventory: Incorporation of ETS data in broader extent for revision of the used EFs and for better sectoral allocation of emissions<br><br>Having an ISO system in place has an advantage of being subject to regular internal and external audits. During our last external audit the activities of the GHG Division were audited as well.<br><br>Other QA/QC activities: Besides ISO requirements, other QA/QC activities are carried out, as well. For every sector of the inventory, there is a responsible person within the core team in the Met. Service. These sectoral responsibilities are laid down in the yearly QA/QC plan. Especially in case of external experts, this responsible member of our team conducts several quality checks on the provided calculations. Moreover, this exercise can be regarded as an interactive process throughout the whole inventory cycle, since the used methodologies, early results are discussed during the process of the emission/removal calculations. This QC procedure also led to a few recalculations. Many elements of the general Tier1 QC procedure are applied. The used parameters and factors, the consistency of data are checked regularly. Completeness checks are undertaken, new and previous estimates are compared every time. Data entry into the database is checked many times by a second person. If possible, activity data from different data sources are compared and thus verified. In response to our request, several data suppliers made declarations as regards quality assurance systems in place during the collection of the data. Nevertheless, the work continues to refine the used QA/QC procedures and implement further elements. | NIR for 1985-2008, Hungary (Draft Excerpts) Jan 2010,<br><br>pp. 17-18 |
| Latvia | According to CoM Regulation No. 157 (17.02.2009) all institutions involved in inventory process are responsible for implementing QC procedures. Mainly Tier 1 General Inventory Level QC procedures outlined in Table 8.1 of IPCC GPG 2000 are used.<br><br>The legislation act determines:<br>• the quality objectives for GHG inventory;<br>• QA/QC plan that has been prepared to improve transparency, comparability, and completeness of GHG inventory. In the QA/QC plan quality control procedures to be used before and during the compilation of GHG inventory are described.<br>• tasks and responsibilities of involved institutions;<br>• check-list and procedure description for independent experts for quality assurance of GHG inventory.<br><br>The result of quality depends on four main stages – planning, preparation, evaluation and improvements and is ensured by inventory experts during compilation and reporting of inventory.<br><br>The inventory planning stage includes the setting of quality objectives and elaboration of the QA/QC plan for the coming inventory preparation, compilation and reporting work. The main objective of Latvia's GHG inventory system is to produce high quality GHG inventories. The quality requirements set for the annual inventories – transparency, consistency, comparability, completeness, accuracy, improvements and timelines.<br><br>MoE as national entity is responsible for overall QC procedures and quality assurance of national system, including UNFCCC reviews. LEGMC is responsible for coordination of the whole process of annual greenhouse gas inventory and has an overall responsibility for QC. | Latvia's Short National Inventory Report 1990-2009<br><br>Jan 2011<br><br>pp.25ff |

| MS | Description of the national QA/QC activities | Source |
|---|---|---|
| **Lithuania** | The Quality Assurance and Quality Control (QA/QC) Plan has been prepared in order to improve transparency, consistency, comparability and completeness of Lithuania's GHG inventory. The QA/QC Plan describes the quality objectives of the GHG inventory, the national system for inventory preparation, tasks and responsibilities. A description is provided of various formal procedures already implemented in the development of the GHG inventory and of planned improvements. The Center for Environmental Policy is responsible for co-ordination and implementation of the Plan.<br><br>**Quality Control (QC):** Analysts of the inventory must adopt adequate procedures for development and modification of the spreadsheets to minimise emission calculation errors. Checks ensure compliance with the established procedures as well as allow detecting the remaining errors. Parameters, emission units and conversion factors used for the calculations must be clearly singled out and specified. Also, additional procedures should be followed to ensure that the parameters and emission factors are correctly written down and that relevant conversion factors are used. The managers of sectors (experts team) shall present the spreadsheets with the input data, calculation results and descriptions of the respective chapters of the NIR to the Manager of the Inventory and to the Manager of Quality Control (Center for Environmental Policy).<br><br>Quality Assurance (QA) activities are not implemented due to limited resources. | Draft National GHG Emission Inventory Report 2011 of the Republic of Lithuania,<br><br>Reported inventory 1990-2009<br><br>Jan 2011 pp. 12-13 |
| **Malta** | The need for a standardised Quality Assurance/Quality Control (QA/QC) system within the national inventory system is recognised and is acknowledged as being an important aspect to be addressed in the ongoing development of the system in general. Work specifically aimed at developing a QA/QC system is expected to form part of the national inventory system team's work plan for 2011, to ensure the quality and reliability of the activity data, emission factors and emission estimates, in line with the principles of transparency, accuracy, consistency, comparability and completeness.<br><br>Efforts were made to ensure as high a level of quality and reliability as possible. A priority task has been to ensure that the best available sources of data are used, especially where these have been verified (for example data on fuel consumption in power generation plants for the most recent years has been derived from verified emission reports that local installations are obliged to submit pursuant to Directive 2003/87/EC ). | National Greenhouse Gas Emissions Inventory Report for Malta<br><br>1990 - 2009<br><br>Jan 2011 p. 5-7 |
| **Poland** | The national entity – National Centre for Emission Management – which is responsible for preparation of GHG inventories, is also responsible for coordination and implementing the QA/QC activities. The programme for Quality Assurance and Quality Control has been elaborated to improve and assure high quality of the Polish annual greenhouse gas inventory. It has been elaborated in line with the IPCC Good Practice Guidance and Uncertainty Management in National GHG Inventories (2000). The QA/QC programme contains tasks, responsibilities as well as time schedule for performance of the QA/QC procedures. The following elements of the Quality Assurance and Quality Control system has been addressed:<br>• Inventory agency responsible for coordinating QA/QC activities,<br>• QA/QC plan,<br>• General QC procedures (Tier 1 method),<br>• Source category-specific QC procedures (Tier 2),<br>• QA review procedures,<br>• Reporting, documentation and archiving procedures.<br><br>QA/QC Plan elaborated in 2007 was updated in November 2009 following the institutional changes made in the inventory system when the National Centre for Emission Management was established in late 2009. | direct communication based on NIR 2010 |

<table>
<tr><th>MS</th><th>Description of the national QA/QC activities</th><th>Source</th></tr>
<tr><td>Romania</td><td>This QA/QC Programme was established according to the UNFCCC and Kyoto Protocol’s provisions related to GHG inventory preparation and national system establishment and also to 1996 Revised IPCC Methodology and Good Practice Guidance. Therefore, the document comprises information on:
<ul>
<li>the national authority responsible for the coordination of QA/QC activities;</li>
<li>the objectives of the QA/QC framework;</li>
<li>the QA/QC Plan;</li>
<li>the QC procedures;</li>
<li>the QA procedures;</li>
<li>the reporting, documenting and archiving procedures.</li>
</ul>
According to the provisions of the Governmental Decision no.1570/2007 establishing the national system and to those in the NEPA’s President Decision no. 24/2009, NEPA represents the competent authority responsible with the implementation of the QA/QC activities under the NGHGI. For this purpose, NEPA is performing the following activities:
<ul>
<li>ensures that specific QA/QC objectives are established;</li>
<li>develops and regularly updates a QA/QC plan;</li>
<li>implements the QA/QC procedures</li>
</ul>
Considering the provisions of relevant regulations, NEPA designated a QA/QC coordinator.<br><br>
The overall objective of the QA/QC programme is to develop the NGHGI in line with the requirements of the IPCC 1996, IPCC GPG 2000 and IPCC GPG 2003 and with the provisions of the Decision 280/2004/EC of the European Parliament and of the Council and Decision 166/2005/EC of the European Commission.<br><br>
Romania’s QA/QC plan closely follows the definitions, guidelines and processes presented in Chapter 8 – Quality Assurance and Quality Control of the IPCC GPG 2000. The QA/QC plan constitutes the heart of the QA/QC procedures. It outlines the current and planned QA/QC activities. The specific QA/QC activities are performed during all stages of the inventory preparation.<br><br>
The QA/QC plan will be reviewed periodically if needed and can be modified as appropriate when changes in processes occur or based on the advice from independent reviewers. The QA/QC plan is intended to ensure the fulfillment of the NGHGI principles in Romania. The objectives of the plan include:
<ul>
<li>applying greater QC effort for key source categories and for those source categories where data and methodological changes have occurred recently;</li>
<li>periodically checking the validity of all information as changes in reporting, methods of collection or frequency of data collection occur;</li>
<li>conducting the general procedures outlined in QC procedures (Tier 1) on all parts of the inventory over a complete exercise;</li>
<li>balancing efforts between development and implementation of QA/QC procedures and continuous improvement of inventory estimates;</li>
<li>customizing the QC procedures to the resources available and the particular characteristics of Romania’s greenhouse gas inventory;</li>
<li>confirming the national statistical institute and other agencies supplying activity data to NEPA have implemented QC procedures</li>
</ul></td><td>QA/QC Programme for the National<br><br>GHG Inventory of Romania<br><br>Jan 2011</td></tr>
<tr><td>Slovakia</td><td>Ministry of the Environment of the Slovak Republic contracted consultation company ISO Management for project “Implementation Process for QA/QC Model and QMS ISO 9001”. Project started in March 2009 and was separated into two parts: Part I Implementation Process for QA/QC Model and Part II Implement QMS ISO 9001:2008. During the preparation phase of Part I of the Project was prepared QA/QC plan for internal and external procedurals steps in preparation of GHG emission inventory. QA/QC plan was only partially implemented because institutional, legal and procedural framework did not allow adopting it in full extent. The internal certification was completed in March 2010. The external certification of the NIS is expected in the future. On 13 January 2010 Part I of the Project was finalized with the meeting and workshop for the experts involved in the National Inventory System.<br><br>
The QA/QC plan for sectors is updated and evaluated annually by quality manager of NIS. The QA/QC Plan is included in Annex to this report.</td><td>Annual report 2011<br><br>Submission under the EC GHG Monitoring Mechanism<br><br>Jan 2011, p.7</td></tr>
</table>

| MS | Description of the national QA/QC activities | Source |
|---|---|---|
| Slovenia | In 2009 the Republic of Slovenia has developed and mostly implemented a Quality Assurance and Quality Control plan as recommended by IPCC Good Practice Guidelines (IPCC 2000). QA/QC plan is a part of the Manual of Procedures, which has already been elaborated in 2005 and was updated in 2009. In beginning of 2009 a QA/QC manager within the inventory agency has been designated.<br>The general part of this system is incorporated into Oracle database (ISEE – "Emission inventory" information system) which has been established in the end of 2008. The main purpose of ISEE is:<br>to enable collection and archiving of activity data, emission factors and other parameters including description of sources from 1980 on for other pollutants, and from 1986 on for GHG emissions.<br>• to calculate GHG and other pollutant emissions<br>• to automatically fill in reporting tables (CRF Reporter)<br>• During developing of database the following QC have been performed:<br>• Check methodological and data changes resulting in recalculations<br>• Completeness checks<br>• Check of activity data, emission factor and other parameters<br>• Check of emission estimates<br>For 2010 the peer review for waste sector has been planned, but upon series reflection the decision was taken, to improve our emission estimates from waste waters. As project is financial demanding it was divided into two parts. In 2009 emissions from industrial waste waters have been renewed and for 2010 the revision of domestic and commercial waste water treatment is planned. We will perform the peer review of waste sector afterwards.<br>The Energy sector and Industrial processes sector is regularly checked by experts from Energy efficiency centre (CEU/IJS) and many useful advices were given how to improve HFC estimates from mobile AC.<br>For Agriculture and LULUCF sector it is very hard to perform peer review as the main institutions (Slovenian Forestry Institute and Agricultural Institute of Slovenia) are already involved in the inventory preparation.<br>QA/QC procedures performed by other institutions (Slovenian Forestry Institute and Agricultural Institute of Slovenia) are described in the relevant chapters in the NIR (LULUCF, Agriculture). Data based on forest statistics are produced by the Slovenian Forestry Institute and SORS. Data based on agricultural statistics are mainly from SORS and the Agricultural Institute. All data were checked. | Slovenia's National Inventory Report 2011 (selected chapters)<br>Jan 2011<br>pp.14-16 |

## 16.5 Uncertainty estimates

Table 16.5 gives an overview of information provided by the new Member States on uncertainty estimates in their national inventory reports 2011 and presents summarised results of these estimates.

**Table 16.5 Overview of uncertainty estimates available from new Member States**

| Member State | Bulgaria | Cyprus | Czech Republic | Estonia | Hungary | Latvia | Lithuania | | Malta | Poland | Romania | Slovakia | Slovenia |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Citation | NIR, Mar 2011, pp. 72-79 | NIR, Mar 2011, pp. 11-12 | NIR, Mar 2011, pp. 34-37 | Uncertainty Table 2011 | NIR, Mar 2011, p. 26 + Uncertainty Tabel | NIR, Mar 2011, p.36 | NIR, Jan 2011, pp. 22-23 | | Uncertainty Table 2011 | NIR, March 2011, p. 19 | Uncertainty Table 2011 | Uncertainty Table 2011 | NIR Mar 2011, p. 25-26 |
| Method used | Tier 1 | Tier 1 | Tier 1 | Tier 1 | Tier 1 | Tier 1 | Tier 1 | Tier 1 | Tier 1 | Tier 1 | Tier 1 | Tier 1 | Tier 1 |
| Documentation in NIR (according to Table 6.1/6.2 of GPG) | Yes | Yes (Annex II) | Yes | No | Yes (Annex 7) | Yes (Annex 7) | Yes (Annex 2) | | Yes (Annex 2) | Yes (Annex 6) | Yes (Annex 7) | Yes (Annex III) | Yes (Annex 7) |
| Years and sectors included | emissions: 2009; BY-2009; excluding LULUCF | emissions: 2009; trend: 1990-2009; including LULUCF | emissions: 2009; trend: 1990-2009; excluding LULUCF | emissions: 1990; trend: 1990-2009; including LULUCF | emissions: 2009; trend: BY-2009; excluding LULUCF | emissions: 2009; trend: 1990-2009; including LULUCF | emissions: 2009; trend: 1990-2009; including LULUCF | | emissions: 2009; trend: 1990-2009; including LULUCF | emissions: 2009; including LULUCF | emissions: 2009; trend: BY - 2009; including LULUCF | emissions 1990; trend: 1990-2008; including LULUCF | emissions: 2009; trend: 1986-2009; including LULUCF |
| Uncertainty (%) | Tier 1 | Tier 1 | Tier 1 | Tier 1 | Tier 1 | Tier 1 | Tier 1 (i. L.) | Tier 1 (e. L.) | Tier 1 | Tier 1 | Tier 1 | Tier 1 | Tier 1 |
| $CO_2$ | | | | | 3,6% | | 3.0% | 1.7% | | 4.6% | | | |
| $CH_4$ | | | | | 18,3% | | 4.0% | 3.3% | | 19.8% | | | |
| $N_2O$ | | | | | 169,1% | | 10.2% | 8.4% | | 48.5% | | | |
| F-gases | | | | | 24.70% | | | | | HFC 47.6%<br>PFC 70.7%<br>SF6 89.7% | | | |
| Total | 15.7% | 2.0% | 10.1% | i. L.: 20.2%<br>e. L.: 8.0% | 17.6% | i. L.: 62.2% ;<br>e. L.: 40,3% | 11.4% | 9.2% | 3.8% | | e. L.: 16,6%<br>i. L.: 33,6% | 13.9% | e. L.: 7,1%<br>i. L.: 30,3% |
| Uncertainty in trend (%) | Tier 1 | | Tier 1 | | Tier 1 | | | | | | Tier 1 | Tier 1 | Tier 1 |
| $CO_2$ | | | | | | | | | | | | | |
| $CH_4$ | | | | | | | | | | | | | |
| $N_2O$ | | | | | | | | | | | | | |
| F-gases | | | | | | | | | | | | | |
| Total | ±4,0% points | ±20% points | ±3,9% points | i. L.: ±5.7% points<br>e. L.: ±3.5% points | ±2,3% points | i. L.: ±127,7% points<br>e. L.: ±31.3% points | ±2,5% points | ±2,0% points | ±3,4% points | | e. L.: ±4.7% points<br>i. L.: ±11.2% points | ±8,2% points | ±4.45% points |

## 16.6 Completeness and data basis

Table 16.6 summarizes timeliness and completeness of the new Member States' submissions in 2011. It shows that GHG inventories for 2009 were submitted by all new Member States by 15 April 2011; some Member States provided resubmissions by 15 May (cut-off date for the 27 May EU resubmission). The completeness of national submissions with regard to individual CRF tables can be found in the status reports in Annex 2.3.

**Table 16.6 Date, mode and content of submissions of new Member States in 2010 (status 15 May 2011)**

| MS | Date | Submission mode | XML | SEF | CRF | KP LULUCF | NIR |
|---|---|---|---|---|---|---|---|
| BG | 13/01/2011 | CDR | BGR-2011-v1.1 | 2010 | 1988-2009 | 2008, 2009 | short NIR |
| BG | 15/03/2011 | CDR | BGR-2011-v1.2 | - | 1988-2009 | 2008, 2009 | yes |
| BG | 15/04/2011 | CDR | BGR-2011-v1.3 | - | 1988-2009 | 2008, 2009 | yes |
| CY | 31/01/2011 | CDR | years only from 1990 to 2008 | not relevant | 1990-2009 | not relevant | yes |
| CY | 24/02/2011 | CDR | CYP-2011-v1.2 | - | 1990-2009 | not relevant | - |
| CY | 22/03/2011 | CDR | CYP-2011-v1.3 | not relevant | 1990-2009 | not relevant | yes |
| CZ | 13/01/2011 | CDR | CZE-2011-v1.2 | 2010 | 1990-2009 | 2008, 2009 | short NIR |
| CZ | 16/03/2011 | CDR | - | - | - | - | yes |
| CZ | 25/03/2011 | FTP | CZE-2011-v1.3 | - | 1990-2009 | 2008, 2009 | - |
| CZ | 15/04/2011 | CDR | CZE-2011-v1.4 | 2010 | 1990-2009 | 2008, 2009 | yes |
| EE | 14/01/2011 | CDR | EST-2011-v1.1 | 2010 | 1990-2009 | 2008, 2009 | yes |
| EE | 15/03/2011 | CDR | EST-2011-v1.2 | 2010 | 1990-2009 | 2008, 2009 | yes |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| EE | 15/04/2011 | CDR | EST-2011-v1.4 | - | 1990-2009 | 2008, 2009 | yes |
| HU | 15/01/2011 | CDR | - | 2010 | - | - | - |
| HU | 03/02/2011 | CDR | HUN-2011-v1.2 | 2010 | 1985-2009 | 2008, 2009 | - |
| HU | 24/03/2011 | CDR | HUN-2011-v1.3 | - | 1985-2009 | 2008, 2009 | yes |
| LT | 15/01/2011 | CDR | LTU-2011-v1.1 | 2010 | 1990-2009 | 2008, 2009 | yes |
| LT | 15/03/2011 | CDR | LTU-2011-v1.2 | - | 1990-2009 | 2008, 2009 | yes |
| LT | 22/03/2011 | CDR | LTU-2011-v1.3 | - | 1990-2009 | 2008, 2009 | - |
| LV | 14/01/2011 | CDR | LVA-2011-v1.1 | 2010 | 1990-2009 | 2008, 2009 | yes |
| LV | 15/03/2011 | CDR | LVA-2011-v1.1 (2011-03-15) | - | 1990-2009 | 2008, 2009 | yes |
| LV | 15/04/2011 | CDR | LVA-2011-v1.2 | 2010 | 1990-2009 | 2008, 2009 | yes |
| MT | 14/01/2011 | CDR | MLT-2011-v1.2 | not relevant | 1990-2009 | not relevant | yes |
| MT | 15/03/2011 | CDR | MLT-2011-v1.4 | - | 1990-2009 | not relevant | yes |
| PL | 17/12/2010 | CDR | POL-2011-v1.1 | 2010 | 1988-2009 | 2008, 2009 | short NIR |
| PL | 15/03/2011 | CDR | - | - | 1988-2009 | 2008, 2009 | yes |
| PL | 16/03/2011 | CDR | POL-2011-v1.2 | - | - | - | - |
| PL | 16/03/2011 | CDR | - | 2010 | - | - | - |
| PL | 13/05/2011 | CDR | POL-2011-v2.1 | | 1988-2009 | 2008, 2009 | yes |
| RO | 14/01/2011 | CDR | ROU-2011-v1.1 | 2010 | 1989-2009 | 1989, 2008, 2009 | |
| RO | 15/03/2011 | CDR | ROU-2011-v1.2 | 2010 | 1989-2009 | 1989, 2008, 2009 | yes |
| RO | 15/04/2011 | CDR | ROU-2011-v1.3 | 2010 | 1989-2009 | 1989, 2008, 2009 | yes |
| SI | 13/01/2011 | CDR | SVN-2011-v1.1 | 2010 | 1986-2009 | 2008, 2009 | short NIR |
| SI | 15/03/2011 | CDR | SVN-2011-v1.2 | 2010 | 1986-2009 | 2008, 2009 | yes |
| SI | 19/04/2011 | CDR | SVN-2011-v1.3 | 2010 | 1986-2009 | 2008, 2009 | yes |
| SK | 15/01/2011 | CDR | SVK-2011-v1.1 | - | 1990-2009 | 2008, 2009 | short NIR |
| SK | 15/03/2011 | CDR | SVK-2011-v1.2 | - | 1990-2009 | 2008, 2009 | yes |
| SK | 17/05/2011 | CDR | - | - | - | - | yes |

*The grey xml files have been used for the EU-27 inventory*

In response to the Saturday paper 2010 the EU mobilized the mechanisms of its national system to further enhance its QA/QC programme and develop an appropriate action plan, in consultation with the MS, geared in particular towards complementing the existing procedures and improving the completeness regarding NEs of the EU greenhouse gas inventory in 2011 and beyond (see description in Chapter 13). During February and March intensive consultation between the EU inventory team and the Member States took place. In some cases the EU inventory team recommended Member States to provide estimates and/or change the use of notation keys. After this consultation the number of NEs in the Member States' GHG inventories could be reduced significantly. As a result of this consultation and the improvements in response to the UNFCCC review cycle 2010 the number of NEs at EU-15 level could be reduced by more than 50% in the 2011 submission compared to the 2010 submission. Annex 2.4 provides a list of all NEs and IEs and includes explanations taken from the Member States' CRF Tables 9. This information is equivalent to CRF Table 9 which cannot be filled-in automatically for the EU-15 due to the amount of information from the Member States.

GHG inventory estimates for 2009 are available for all new Member States. However, based on the completeness checks mentioned above; for Romania NEs from fugitive emissions from oil and gas were gap-filled. Table 16.7 provides an overview of the gaps and the gap-filling methods used. For a general description of the gap filling procedure under the EU GHG Monitoring Mechanism see Chapter 1.7.2.

**Table 16.7 Overview of the source categories and methods used for gap.filling for Romania**

| Source category | Gap filling method |
|---|---|
| 1.B.2.A.2-Production,$CO_2$ | Use Bulgarian IEF from 2010, v6.1 (constant IEF) and apply to AD in the 2011 CRF of Romania |
| 1.B.2.A.3-Transport,$CO_2$ | Use ratio $CO_2$ to $CH_4$ given in the GPG table 2.16 on page 2.87 for oil transport (0.092) |
| 1.B.2.B.2-Production / Processing,$CO_2$ | Use Bulgarian IEF from 2010, v6.1 (IEF is not constant for all years, but small fluctuations therefore use an average 1990-2008) and apply to AD in the 2011 CRF of Romania |
| 1.B.2.B.3-Transmission,$CO_2$ | Use ratio $CO_2$ to $CH_4$ given in the GPG table 2.16 on page 2.86 for gas transmission (0.0064) |
| 1.B.2.C.1.1-Oil, $CO_2$ | Calculate ratio $CO_2$ (from 2010, v6.1) to oil produced (Eurostat) for Bulgaria and apply to oil produced (Eurostat) of Romania; extrapolate for 2009 |
| 1.B.2.C.1.1-Oil,$CH_4$ | Calculate ratio $CH_4$ (from 2010, v6.1) to oil produced (Eurostat) for Bulgaria and apply to oil produced (Eurostat) of Romania; extrapolate for 2009 |

Table 16.8 to Table 16.11 show the data basis of the 2010 EU GHG inventory.

**Table 16.8 Data basis of $CO_2$ emissions excluding LULUCF (Tg)**

| EU Member State | 1990 | 1995 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| EU-15 | 3,359 | 3,290 | 3,362 | 3,428 | 3,419 | 3,478 | 3,490 | 3,473 | 3,450 | 3,396 | 3,323 | 3,063 |
| Bulgaria | 83 | 62 | 48 | 51 | 48 | 53 | 51 | 52 | 54 | 57 | 54 | 46 |
| Cyprus | 4 | 5 | 8 | 8 | 7 | 8 | 8 | 8 | 8 | 8 | 9 | 8 |
| Czech Republic | 165 | 132 | 127 | 129 | 125 | 125 | 125 | 125 | 125 | 126 | 120 | 113 |
| Estonia | 36 | 18 | 15 | 16 | 15 | 17 | 17 | 16 | 16 | 19 | 17 | 14 |
| Hungary | 72 | 61 | 58 | 60 | 58 | 61 | 60 | 61 | 59 | 58 | 56 | 50 |
| Latvia | 19 | 9 | 7 | 7 | 7 | 8 | 8 | 8 | 8 | 9 | 8 | 7 |
| Lithuania | 36 | 15 | 12 | 13 | 13 | 13 | 13 | 14 | 14 | 16 | 15 | 13 |
| Malta | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| Poland | 369 | 366 | 320 | 317 | 305 | 316 | 317 | 318 | 331 | 328 | 325 | 310 |
| Romania | 172 | 130 | 95 | 100 | 106 | 111 | 112 | 106 | 111 | 110 | 105 | 86 |
| Slovakia | 63 | 45 | 41 | 42 | 41 | 42 | 42 | 42 | 41 | 39 | 39 | 35 |
| Slovenia | 15 | 15 | 15 | 16 | 16 | 16 | 16 | 17 | 17 | 17 | 18 | 16 |
| **EU-27** | **4,396** | **4,150** | **4,111** | **4,189** | **4,164** | **4,249** | **4,262** | **4,241** | **4,237** | **4,185** | **4,092** | **3,765** |

**Table 16.9 Data basis of $CH_4$ emissions in $CO_2$ equivalents (Tg)**

| EU Member State | 1990 | 1995 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| EU-15 | 452 | 423 | 379 | 369 | 360 | 348 | 337 | 331 | 325 | 321 | 317 | 311 |
| Bulgaria | 15 | 12 | 11 | 10 | 10 | 11 | 11 | 10 | 10 | 10 | 9 | 9 |
| Cyprus | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Czech Republic | 19 | 14 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 11 |
| Estonia | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 |
| Hungary | 12 | 9 | 10 | 9 | 10 | 10 | 9 | 9 | 9 | 9 | 9 | 8 |
| Latvia | 4 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| Lithuania | 6 | 4 | 3 | 3 | 3 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| Malta | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Poland | 48 | 45 | 41 | 41 | 40 | 40 | 39 | 40 | 40 | 39 | 38 | 37 |
| Romania | 43 | 32 | 27 | 27 | 27 | 28 | 28 | 28 | 28 | 27 | 28 | 26 |
| Slovakia | 5 | 4 | 4 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 |
| Slovenia | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| **EU-27** | **610** | **551** | **494** | **483** | **474** | **464** | **452** | **445** | **439** | **433** | **428** | **418** |

**Table 16.10 Data basis of $N_2O$ emissions in $CO_2$ equivalents (Tg)**

| EU Member State | 1990 | 1995 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| EU-15 | 403 | 382 | 343 | 334 | 326 | 320 | 321 | 312 | 300 | 299 | 291 | 280 |
| Bulgaria | 13 | 7 | 5 | 5 | 5 | 5 | 6 | 5 | 5 | 5 | 5 | 5 |
| Cyprus | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Czech Republic | 12 | 8 | 8 | 8 | 8 | 7 | 8 | 8 | 8 | 8 | 8 | 7 |
| Estonia | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Hungary | 13 | 7 | 8 | 9 | 8 | 8 | 9 | 9 | 9 | 8 | 7 | 7 |
| Latvia | 4 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| Lithuania | 7 | 3 | 4 | 4 | 4 | 5 | 5 | 5 | 5 | 6 | 5 | 5 |
| Malta | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Poland | 38 | 31 | 29 | 29 | 28 | 29 | 29 | 29 | 31 | 31 | 31 | 28 |
| Romania | 33 | 24 | 19 | 20 | 20 | 21 | 20 | 21 | 21 | 19 | 20 | 18 |
| Slovakia | 6 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| Slovenia | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| **EU-27** | **532** | **471** | **424** | **418** | **408** | **403** | **406** | **398** | **387** | **384** | **377** | **358** |

**Table 16.11 Data basis of actual HFCs, PFCs and $SF_6$ emissions in $CO_2$ equivalents (Gg)**

| Member State | | 1990 | 1995 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **EU-15** | HFC | 40,891 | 35,732 | 46,210 | 45,196 | 43,950 | 46,004 | 50,086 | 51,458 | 55,106 | 56,911 | 60,077 | 63,433 |
| | PFC | 15,003 | 11,572 | 8,679 | 7,281 | 6,490 | 8,274 | 6,694 | 5,271 | 4,117 | 3,668 | 3,409 | 2,869 |
| | $SF_6$ | 14,313 | 14,395 | 10,351 | 10,192 | 9,338 | 8,352 | 7,694 | 7,786 | 7,713 | 7,134 | 6,801 | 6,377 |
| Bulgaria | HFC | IE,NA,NO | 9 | 28 | 35 | 46 | 62 | 86 | 114 | 179 | 209 | 310 | 268 |
| | PFC | IA,NE,NO | IA,NE,NO | IA,NE,NO | IA,NE,NO | IA,NE,NO | IA,NE,NO | IE,NA,NO | IE,NA,NO | IE,NA,NO | IE,NA,NO | 0 | 0 |
| | $SF_6$ | 4 | 5 | 7 | 7 | 8 | 8 | 9 | 9 | 9 | 9 | 10 | 10 |
| Cyprus | HFC | NA,NO | NA,NO | 0 | 1 | 74 | 73 | 69 | 136 | 53 | 21 | 76 | 7 |
| | PFC | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO |
| | $SF_6$ | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO |
| Czech Republic | HFC | IA,NE,NO | 1 | 263 | 393 | 391 | 590 | 600 | 594 | 872 | 1,606 | 1,262 | 1,042 |
| | PFC | IA,NE,NO | 0 | 9 | 12 | 14 | 25 | 17 | 10 | 23 | 20 | 27 | 27 |
| | $SF_6$ | 78 | 75 | 142 | 169 | 68 | 101 | 52 | 86 | 83 | 76 | 47 | 50 |
| Estonia | HFC | IA,NE,NO | 26 | 70 | 86 | 87 | 93 | 105 | 119 | 136 | 141 | 132 | 141 |
| | PFC | IA,NE,NO | IA,NE,NO | IA,NE,NO | IA,NE,NO | IA,NE,NO | IA,NE,NO | IA,NE,NO | IA,NE,NO | 0 | 0 | 0 | IA,NE,NO |
| | $SF_6$ | IA,NE,NO | 3 | 3 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Hungary | HFC | NA,NO | 1 | 222 | 322 | 396 | 498 | 551 | 610 | 667 | 808 | 923 | 832 |
| | PFC | 271 | 167 | 211 | 199 | 203 | 190 | 201 | 209 | 2 | 2 | 2 | 2 |
| | $SF_6$ | 40 | 70 | 140 | 107 | 120 | 162 | 178 | 201 | 244 | 172 | 232 | 220 |
| Latvia | HFC | IA,NE,NO | 1 | 5 | 8 | 10 | 16 | 20 | 32 | 71 | 113 | 91 | 95 |
| | PFC | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO |
| | $SF_6$ | IA,NE,NO | 0 | 1 | 2 | 3 | 4 | 5 | 8 | 7 | 9 | 10 | 14 |
| Lithuania | HFC | NA,NO | 2 | 5 | 5 | 7 | 9 | 12 | 16 | 20 | 24 | 30 | 36 |
| | PFC | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO |
| | $SF_6$ | NA,NO | 0 | 0 | 0 | 0 | 2 | 1 | 1 | 1 | 1 | 6 | 5 |
| Malta | HFC | 8 | 18 | 7 | 10 | 12 | 14 | 20 | 23 | 32 | 41 | 46 | 42 |
| | PFC | NA,NO | NA,NO | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | $SF_6$ | 0 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| Poland | HFC | NA,NO | 26 | 595 | 1,073 | 1,519 | 1,816 | 2,414 | 3,016 | 3,045 | 3,489 | 3,662 | 3,931 |
| | PFC | 208 | 252 | 249 | 270 | 287 | 278 | 285 | 260 | 270 | 299 | 226 | 29 |
| | $SF_6$ | NA,NO | 31 | 24 | 24 | 24 | 22 | 23 | 28 | 35 | 33 | 34 | 39 |
| Romania | HFC | IA,NE,NO | 0 | 3 | 4 | 4 | 6 | 9 | 7 | 23 | 18 | 21 | 25 |
| | PFC | 2,116 | 1,774 | 1,300 | 1,054 | 731 | 472 | 513 | 570 | 610 | 626 | 631 | 478 |
| | $SF_6$ | IA,NE,NO | 0 | 0 | 0 | 0 | 18 | 23 | 50 | 68 | 58 | 16 | 7 |
| Slovakia | HFC | NA,NO | 22 | 76 | 82 | 102 | 132 | 153 | 172 | 199 | 227 | 264 | 300 |
| | PFC | 271 | 114 | 12 | 16 | 14 | 22 | 20 | 20 | 36 | 25 | 36 | 18 |
| | $SF_6$ | 0 | 10 | 13 | 14 | 15 | 15 | 16 | 17 | 17 | 17 | 19 | 19 |
| Slovenia | HFC | NA,NO | 29 | 29 | 36 | 47 | 59 | 73 | 87 | 97 | 111 | 117 | 121 |
| | PFC | 257 | 106 | 106 | 106 | 116 | 119 | 120 | 133 | 125 | 91 | 21 | 7 |
| | $SF_6$ | 10 | 13 | 16 | 16 | 17 | 18 | 18 | 19 | 18 | 17 | 16 | 14 |
| **EU-27** | HFC | 40,899 | 35,866 | 47,512 | 47,251 | 46,645 | 49,374 | 54,198 | 56,385 | 60,500 | 63,718 | 67,012 | 70,271 |
| | PFC | 18,126 | 13,986 | 10,565 | 8,938 | 7,854 | 9,380 | 7,851 | 6,473 | 5,182 | 4,730 | 4,354 | 3,430 |
| | $SF_6$ | 14,445 | 14,604 | 10,699 | 10,535 | 9,596 | 8,706 | 8,022 | 8,206 | 8,198 | 7,529 | 7,194 | 6,758 |

Table 16.12 shows the geographical coverage of the new Member States' national inventories. As the EU inventory is the sum of the Member States' inventories, the EU inventory covers the same geographical area as the inventories of the Member States.

**Table 16.12 Geographical coverage of the new Member States**

| Member State | Geographical coverage |
|---|---|
| Bulgaria | Bulgaria |
| Cyprus | Area under the effective control of the Republic of Cyprus |
| Czech Republic | Czech Republic |
| Estonia | Estonia |
| Hungary | Hungary |
| Latvia | Latvia |
| Lithuania | Lithuania |
| Malta | Malta |
| Poland | Poland |
| Romania | Romania |
| Slovakia | Slovakia |
| Slovenia | Slovenia |

# 17 EU-27 GREENHOUSE GAS EMISSION TRENDS

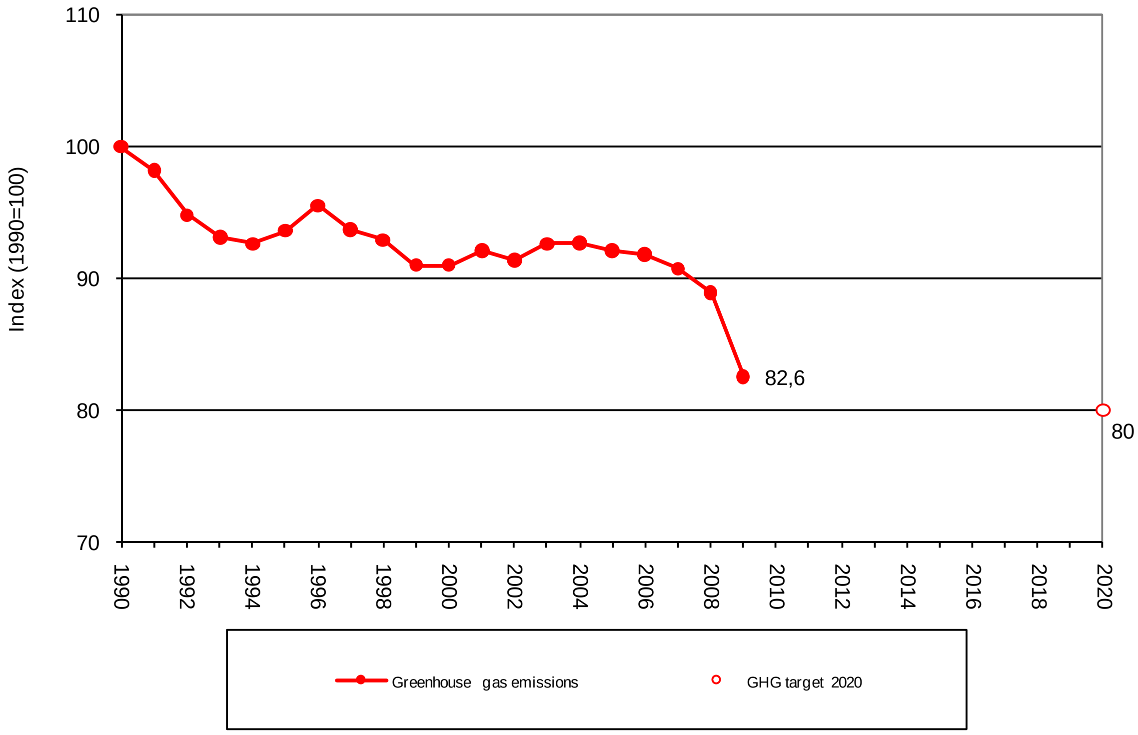
This chapter presents the main GHG emission trends in the EU-27. Firstly, aggregated results are described for EU-27. Then, emission trends are briefly analysed mainly at gas level and a short overview of Member States' contributions to EU GHG trends is given. Finally, also the trends of indirect GHGs and $SO_2$ emissions are also presented.

## 17.1 Aggregated greenhouse gas emissions

On 23 January 2008 the European Commission adopted the 'Climate Action and Renewable Energy' package. The proposal was part of draft legislation implementing the 'Integrated Energy and Climate Change' package of 10 January 2007, which was endorsed by the European Council in March 2007. In December 2008 the European Parliament and the Council reached agreement on the package. It was adopted by the Council on 6 April 2009. The package underlines the objective of limiting the rise in global average temperature to no more than two degrees Celsius above pre-industrial levels. To achieve this goal the EU committed to a unilateral emission reduction target of 20%[46] by 2020, compared with 1990 levels, and agreed to a reduction by 30% provided that other major emitters agree to take on their fair share of a global reduction effort.

Total GHG emissions, without LULUCF, in the EU-27 decreased by 17.4 % between 1990 and 2009 (974 million tonnes $CO_2$ equivalents). Emissions decreased by 7.1 % (-354 million tonnes $CO_2$ equivalents) between 2008 and 2009 (Figure 16.1).

**Figure 17.1 EU-27 GHG emissions 1990–2009 (excl. LULUCF)**




[46] All emission information for EU-27 in this report uses 1990 as the starting point when addressing emission reductions. EU-27 does not have a common target under the Kyoto Protocol in the same way as EU-15.

*Notes: GHG emission data for the EU-27 as a whole refer to domestic emissions (i.e. within its territory) and do not include emissions and removals from LULUCF; nor do they include emissions from international aviation and international maritime transport. $CO_2$ emissions from biomass with energy recovery are reported as a Memorandum item according to UNFCCC Guidelines and not included in national totals. In addition, no adjustments for temperature variations or electricity trade are considered. The global warming potentials are those from the 1996 revised IPCC Guidelines for National Greenhouse Gas Inventories.*

### 17.1.1 Main trends by source category, 1990-2009

Table 17.1 shows the source categories contributing the most to changes in greenhouse gas emissions between 1990 and 2009.

**Table 17.1 EU-27: Overview of Top decreasing/increasing source categories 1990-2009 (+/- 20 Million tonnes $CO_2$ equivalents)**

| Source category | EU-27<br>Million tonnes ($CO_2$ eq.) |
|---|---|
| Road transport (CO2 from 1A3b) | 164.8 |
| Consumption of Halocarbons (HFC from 2F) | 69.9 |
| Cement production ($CO_2$ from 2A1) | -20.5 |
| Production of Halocarbons (HFC from 2E) | -25.6 |
| Nitric acid production (N2O from 2B2) | -33.4 |
| Enteric Fermentation ($CH_4$ from 4A) | -38.9 |
| Adipic acid production ($N_2O$ from 2B3) | -49.1 |
| Manufacture of Solid fuels (CO2 from 1A1c) | -57.6 |
| Fugitive Emissions ($CH_4$ from 1B) | -71.0 |
| Solid Waste Disposal ($CH_4$ from 6A) | -63.9 |
| Agricultural Soils ($N_2O$ from 4D) | -76.7 |
| Iron and steel production ($CO_2$ from 1A2a+2C1) | -105.1 |
| Households and services ($CO_2$ from 1A4) | -117.3 |
| Manufacturing industries (excl. iron and steel) (Energy-related $CO_2$ from 1A2 excl. 1A2a) | -227.7 |
| Public Electricity and Heat Production (CO2 from 1A1a) | -232.3 |
| **Total** | **-974.3** |

***Notes:*** *As the table only presents sectors whose emissions increased or decreased by 20 million tonnes $CO_2$-equivalents, the sum for each country grouping EU-15/EU-27 does not match the total change listed at the bottom of the table.*

### 17.1.2 Main trends by source category, 2008-2009

Between 2008 and 2009 emissions decreased by 7.1 % in the EU-27. This was mainly due to emission decreases in public electricity and heat production (Table 17.2).

**Table 17.2** **EU-27: Overview of Top decreasing/increasing source categories 2007-2009 (+/- 3 Million tonnes $CO_2$ equivalents)**

| Source category | EU-27<br>Million tonnes ($CO_2$ eq.) |
|---|---|
| Public Electricity and Heat Production ($CO_2$ from 1A1a) | -103.2 |
| Manufacturing industries (excl. iron and steel) (Energy-related $CO_2$ from 1A2 excl. 1A2a) | -65.9 |
| Iron and Steel production ($CO_2$ from 1A2a+2C1) | -53.6 |
| Road transport ($CO_2$ from 1A3b) | -23.7 |
| Households and Services ($CO_2$ from 1A4) | -22.0 |
| Cement production ($CO_2$ from 2A1) | -18.6 |
| Manufacture of Solid Fuels ($CO_2$ from 1A1c) | -10.8 |
| Nitric acid production (N2O from 2B2) | -9.4 |
| Refineries (CO2 from 1A1b) | -8.4 |
| Agricultural Soils ($N_2O$ from 4D) | -8.0 |
| Fugitive Emissions ($CH_4$ from 1B) | -4.1 |
| **Total** | **-354.5** |

***Notes:*** *As the table only presents sectors whose emissions have increased or decreased by at least 3 million tonnes of $CO_2$- equivalents, the sum for each country grouping does not match the total change listed at the bottom of the table*

## *17.1.3 Main reasons for emission changes 2008-2009*

Between 2008 and 2009, decreases in the EU-27 were mainly due to:

- $CO_2$ from public electricity and heat production (-103.2 million tonnes or -7.8 %)

  This decrease is mainly caused by the EU-15, but also by Czech Republic, Poland and Romania.

- $CO_2$ from manufacturing industries excl. iron and steel (-65.9 million tonnes or -12.9 %).

  The decrease is mainly due to EU-15 Member States, but also all new Member States reduced emissions.

- $CO_2$ from iron and steel production (-53.6 million tonnes or -29.6 %)

  This reduction was due to a significant decline in the in crude steel production in all major steel producing countries in the EU-27 (-29.7 % according to the World Steel Association).

- $CO_2$ from road transport (-23.7 million tonnes or -2.7 %).

  Reductions in the EU-27 are mainly due to the EU-15 Member States, but also most new Member States except for Malta, Poland and Romania reported decreases.

- $CO_2$ from households and services (-22 million tonnes or -3.2 %)

  EU-15 Member States contributed most to the decrease in the EU-27. Within the new Member States the Czech Republic, Hungary, Romania and Bulgaria reported the highest decreases.

- $CO_2$ from cement production (-18.6 million tonnes or -18.7 %)

  The decrease is caused mainly caused by the EU-15 Member States but also Romania, Poland and Bulgaria contributed significantly to this reduction.

There were no substantial emission increases (+/- 3 million tonnes $CO_2$ equivalents) between 2008 and 2009.

### 17.1.4 Overview of GHG emissions in new Member States

**Table 17.3** **Greenhouse gas emissions in $CO_2$ equivalents (excl. LULUCF) and Kyoto Protocol targets for 2008–12**

| MEMBER STATE | 1990 (million tonnes) | Kyoto Protocol base year [a] (million tonnes) | 2009 (million tonnes) | 2008–2009 (million tonnes) | Change 2008–2009 (%) | Change 1990-2009 (%) | Change base year–2009 (%) | Targets 2008–12 under Kyoto Protocol and "EU burden sharing" (%) |
|---|---|---|---|---|---|---|---|---|
| **EU-15** | **4264.9** | **4265.5** | **3723.7** | **-274.3** | **-6.9%** | **-12.7%** | **-12.7%** | **-8.0%** |
| Bulgaria | 111.4 | 132.6 | 59.5 | -9.5 | -13.8% | -46.6% | -55.1% | -8.0% |
| Cyprus | 5.3 | Not applicable | 9.4 | -0.8 | -7.7% | 78.3% | Not applicable | Not applicable |
| Czech Republic | 195.5 | 194.2 | 132.9 | -8.2 | -5.8% | -32.0% | -31.6% | -8.0% |
| Estonia | 41.1 | 42.6 | 16.8 | -3.2 | -16.1% | -59.0% | -60.5% | -8.0% |
| Hungary | 96.8 | 115.4 | 66.7 | -6.4 | -8.7% | -31.1% | -42.2% | -6.0% |
| Latvia | 26.6 | 25.9 | 10.7 | -1.2 | -10.0% | -59.7% | -58.6% | -8.0% |
| Lithuania | 49.6 | 49.4 | 21.6 | -2.4 | -10.1% | -56.4% | -56.3% | -8.0% |
| Malta | 2.1 | Not applicable | 2.9 | -0.14 | -4.7% | 38.8% | Not applicable | Not applicable |
| Poland | 452.9 | 563.4 | 376.7 | -19.1 | -4.8% | -16.8% | -33.2% | -6.0% |
| Romania | 250.1 | 278.2 | 130.8 | -22.6 | -14.7% | -47.7% | -53.0% | -8.0% |
| Slovakia | 74.1 | 72.1 | 43.4 | -4.8 | -9.9% | -41.4% | -39.8% | -8.0% |
| Slovenia | 18.5 | 20.4 | 19.3 | -1.9 | -9.1% | 4.7% | -5.0% | -8.0% |
| **EU-27** | **5588.8** | **Not applicable** | **4614.5** | **-354.5** | **-7.1%** | **-17.4%** | **Not applicable** | **Not applicable** |

([a]) *The base year under the Kyoto Protocol for each new Member State is further outlined in Table 16.3. As Cyprus, Malta and EU-27 do not have targets under the Kyoto Protocol, they do not have applicable Kyoto Protocol base years.*

## 17.2 Emission trends by gas

Table 17.4 gives an overview of the main trends in EU-27 GHG emissions and removals for 1990–2009. The most important GHG by far is $CO_2$, accounting for 81.6 % of total EU-27 emissions in 2009 excluding LULUCF. In 2009, EU-27 $CO_2$ emissions without LULUCF were 3 765 Tg, which was 14.3 % below 1990 levels. Compared to 2008, $CO_2$ emissions decreased by 8 %.

**Table 17.4** **Overview of EU-27 GHG emissions and removals from 1990 to 2009 in $CO_2$ equivalents (Tg)**

| **GREENHOUSE GAS EMISSIONS** | **1990** | **1995** | **2000** | **2001** | **2002** | **2003** | **2004** | **2005** | **2006** | **2007** | **2008** | **2009** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Net $CO_2$ emissions/removals | 4,043 | 3,767 | 3,732 | 3,780 | 3,795 | 3,890 | 3,883 | 3,852 | 3,826 | 3,795 | 3,675 | 3,325 |
| $CO_2$ emissions (without LULUCF) | 4,396 | 4,150 | 4,111 | 4,189 | 4,164 | 4,249 | 4,262 | 4,241 | 4,237 | 4,185 | 4,092 | 3,765 |
| $CH_4$ | 610 | 551 | 494 | 483 | 474 | 464 | 452 | 445 | 439 | 433 | 428 | 418 |
| $N_2O$ | 532 | 471 | 424 | 418 | 408 | 403 | 406 | 398 | 387 | 384 | 377 | 358 |
| HFCs | 28 | 41 | 46 | 46 | 49 | 53 | 56 | 60 | 62 | 67 | 70 | 72 |
| PFCs | 20 | 13 | 9 | 8 | 10 | 8 | 6 | 5 | 5 | 4 | 4 | 3 |
| $SF_6$ | 11 | 16 | 11 | 10 | 9 | 8 | 8 | 8 | 8 | 7 | 7 | 6 |
| **Total (with net $CO_2$ emissions/removals)** | **5,244** | **4,859** | **4,716** | **4,744** | **4,744** | **4,827** | **4,810** | **4,768** | **4,727** | **4,691** | **4,560** | **4,182** |
| **Total (without CO2 from LULUCF)** | **5,597** | **5,242** | **5,095** | **5,154** | **5,114** | **5,186** | **5,189** | **5,157** | **5,138** | **5,080** | **4,977** | **4,622** |
| **Total (without LULUCF)** | **5,589** | **5,232** | **5,086** | **5,145** | **5,105** | **5,177** | **5,181** | **5,149** | **5,129** | **5,071** | **4,969** | **4,615** |

## 17.3 Emission trends by source

Table 17.5 gives an overview of EU-27 GHG emissions in the main source categories for 1990–2009. The most important sector by far is Energy (i.e. combustion and fugitive emissions) accounting for 79.3 % of total EU-27 emissions in 2009. The second largest sector is Agriculture (10.3%), followed by Industrial Processes (7.0 %).

**Table 17.5 Overview of EU-27 GHG emissions in the main source and sink categories 1990 to 2009 in $CO_2$ equivalents (Tg)**

| GHG SOURCE AND SINK | 1990 | 1995 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Energy | 4,284 | 4,044 | 3,984 | 4,071 | 4,043 | 4,116 | 4,113 | 4,085 | 4,073 | 4,010 | 3,934 | 3,660 |
| 2. Industrial Processes | 463 | 441 | 391 | 377 | 372 | 385 | 398 | 403 | 400 | 411 | 387 | 321 |
| 3. Solvent and Other Product Use | 17 | 14 | 14 | 14 | 13 | 13 | 13 | 12.780 | 13 | 13 | 12 | 11 |
| 4. Agriculture | 610 | 528 | 515 | 507 | 503 | 496 | 495 | 490 | 487 | 485 | 487 | 476 |
| 5. Land-Use, Land-Use Change and Forestry | -345 | -373 | -370 | -401 | -360 | -351 | -371 | -381 | -402 | -381 | -409 | -432 |
| 6. Waste | 214 | 205 | 182 | 176 | 174 | 168 | 162 | 159 | 157 | 152 | 149 | 147 |
| 7. Other | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Total (with net $CO_2$ emissions/removals)** | **5,244** | **4,859** | **4,716** | **4,744** | **4,744** | **4,827** | **4,810** | **4,768** | **4,727** | **4,691** | **4,560** | **4,182** |
| **Total (without LULUCF)** | **5,589** | **5,232** | **5,086** | **5,145** | **5,105** | **5,177** | **5,181** | **5,149** | **5,129** | **5,071** | **4,969** | **4,615** |

## 17.4 Emission trends by Member State

Table 17.6 gives an overview of new Member States' contributions to the EU GHG emissions for 1990–2009. Member States show large variations in GHG emission trends.

**Table 17.6 Overview of new Member States' contributions to EU GHG emissions excluding LULUCF from 1990 to 2009 in $CO_2$ equivalents (Tg)**

| Member State | 1990 | 1995 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **EU-15** | **4,265** | **4,155** | **4,140** | **4,185** | **4,162** | **4,205** | **4,208** | **4,178** | **4,137** | **4,080** | **3,998** | **3,724** |
| Bulgaria | 111 | 81 | 63 | 66 | 63 | 68 | 68 | 67 | 68 | 72 | 69 | 59 |
| Cyprus | 5 | 7 | 9 | 9 | 9 | 9 | 9 | 10 | 10 | 10 | 10 | 9 |
| Czech Republic | 196 | 154 | 147 | 150 | 145 | 144 | 145 | 145 | 146 | 147 | 141 | 133 |
| Estonia | 41 | 20 | 18 | 18 | 18 | 19 | 20 | 19 | 19 | 22 | 20 | 17 |
| Hungary | 97 | 78 | 77 | 79 | 77 | 80 | 79 | 79 | 78 | 75 | 73 | 67 |
| Latvia | 27 | 13 | 10 | 11 | 11 | 11 | 11 | 11 | 12 | 12 | 12 | 11 |
| Lithuania | 50 | 22 | 19 | 20 | 21 | 21 | 22 | 23 | 23 | 25 | 24 | 22 |
| Malta | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| Poland | 453 | 440 | 389 | 386 | 373 | 385 | 386 | 388 | 402 | 401 | 396 | 377 |
| Romania | 250 | 188 | 142 | 148 | 155 | 161 | 160 | 156 | 160 | 156 | 153 | 131 |
| Slovakia | 74 | 53 | 49 | 51 | 50 | 51 | 51 | 50 | 50 | 48 | 48 | 43 |
| Slovenia | 18 | 18 | 19 | 20 | 20 | 20 | 20 | 20 | 20 | 21 | 21 | 19 |
| **EU-27** | **5,589** | **5,232** | **5,086** | **5,145** | **5,105** | **5,177** | **5,181** | **5,149** | **5,129** | **5,071** | **4,969** | **4,615** |

The overall EU GHG emission trend is dominated by the EU-15 (mainly by Germany, the United Kingdom, Italy, France and Spain) accounting for 62 % of total EU-27 GHG emissions. Of the new Member States Poland contributes most to the total EU-27 GHG emissions, namely 8.2 %, followed by Romania and Czech Republic (share of about 3 % each). Poland decreased GHG emissions by 16.8 % between 1990 and 2009 (-33.2 % since the base year, which is 1988 in the case of Poland). Main factors for decreasing emissions in Poland — as for other new Member States — was the decline of energy inefficient heavy industry and the overall restructuring of the economy in the late 1980s and early 1990s. The notable exception was transport (especially road transport) where emissions increased.

## 17.5 Emission trends for indirect greenhouse gases and sulphur dioxide

Emissions of CO, NOx, NMVOC and $SO_2$ have to be reported to the UNFCCC Secretariat because they influence climate change indirectly: CO, NOx and NMVOC are precursor substances for ozone which itself is a greenhouse gas. Sulphur emissions produce microscopic particles (aerosols) that can reflect sunlight back out into space and also affect cloud formation. In the EU-27, $SO_2$ emissions decreased by 78 %, followed by CO (-61 %), NMVOC (-50 %) and NOx (-44 %) (Table 17.7).

**Table 17.7 Overview of EU-27 indirect GHG and SO2 emissions for 1990–2009 (Gg)**

| GREENHOUSE GAS EMISSIONS | 1990 | 1995 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | (Gg) | | | | | | | | | | | |
| NOx | 16,954 | 14,714 | 12,728 | 12,468 | 12,193 | 12,133 | 11,957 | 11,716 | 11,453 | 11,155 | 10,351 | 9,528 |
| CO | 64,783 | 51,436 | 40,716 | 37,841 | 35,624 | 34,492 | 33,779 | 30,600 | 29,423 | 28,252 | 27,506 | 24,965 |
| NMVOC | 18,491 | 14,944 | 12,389 | 11,806 | 11,301 | 11,345 | 11,037 | 10,636 | 10,598 | 10,500 | 9,501 | 9,260 |
| SO2 | 25,367 | 16,795 | 10,387 | 10,201 | 9,713 | 9,255 | 8,685 | 8,037 | 7,877 | 7,667 | 6,392 | 5,509 |

Table 17.8 shows the NOx emissions of the new Member States between 1990 and 2009. The EU-15 makes up for 79 % of total NOx emissions, followed by Poland with a share of 8.6 % in 2009. Most new Member States reduced their emissions, only Hungary, Cyprus, Malta and Slovenia had emission increases between 1990 and 2009.

**Table 17.8 Overview of the EU-15 and the new Member States' contributions EU-27 NOx emissions for 1990–2009 (Gg)**

| Member State | 1990 | 1995 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **EU-15** | **13,555** | **11,963** | **10,517** | **10,312** | **10,060** | **9,902** | **9,749** | **9,502** | **9,207** | **8,900** | **8,201** | **7,503** |
| Bulgaria | 289 | 216 | 171 | 186 | 179 | 201 | 201 | 207 | 214 | 222 | 218 | 195 |
| Cyprus | 18 | 18 | 21 | 21 | 20 | 20 | 20 | 20 | 20 | 21 | 19 | 18 |
| Czech Republic | 742 | 430 | 397 | 333 | 319 | 326 | 334 | 279 | 284 | 286 | 263 | 253 |
| Estonia | 78 | 41 | 37 | 39 | 38 | 38 | 38 | 37 | 36 | 39 | 36 | 31 |
| Hungary | 8 | 185 | 185 | 183 | 183 | 211 | 185 | 203 | 202 | 185 | 169 | 154 |
| Latvia | 65 | 39 | 36 | 39 | 39 | 39 | 39 | 37 | 37 | 38 | 34 | 28 |
| Lithuania | 164 | 63 | 50 | 48 | 51 | 54 | 56 | 57 | 65 | 71 | 68 | 62 |
| Malta | 8 | 9 | 8 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 8 |
| Poland | 1,280 | 1,120 | 838 | 805 | 796 | 805 | 804 | 873 | 865 | 885 | 828 | 819 |
| Romania | 459 | 386 | 304 | 328 | 342 | 353 | 367 | 332 | 344 | 348 | 359 | 324 |
| Slovakia | 222 | 178 | 107 | 108 | 100 | 96 | 100 | 104 | 99 | 97 | 95 | 85 |
| Slovenia | 65 | 65 | 56 | 58 | 56 | 79 | 56 | 57 | 72 | 56 | 54 | 48 |
| **EU-27** | **16,954** | **14,714** | **12,728** | **12,468** | **12,193** | **12,133** | **11,957** | **11,716** | **11,453** | **11,155** | **10,351** | **9,528** |

Table 17.9 shows the CO emissions of the new Member States between 1990 and 2009. The EU-15 has a share of 73 %, followed by Poland and Romania. These two account for almost 17 % of EU-27 emissions in 2009. All new Member States, except for Hungary, Malta and Romania reduced emissions between 1990 and 2009.

**Table 17.9 Overview of the EU-15 and the new Member States' contributions EU-27 CO emissions for 1990–2009 (Gg)**

| Member State | 1990 | 1995 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **EU-15** | **52,547** | **41,837** | **31,817** | **30,166** | **28,174** | **27,046** | **25,954** | **24,002** | **22,782** | **21,642** | **20,685** | **18,310** |
| Bulgaria | 718 | 565 | 454 | 430 | 490 | 479 | 495 | 477 | 510 | 471 | 508 | 501 |
| Cyprus | 53 | 46 | 34 | 33 | 32 | 31 | 28 | 26 | 24 | 24 | 22 | 19 |
| Czech Republic | 1,072 | 934 | 682 | 689 | 589 | 632 | 624 | 558 | 542 | 584 | 498 | 454 |
| Estonia | 169 | 120 | 124 | 132 | 120 | 113 | 107 | 102 | 97 | 104 | 100 | 99 |
| Hungary | 166 | 644 | 593 | 579 | 573 | 600 | 583 | 588 | 594 | 577 | 570 | 554 |
| Latvia | 455 | 347 | 289 | 298 | 288 | 288 | 284 | 282 | 281 | 266 | 249 | 267 |
| Lithuania | 519 | 288 | 1,532 | 221 | 220 | 224 | 186 | 193 | 204 | 202 | 224 | 202 |
| Malta | 24 | 30 | 30 | 29 | 29 | 29 | 28 | 28 | 28 | 29 | 30 | 31 |
| Poland | 7,406 | 4,547 | 3,463 | 3,528 | 3,410 | 3,318 | 3,426 | 2,521 | 2,603 | 2,603 | 2,690 | 2,690 |
| Romania | 824 | 1,370 | 1,196 | 1,238 | 1,233 | 1,269 | 1,610 | 1,390 | 1,345 | 1,365 | 1,542 | 1,497 |
| Slovakia | 512 | 420 | 308 | 315 | 296 | 300 | 303 | 290 | 276 | 256 | 251 | 217 |
| Slovenia | 318 | 289 | 194 | 183 | 170 | 163 | 150 | 143 | 135 | 128 | 136 | 125 |
| **EU-27** | **64,783** | **51,436** | **40,716** | **37,841** | **35,624** | **34,492** | **33,779** | **30,600** | **29,423** | **28,252** | **27,506** | **24,965** |

Table 17.10 shows the NMVOC emissions of the EU-27 Member States between 1990 and 2009. The EU-15 makes up 78 % of total NMVOC emissions in 2009. Of the new Member States Poland and Romania have the highest shares. All new Member States except for Hungary and Romania reduced emissions between 1990 and 2009.

**Table 17.10 Overview of the EU-15 and the new Member States' contributions EU-27 NMVOC emissions for 1990–2009 (Gg)**

| Member State | 1990 | 1995 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **EU-15** | **15,928** | **13,012** | **10,634** | **10,131** | **9,608** | **9,604** | **8,966** | **8,730** | **8,629** | **8,070** | **7,697** | **7,265** |
| Bulgaria | 541 | 146 | 103 | 92 | 97 | 104 | 100 | 106 | 114 | 111 | 113 | 108 |
| Cyprus | 17 | 16 | 14 | 14 | 14 | 14 | 14 | 14 | 13 | 13 | 12 | 11 |
| Czech Republic | 311 | 215 | 244 | 220 | 203 | 203 | 198 | 182 | 179 | 174 | 166 | 151 |
| Estonia | 52 | 37 | 32 | 32 | 31 | 31 | 31 | 30 | 31 | 33 | 29 | 24 |
| Hungary | 63 | 170 | 166 | 162 | 160 | 169 | 157 | 176 | 187 | 168 | 168 | 134 |
| Latvia | 102 | 67 | 65 | 69 | 65 | 65 | 110 | 73 | 75 | 84 | 74 | 61 |
| Lithuania | 116 | 75 | 71 | 67 | 67 | 81 | 76 | 91 | 85 | 84 | 73 | 72 |
| Malta | 6 | 7 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |
| Poland | 831 | 769 | 599 | 576 | 600 | 585 | 597 | 566 | 567 | 596 | 582 | 611 |
| Romania | 335 | 281 | 336 | 316 | 332 | 363 | 665 | 539 | 601 | 1,056 | 481 | 724 |
| Slovakia | 141 | 101 | 69 | 73 | 72 | 73 | 73 | 76 | 71 | 69 | 69 | 65 |
| Slovenia | 48 | 47 | 53 | 51 | 50 | 51 | 47 | 49 | 42 | 39 | 34 | 31 |
| **EU-27** | **18,491** | **14,944** | **12,389** | **11,806** | **11,301** | **11,345** | **11,037** | **10,636** | **10,598** | **10,500** | **9,501** | **9,260** |

Table 17.11 shows the SO2 emissions of the new Member States between 1990 and 2009. The largest emitters beside the EU-15, which makes up 47 %, are Bulgaria, Poland and Romania. These three States account for 44 % of total EU-27 emissions in 2009. All new Member States except for Hungary reduced emissions between 1990 and 2009.

**Table 17.11 Overview of Member States' contributions to EU-15 and EU-27 SO2 emissions for 1990–2009 (Gg)**

| Member State | 1990 | 1995 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **EU-15** | **16,485** | **9,981** | **6,153** | **5,887** | **5,638** | **5,161** | **4,932** | **4,560** | **4,348** | **4,162** | **3,100** | **2,608** |
| Bulgaria | 1,767 | 1,350 | 1,080 | 1,198 | 1,113 | 1,234 | 1,195 | 1,143 | 1,147 | 1,278 | 1,238 | 1,162 |
| Cyprus | 36 | 38 | 47 | 44 | 44 | 45 | 39 | 36 | 29 | 27 | 22 | 17 |
| Czech Republic | 1,876 | 1,095 | 264 | 251 | 237 | 232 | 227 | 219 | 211 | 217 | 174 | 173 |
| Estonia | 170 | 74 | 78 | 76 | 75 | 87 | 81 | 75 | 74 | 79 | 73 | 61 |
| Hungary | 10 | 707 | 489 | 404 | 365 | 348 | 249 | 147 | 123 | 99 | 106 | 89 |
| Latvia | 105 | 49 | 16 | 12 | 11 | 9 | 7 | 7 | 6 | 6 | 5 | 4 |
| Lithuania | 215 | 86 | 42 | 39 | 38 | 38 | 41 | 42 | 42 | 34 | 29 | 31 |
| Malta | 16 | 27 | 24 | 26 | 25 | 27 | 11 | 11 | 11 | 12 | 11 | 7 |
| Poland | 3,210 | 2,376 | 1,511 | 1,564 | 1,455 | 1,375 | 1,241 | 1,145 | 1,237 | 1,131 | 1,018 | 860 |
| Romania | 755 | 636 | 457 | 505 | 539 | 530 | 512 | 522 | 542 | 537 | 535 | 421 |
| Slovakia | 526 | 246 | 127 | 131 | 103 | 106 | 96 | 89 | 88 | 71 | 69 | 64 |
| Slovenia | 197 | 129 | 98 | 65 | 70 | 63 | 54 | 41 | 18 | 15 | 13 | 12 |
| **EU-27** | **25,367** | **16,795** | **10,387** | **10,201** | **9,713** | **9,255** | **8,685** | **8,037** | **7,877** | **7,667** | **6,392** | **5,509** |

# 18 ENERGY (CRF SECTOR 1)

## 18.1 Overview of sector (EU-27)

**Figure 18.1** **CRF Sector 1 Energy: EU-27 GHG emissions in $CO_2$ equivalents (Tg) for 1990–2009**

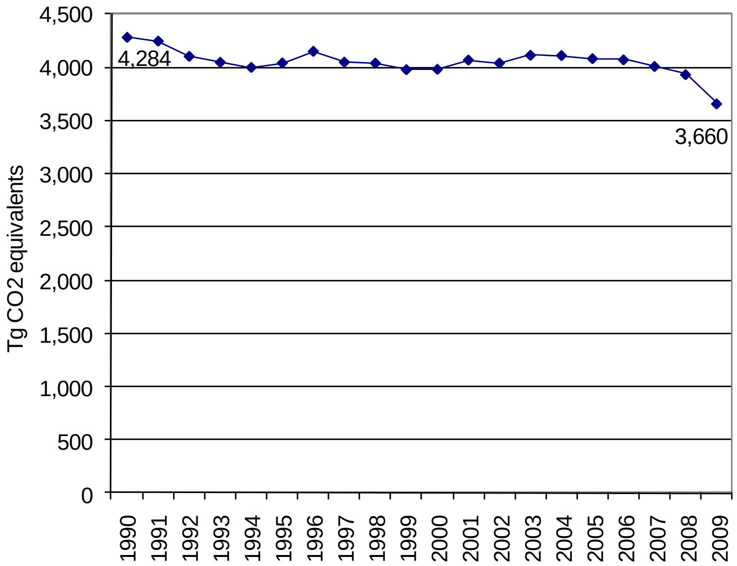
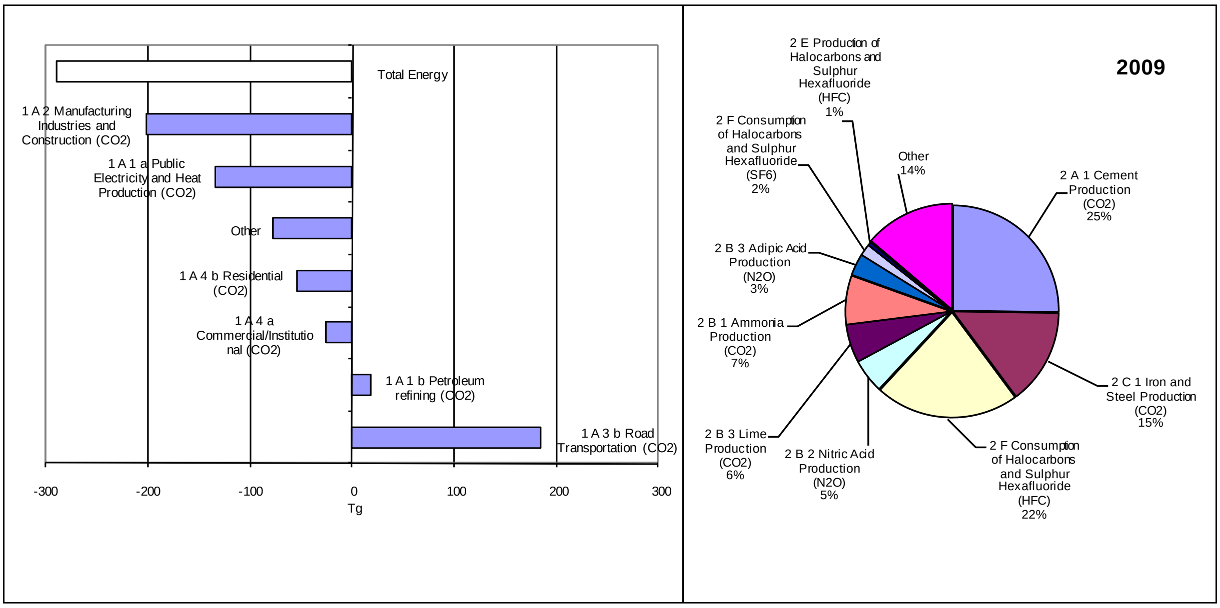



**Figure 18.2** **CRF Sector 1 Energy: Absolute change of GHG emissions in $CO_2$ equivalents (Tg) by large key source categories for 1990–2009 and share of largest key source categories in 2009**



# 18.2 Source categories (EU-27)

## 18.2.1 Energy industries (CRF Source Category 1A1)(EU 27)

### 18.2.1.1 Public Electricity and Heat Production (1A1a) (EU-27)

**Figure 18.3 1A1a-Public Electricity and Heat Production: Total, $CO_2$ and $N_2O$ emission and activity trends**

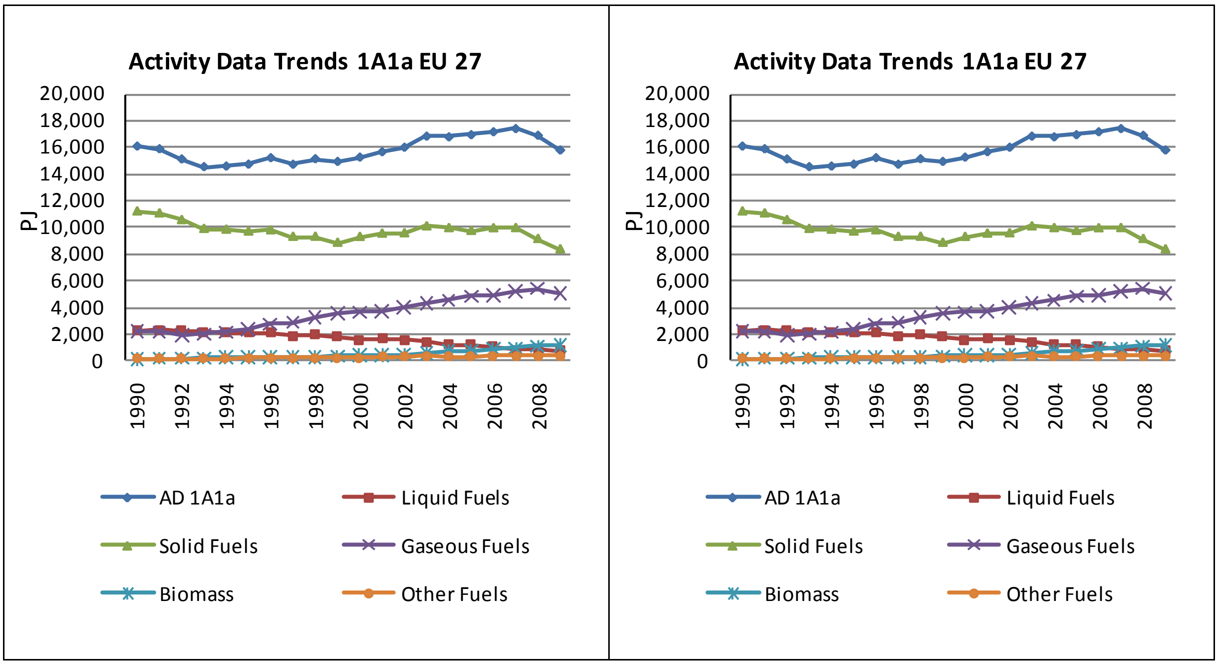



**Table 18.1 1A1a Public Electricity and Heat Production, liquid fuels: $CO_2$ emissions of EU-27**

| Member State | $CO_2$ emissions in Gg | | | Share in EU27 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| EU-15 | 123,501 | 65,779 | 51,226 | 78.5% | -14,553 | -22% | -72,276 | -59% | | |
| Bulgaria | 3,211 | 149 | 210 | 0.3% | 61 | 41% | -3,001 | -93% | T1 | D |
| Cyprus | 1,708 | 3,653 | 3,802 | 5.8% | 148 | 4% | 2,094 | 123% | T1,T3 | CS |
| Czech Republic | 819 | 539 | 407 | 0.6% | -132 | -25% | -412 | -50% | T1 | D |
| Estonia | 4,825 | 427 | 408 | 0.6% | -20 | -5% | -4,417 | -92% | T1,T2 | CS,D |
| Hungary | 1,830 | 452 | 452 | 0.7% | 0 | 0% | -1,378 | -75% | T2 | D,PS |
| Latvia | 3,051 | 96 | 87 | 0.1% | -9 | -10% | -2,964 | -97% | T1 | CS |
| Lithuania | 6,281 | 695 | 442 | 0.7% | -254 | -36% | -5,840 | -93% | T1,T2 | D,CS |
| Malta | 738 | 1,976 | 2,017 | 3.1% | 41 | 2% | 1,279 | 173% | D | D |
| Poland | 5,115 | 694 | 611 | 0.9% | -83 | -12% | -4,505 | -88% | T2 | D |
| Romania | 22,727 | 6,407 | 5,510 | 8.4% | -897 | -14% | -17,217 | -76% | T1a | CS |
| Slovakia | 1,033 | 26 | 17 | 0.0% | -10 | -37% | -1,017 | -98% | T2 | CS |
| Slovenia | 277 | 44 | 32 | 0.0% | -12 | -28% | -245 | -89% | T1 | D |
| **EU-27** | **175,118** | **80,938** | **65,219** | **100.0%** | **-15,719** | **-19%** | **-109,899** | **-63%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

**Figure 18.4** 1A1a- Public Electricity and Heat Production, liquid fuels: Activity Data and Implied Emission Factors for $CO_2$

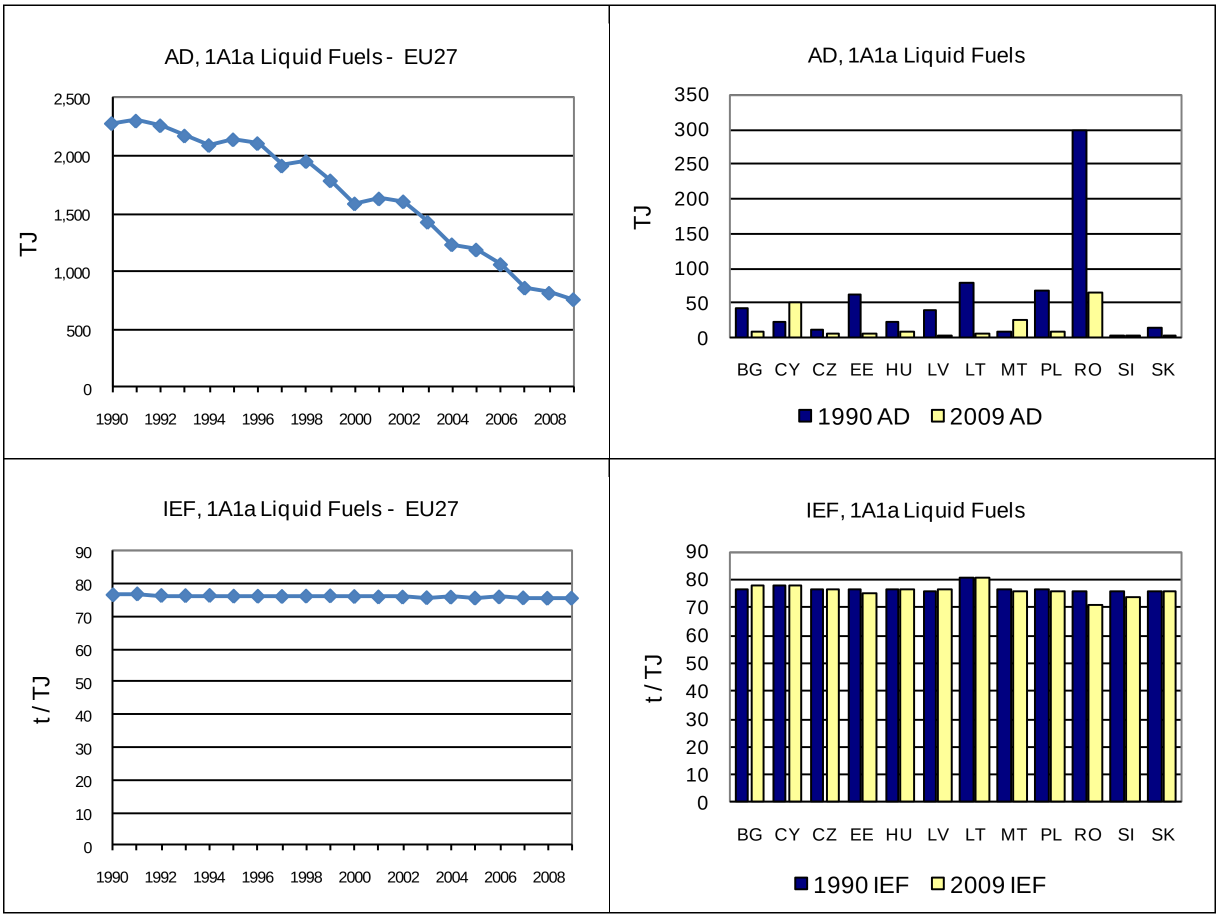



**Table 18.2** 1A1a Public Electriciy and Heat Production, solid fuels: $CO_2$ emissions of EU-27

| Member State | $CO_2$ emissions in Gg | | | Share in EU27 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| EU-15 | 752,396 | 686,309 | 684,317 | 68.2% | -1,992 | 0% | -68,080 | -9% | | |
| Bulgaria | 27,876 | 24,262 | 27,652 | 2.8% | 3,390 | 14% | -224 | -1% | T2 | CS,D |
| Cyprus | NO | NO | NO | - | - | - | - | - | NO | NO |
| Czech Republic | 51,658 | 58,462 | 61,939 | 6.2% | 3,478 | 6% | 10,281 | 20% | T1 | CS |
| Estonia | 21,676 | 9,773 | 11,915 | 1.2% | 2,142 | 22% | -9,761 | -45% | T1,T2,T3 | CS,D |
| Hungary | 12,725 | 8,758 | 8,891 | 0.9% | 133 | 2% | -3,835 | -30% | T3 | CS,PS |
| Latvia | 339 | 12 | 31 | 0.0% | 19 | 164% | -308 | -91% | T1 | CS |
| Lithuania | 193 | 44 | 74 | 0.0% | 30 | 67% | -119 | -62% | T2 | D,C |
| Malta | 611 | NA | NA | - | - | - | -611 | -100% | NA | NA |
| Poland | 214,836 | 169,966 | 165,259 | 136.4% | -4,707 | -3% | -49,577 | -23% | T2 | CS,D |
| Romania | 36,266 | 30,501 | 31,419 | 25.9% | 918 | 3% | -4,848 | -13% | T1a | CS |
| Slovakia | 11,542 | 5,815 | 5,206 | 0.5% | -609 | -10% | -6,336 | -55% | T2 | CS |
| Slovenia | 5,600 | 6,050 | 6,269 | 0.6% | 219 | 4% | 669 | 12% | T2 | CS |
| **EU-27** | **1,135,720** | **999,952** | **1,002,972** | **100.0%** | **3,020** | **0%** | **-132,748** | **-12%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

**Figure 18.5** 1A1a- Public Electricity and Heat Production, solid fuels: Activity Data and Implied Emission Factors for $CO_2$

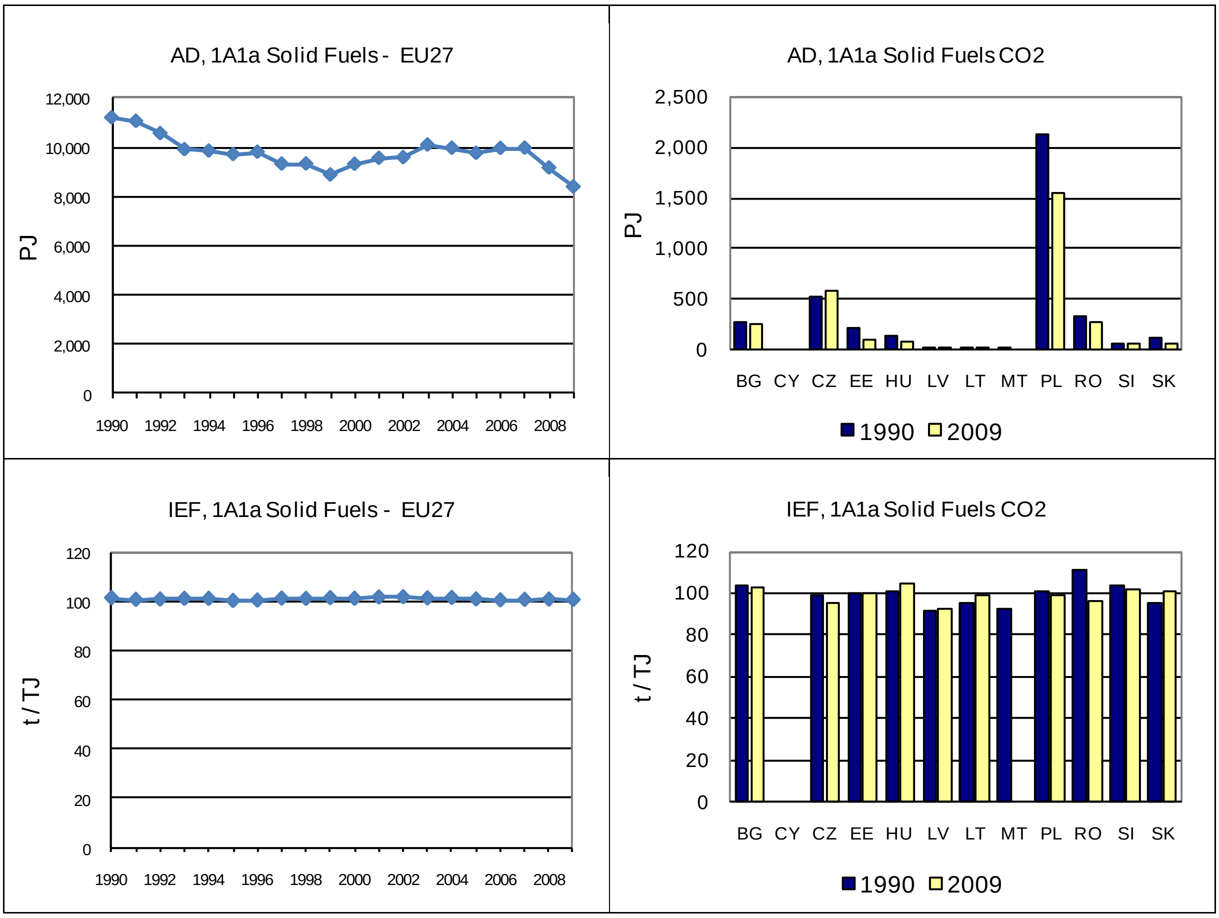



**Table 18.3** 1A1a Electricity and heat production, solid fuels: $N_2O$ emissions of EU-27

| Member State | $N_2O$ emissions (Gg $CO_2$ equivalents) | | | Share in EU27 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| EU-15 | 6,374 | 5,703 | 5,698 | 80.2% | -5 | 0% | -676 | -11% | | |
| Bulgaria | 117 | 103 | 117 | 1.6% | 14 | 14% | 0 | 0% | T1 | D |
| Cyprus | NA | NA | NA | - | - | - | - | - | NA | NA |
| Czech Republic | 229 | 266 | 282 | 4.0% | 16 | 6% | 52 | 23% | T1 | D |
| Estonia | 5 | 11 | 11 | 0.2% | 0 | 5% | 6 | 114% | T1,T2 | CS,D |
| Hungary | 59 | 38 | 40 | 0.6% | 2 | 5% | -19 | -32% | T1 | D |
| Latvia | 3 | 0.07 | 0.16 | 0.0% | 0.09 | 129% | -3 | -94% | T1 | D |
| Lithuania | 1 | 0.34 | 0.72 | 0.0% | 0.38 | 114% | 0 | -30% | T1,T2 | CS,D |
| Malta | 3 | NA | NA | - | - | - | -3 | -100% | NA | NA |
| Poland | 982 | 789 | 770 | 10.8% | -19 | -2% | -212.4 | -22% | T2 | D |
| Romania | 142 | 134 | 137 | 1.9% | 4 | 3% | -4 | -3% | T1,T1a | CS,D |
| Slovakia | 52 | 26 | 22 | 0.3% | -4 | -14% | -30 | -57% | T1 | D |
| Slovenia | 24 | 26 | 26 | 0.4% | 1 | 2% | 3 | 13% | T1 | D |
| **EU-27** | **7,991** | **7,095** | **7,105** | **100.0%** | **10** | **0%** | **-887** | **-11%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

**Table 18.4 1A1a Electricity and heat production, gaseous fuels: $CO_2$ emissions of EU-27**

| Member State | $CO_2$ emissions in Gg | | | Share in EU27 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| EU-15 | 60,419 | 238,283 | 257,845 | 88.0% | 19,562 | 8% | 197,426 | 327% | | |
| Bulgaria | 6,263 | 1,875 | 1,880 | 0.6% | 5 | 0% | -4,383 | -70% | T1 | D |
| Cyprus | NO | NO | NO | - | - | - | - | - | NO | NO |
| Czech Republic | 1,541 | 2,802 | 2,183 | 0.7% | -619 | -22% | 642 | 42% | T1 | D |
| Estonia | 1,961 | 1,204 | 1,163 | 0.4% | -41 | -3% | -798 | -41% | T2 | CS |
| Hungary | 5,825 | 8,266 | 8,827 | 3.0% | 562 | 7% | 3,003 | 52% | T3 | D |
| Latvia | 2,644 | 1,893 | 1,772 | 0.6% | -122 | -6% | -872 | - | T2 | CS |
| Lithuania | 5,982 | 3,033 | 2,847 | 1.0% | -186 | -6% | -3,134 | -52% | T2 | CR |
| Malta | NA | NA | NA | - | - | - | - | - | NA | NA |
| Poland | 1,208 | 2,948 | 2,772 | 0.9% | -176 | -6% | 1,564 | 129% | T2 | D |
| Romania | 38,778 | 11,880 | 11,509 | 3.9% | -371 | -3% | -27,269 | -70% | T1a | CS |
| Slovakia | 2,089 | 2,345 | 1,990 | 0.7% | -355 | -15% | -99 | -5% | T2 | CS |
| Slovenia | 112 | 247 | 264 | 0.1% | 17 | 7% | 152 | 136% | T1 | CS |
| **EU-27** | **126,821** | **274,777** | **293,053** | **100.0%** | **18,276** | **7%** | **166,232** | **131%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

**Figure 18.6 1A1a- Public Electricity and Heat Production, gaseous fuels: Activity Data and Implied Emission Factors for $CO_2$**

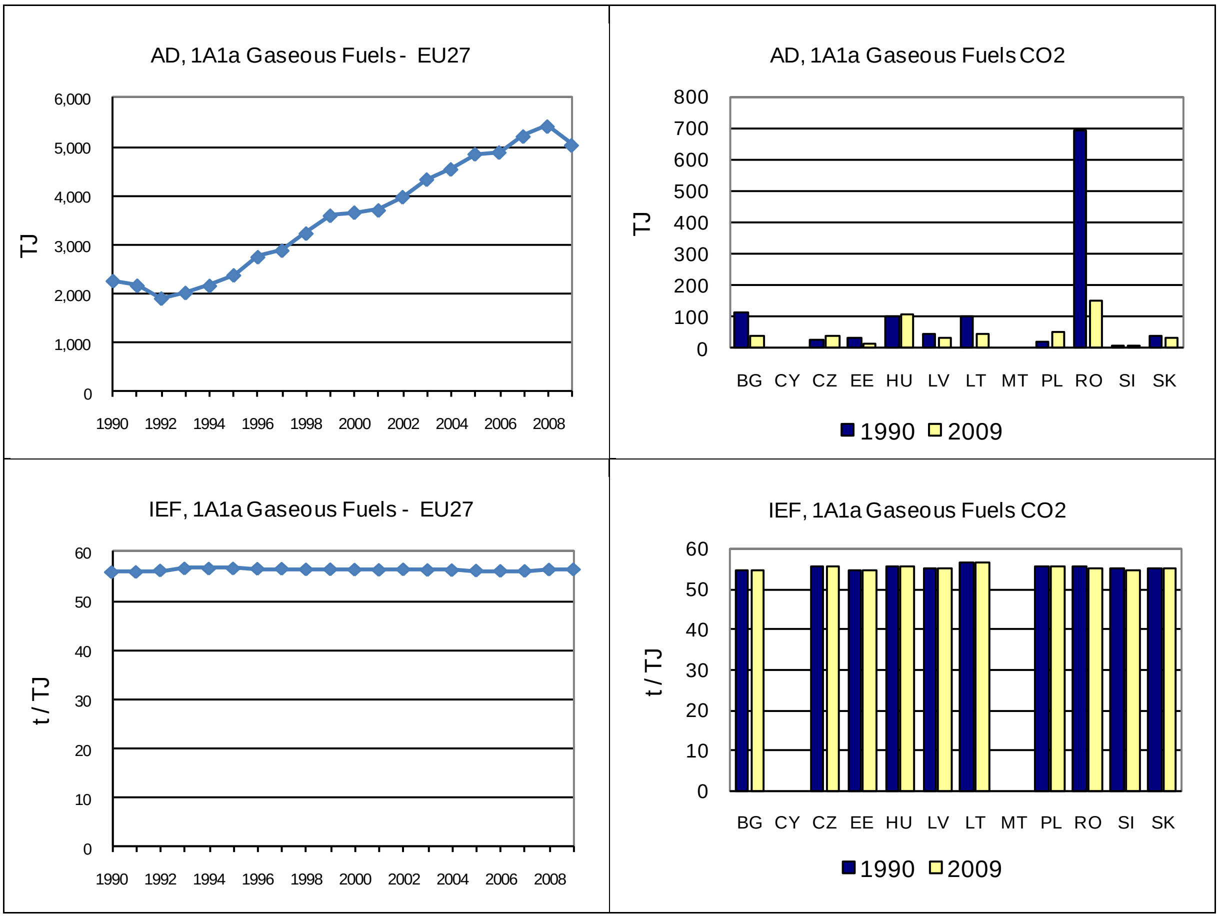


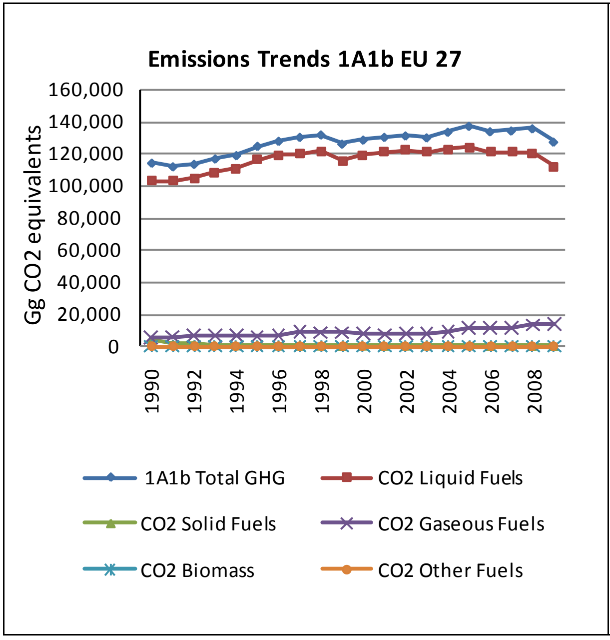
**Table 18.5** **1A1a Public Electriciy and Heat Production, other fuels: $CO_2$ emissions of EU-27**

| Member State | $CO_2$ emissions in Gg | | | Share in EU27 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| EU-15 | 12,660 | 29,286 | 31,247 | 260.6% | 1,960 | 7% | 18,587 | 147% | | |
| Bulgaria | NO | NO | NO | - | - | - | - | - | NO | NO |
| Cyprus | NO | NO | NO | - | - | - | - | - | NO | NO |
| Czech Republic | NO | NO | NO | - | - | - | - | - | NA | NA |
| Estonia | NO | NO | NO | - | - | - | - | - | NO | NO |
| Hungary | 63 | 259 | 336 | 3% | 77 | 30% | 273 | 435% | T2 | D,PS |
| Latvia | NO | NO | NO | - | - | - | - | - | NA | NA |
| Lithuania | NO | NO | NO | - | - | - | - | - | NO | NO |
| Malta | NA | NA | NA | - | - | - | - | - | NA | NA |
| Poland | NA | NA | NA | - | - | - | - | - | NO | NO |
| Romania | NE | NE | NE | - | - | - | - | - | NA | NA |
| Slovakia | 170 | 64 | 65 | 0.5% | 1 | 1% | -105 | -62% | T1a,T2 | CS,D |
| Slovenia | NO | NO | NO | - | - | - | - | - | T1 | D |
| **EU-27** | **12,893** | **29,609** | **31,648** | **263.9%** | **2,038** | **7%** | **18,755** | **145%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

## 18.2.1.2 Petroleum Refining (1A1b) (EU-27)

**Figure 18.7** **1A1b Petroleum Refining: Total, $CO_2$ and $N_2O$ emission and activity trends**



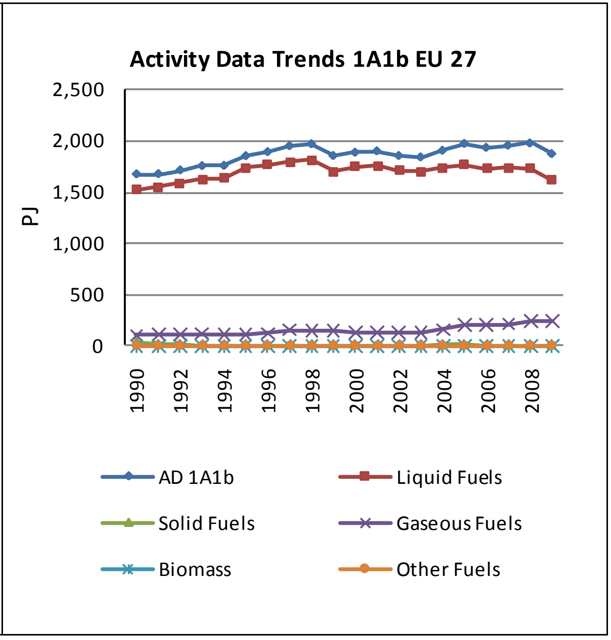



**Table 18.6 1A1b Petroleum Refining, liquid fuels: $CO_2$ emissions of EU-27**

| Member State | $CO_2$ emissions in Gg | | | Share in EU27 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| EU-15 | 97,195 | 111,621 | 111,735 | 92.2% | 114 | 0% | 14,541 | 15% | | |
| Bulgaria | 856 | 698 | 694 | 0.6% | -4 | -1% | -162 | -19% | T1 | D |
| Cyprus | 74 | NO | NO | - | - | - | -74 | -100% | T1,NO | CS,NO |
| Czech Republic | 923 | 733 | 724 | 0.6% | -9 | -1% | -200 | -22% | T1 | D |
| Estonia | NO | NO | NO | - | - | - | - | - | NO | NO |
| Hungary | 928 | 982 | 968 | 0.8% | -15 | -1% | 39 | 4% | T2 | D,PS |
| Latvia | NO | NO | NO | - | - | - | - | - | NA | NA |
| Lithuania | 1,495 | 1,512 | 1,443 | 1.2% | -69 | -5% | -52 | -3% | T2 | D,CS |
| Malta | NO | NO | NO | - | - | - | - | - | NA | NA |
| Poland | 1,373 | 4,832 | 4,603 | 10.3% | -230 | -5% | 3,230 | 235% | T2 | D |
| Romania | IE | IE | IE | - | - | - | - | - | NA | NA |
| Slovakia | 507 | 947 | 990 | 0.8% | 43 | 5% | 483 | 95% | T2 | CS |
| Slovenia | 43 | 1 | 0 | 0.0% | 0 | -56% | -42 | -99% | T1 | D |
| **EU-27** | **103,394** | **121,327** | **121,157** | **100.0%** | **-169** | **0%** | **17,764** | **17%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

**Figure 18.8 1A1b Petroleum Refining, liquid fuels: Activity Data and Implied Emission Factors for $CO_2$**

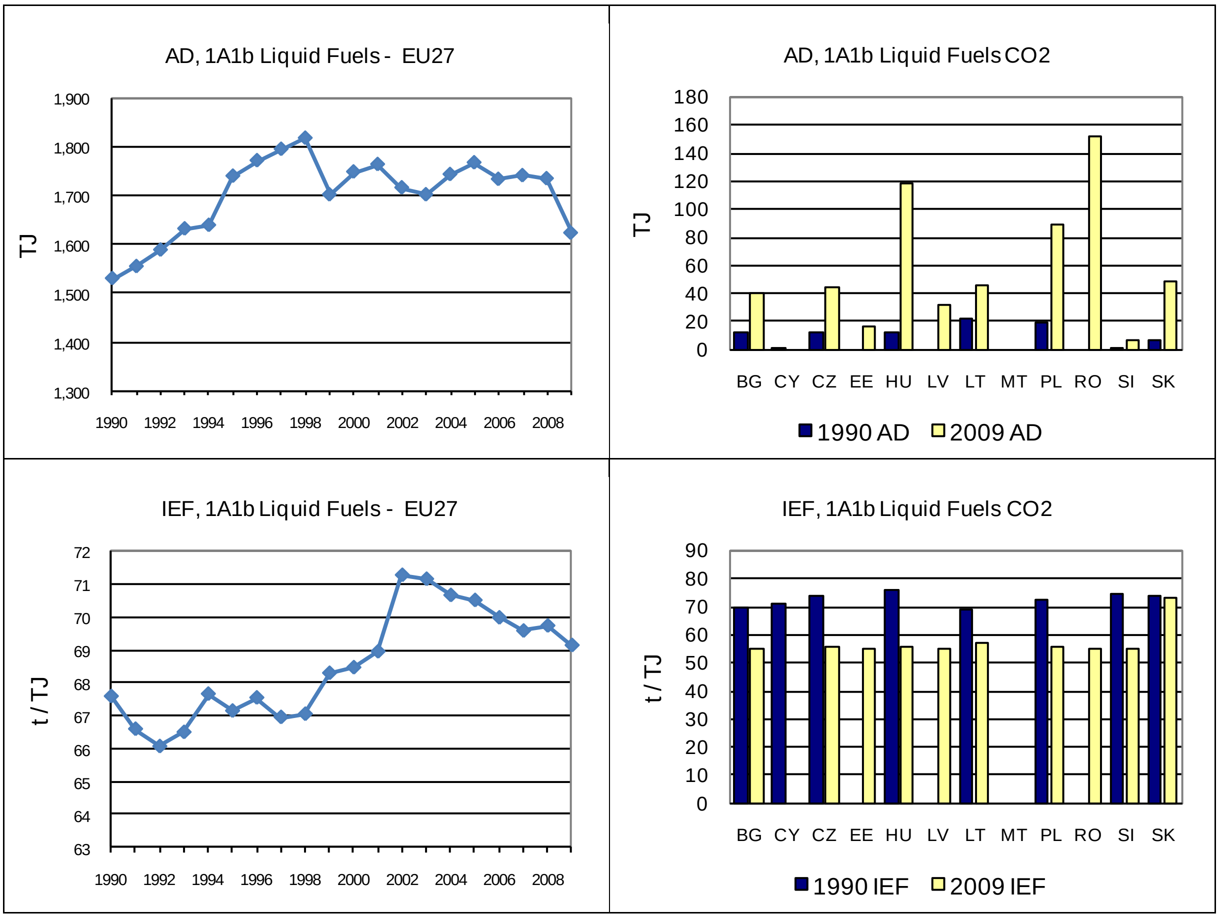


**Table 18.7 1A1b Petroleum Refining, solid fuels: $CO_2$ emissions of EU-27**

| Member State | $CO_2$ emissions in Gg | | | Share in EU27 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| EU-15 | 3,581 | 511 | 674 | 2.9% | 163 | 32% | -2,907 | -81% | | |
| Bulgaria | NO | NO | NO | - | - | - | - | - | NO | NO |
| Cyprus | NO | NO | NO | - | - | - | - | - | NO | NO |
| Czech Republic | NO | NO | NO | - | - | - | - | - | T1 | CS |
| Estonia | NO | NO | NO | - | - | - | - | - | NO | NO |
| Hungary | NO | NO | NO | - | - | - | - | - | NA | NA |
| Latvia | NO | NO | NO | - | - | - | - | - | NA | NA |
| Lithuania | NO | NO | NO | - | - | - | - | - | NO | NO |
| Malta | NO | NO | NO | - | - | - | - | - | NA | NA |
| Poland | 736 | 31 | NO | - | -31 | - | -736 | -100% | T2 | CS,D |
| Romania | IE | IE | IE | - | - | - | - | - | NA | NA |
| Slovakia | NO | 155 | 184 | 0.8% | 30 | 19% | 184 | - | T2 | CS |
| Slovenia | NO | NO | NO | - | - | - | - | - | NA | NA |
| **EU-27** | **4,317** | **697** | **858** | **100.0%** | **161** | **23%** | **-3,458** | **-80%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

**Table 18.8 1A1b Petroleum Refining, gaseous fuels: $CO_2$ emissions of EU-27**

| Member State | $CO_2$ emissions in Gg | | | Share in EU27 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| EU-15 | 3,846 | 9,408 | 9,622 | 42.0% | 214 | 2% | 5,776 | 150% | | |
| Bulgaria | 68 | 157 | 155 | 0.7% | -3 | -2% | 86 | 127% | T1 | D |
| Cyprus | NO | NO | NO | - | - | - | - | - | NO | NO |
| Czech Republic | 324 | 265 | 255 | 1.1% | -10 | -4% | -69 | -21% | T1 | D |
| Estonia | NO | NO | NO | - | - | - | - | - | NO | NO |
| Hungary | 689 | 482 | 424 | 1.8% | -58 | -12% | -265 | -38% | T3 | PS |
| Latvia | NO | NO | NO | - | - | - | - | - | NA | NA |
| Lithuania | NO | 0.28 | 0.28 | 0.0% | 0.00 | 0% | - | - | T2 | CR |
| Malta | NO | NO | NO | - | - | - | - | - | NA | NA |
| Poland | 93 | 832 | 1,162 | 5.1% | 330 | 40% | 1,069 | 1146% | T2 | D |
| Romania | IE | IE | IE | - | - | - | - | - | NA | NA |
| Slovakia | 755 | 358 | 373 | 1.6% | 16 | 4% | -382 | -51% | T2 | CS |
| Slovenia | 126 | 8 | NO | - | -8 | - | -126 | -100% | T1 | CS |
| **EU-27** | **5,903** | **11,510** | **11,992** | **100.0%** | 482 | 4% | 6,088 | - | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'*

### 18.2.1.3 Manufacture of Solid Fuels and Other Energy Industries (1A1c) (EU-27)

**Figure 18.9 1A1c- Manufacture of Solid Fuels and Other Energy Industries: Total, $CO_2$ and $N_2O$ emission and activity trends**

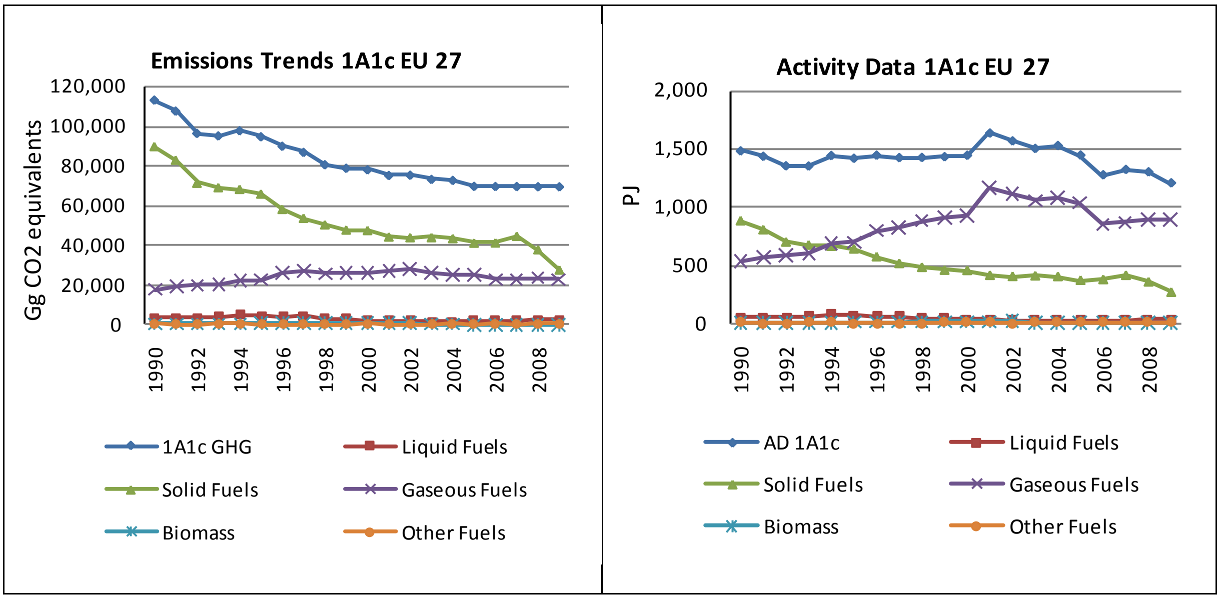



**Table 18.9 1A1c Manufacture of Solid Fuels and Other Energy Industries, gaseous fuels: $CO_2$ emissions of EU-27**

| Member State | $CO_2$ emissions in Gg | | | Share in EU27 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| EU-15 | 16,968 | 20,552 | 20,795 | 90.7% | 244 | 1% | 3,827 | 23% | | |
| Bulgaria | NO | 51 | 59 | 0.3% | 9 | 17% | 59 | - | T1 | CS |
| Cyprus | NO | NO | NO | - | - | - | - | - | NO | NO |
| Czech Republic | NO | 15 | 16 | 0.1% | 1 | 7% | 16 | - | T1 | D |
| Estonia | NO | NO | NO | - | - | - | - | - | NO | NO |
| Hungary | IE | 3 | 3 | 0.0% | 0 | 5% | 3 | - | T1 | D |
| Latvia | 45 | 52 | 32 | 0.1% | -20 | -39% | -13 | -29% | T2 | CS |
| Lithuania | NO | 5 | 5 | 0.0% | -0.1 | -1% | 5 | - | T2 | CR |
| Malta | NO | NO | NO | - | - | - | - | - | NA | NA |
| Poland | 747 | 757 | 564 | 2.5% | -193 | -26% | -183 | -25% | T2 | D |
| Romania | IE | IE | IE | - | - | - | - | - | NA | NA |
| Slovakia | NO | 1,456 | 1,460 | 6.4% | 3 | 0% | 1,460 | - | T2 | CS |
| Slovenia | 42 | NO | NO | - | 0 | - | -42 | -100% | T1 | CS |
| **EU-27** | **17,801** | **22,891** | **22,934** | **100.0%** | **43** | **0%** | **5,133** | **29%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

**Table 18.10 1A1c Manufacture of Solid Fuels and Other Energy Industries, solid fuels: $CO_2$ emissions of EU-27**

| Member State | $CO_2$ emissions in Gg | | | Share in EU27 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| EU-15 | 82,793 | 37,087 | 37,873 | 165.1% | 786 | 2% | -44,920 | -54% | | |
| Bulgaria | 291 | 142 | 124 | 0.5% | -18 | -13% | -166 | -57% | T2 | CS,D |
| Cyprus | NO | NO | NO | - | - | - | - | - | NO | NO |
| Czech Republic | 2,393 | 473 | 447 | 1.9% | -26 | -6% | -1,946 | -81% | T1 | CS |
| Estonia | 109 | 283 | 268 | 1.2% | -15 | -5% | 159 | 145% | T2 | CS |
| Hungary | IE | 155 | 166 | 0.7% | 11 | 7% | 166 | - | T2 | D,PS |
| Latvia | 164 | 1 | 3 | 0.0% | 2 | 232% | -160 | -98% | T1 | CS |
| Lithuania | NA,NO | NA,NO | NA,NO | - | - | - | - | - | T2 | D |
| Malta | NO | NO | NO | - | - | - | - | - | NA | NA |
| Poland | 4,063 | 3,442 | 6,022 | 26.3% | 2,580 | 75% | 1,959 | 48% | T2 | CS,D |
| Romania | IE | IE | IE | - | - | - | - | - | NA | NA |
| Slovakia | 10 | NO | NO | - | 0 | - | -10 | -100% | T2 | CS |
| Slovenia | 36 | NO | NO | - | - | - | -36 | -100% | NA | NA |
| **EU-27** | **89,860** | **41,583** | **44,904** | **100.0%** | **3,321** | **8%** | **-44,956** | **-50%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

## *18.2.2 Manufacturing industries and construction (CRF Source Category 1A2)(EU 27)*

### 18.2.2.1 Iron and Steel (1A2a) (EU-27)

**Figure 18.10 1A2a- Iron and Steel: Total, $CO_2$ and $N_2O$ emission and activity trends**

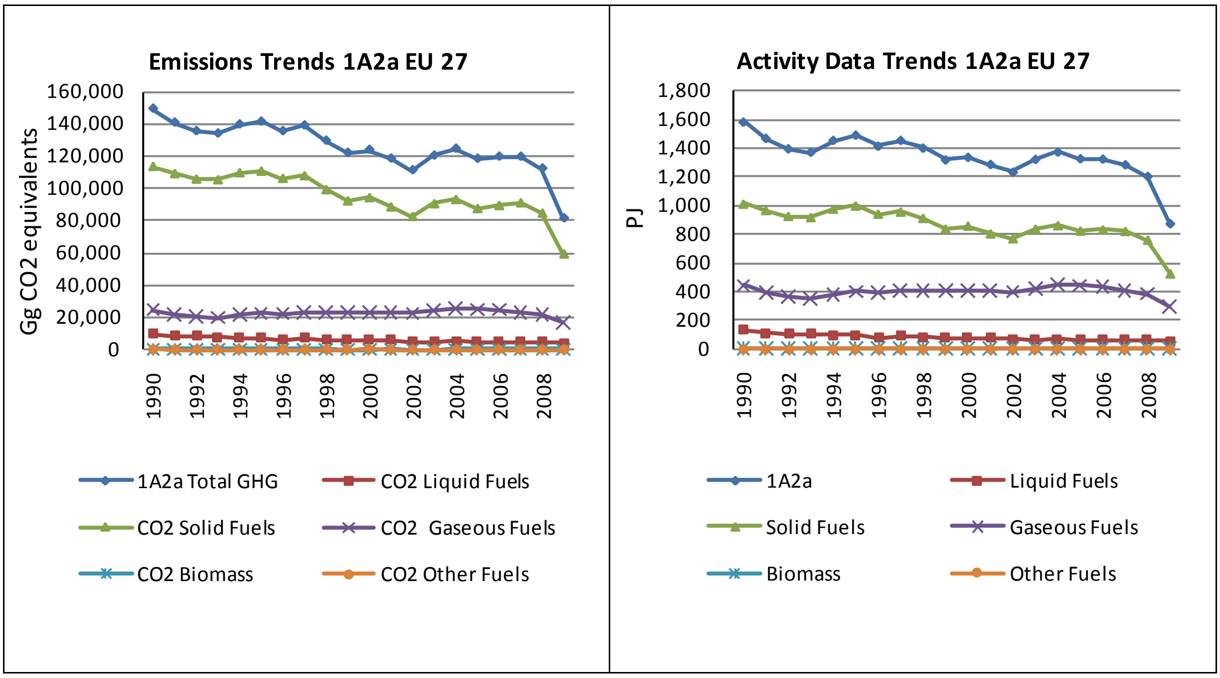


**Table 18.11 1A2a Iron and Steel, liquid fuels: $CO_2$ emissions of EU-27**

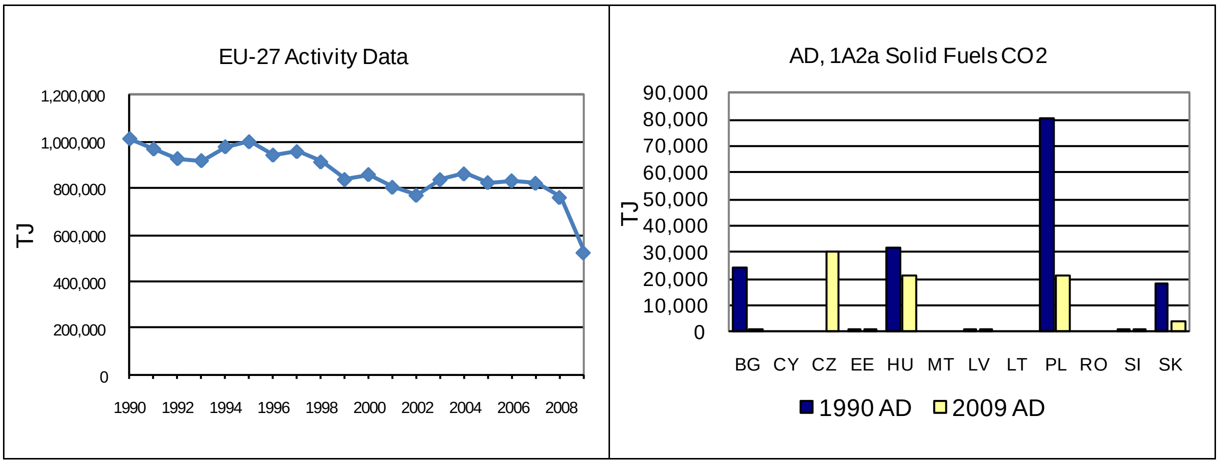
| Member State | $CO_2$ emissions in Gg | | | Share in EU27 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| EU-15 | 7,520 | 4,026 | 4,047 | 91.8% | 21 | 1% | -3,473 | -46% | | |
| Bulgaria | 37 | 6 | 3.1 | - | -3 | - | -34 | -92% | T1 | D |
| Cyprus | NE | NE | NE | - | - | - | - | - | NE | NE |
| Czech Republic | IE | 139 | 161 | 3.7% | 22 | 16% | 161 | - | T1 | D |
| Estonia | NO | 0 | NA | - | - | - | - | - | T1,T2 | CS,D |
| Hungary | 803 | 8 | 10 | 0.2% | 2 | 23% | -793 | -99% | T2 | D |
| Latvia | 154 | 76 | 76 | 1.7% | 0 | 0% | -78 | -51% | T1 | CS |
| Lithuania | NO | NO | NO | - | - | - | - | - | NO | NO |
| Malta | 56 | 74 | 96 | 2.2% | 23 | 31% | 41 | 74% | D,T1 | D |
| Poland | 855 | 9 | 6 | 0.1% | -3 | -34% | -849 | -99% | T2 | D |
| Romania | IE | IE | IE | - | - | - | - | - | NA | NA |
| Slovakia | 164 | 1.5 | 0 | - | -1.2 | - | -164 | -100% | T2 | CS |
| Slovenia | 54 | 10 | 7 | 0.2% | -3 | -27% | -46 | -86% | T1 | D |
| **EU-27** | **9,643** | **4,349** | **4,407** | **100.0%** | **57** | **1%** | **-5,236** | **-54%** | | |

**Table 18.12 1A2a Iron and Steel, solid fuels: $CO_2$ emissions of EU-27**

| Member State | $CO_2$ emissions in Gg | | | Share in EU27 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| EU-15 | 93,103 | 74,816 | 75,560 | 83.0% | 744 | 1% | -17,543 | -19% | | |
| Bulgaria | 2,512 | 2,621 | 2,434 | 2.7% | -187 | -7% | -78 | -3% | T2 | CS,D |
| Cyprus | NO | NO | NO | - | - | - | - | - | NO | NO |
| Czech Republic | IE | 2,431 | 2,771 | 3.0% | 340 | 14% | 2,771 | - | T1 | CS |
| Estonia | 3 | 1 | 2 | 0.0% | 1 | 42% | -1 | -40% | T1 | D |
| Hungary | 2,946 | 2,076 | 2,211 | 2.4% | 134 | 6% | -736 | -25% | T2 | D,PS |
| Latvia | 5 | 11 | 9 | 0.01% | -2 | -20% | 5 | 100% | T1 | CS |
| Lithuania | NO | NO | NO | - | - | - | - | - | NO | NO |
| Malta | NO | NO | NO | - | - | - | - | - | NA | NA |
| Poland | 11,906 | 5,825 | 6,982 | 7.7% | 1,157 | 20% | -4,924 | -41% | T2 | CS,D |
| Romania | IE | IE | IE | - | - | - | - | - | NA | NA |
| Slovakia | 3,093 | 1,574 | 1,078 | 1.2% | -496 | -32% | -2,016 | -65% | T3 | PS |
| Slovenia | 56 | 35 | 29 | 0.0% | -7 | -19% | -27 | -49% | T1 | D |
| **EU-27** | **113,624** | **89,391** | **91,076** | **100.0%** | **1,685** | **2%** | **-22,549** | **-20%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

**Figure 18.11 1A2a Iron and Steel, solid fuels: Activity Data and Implied Emission Factors for $CO_2$**



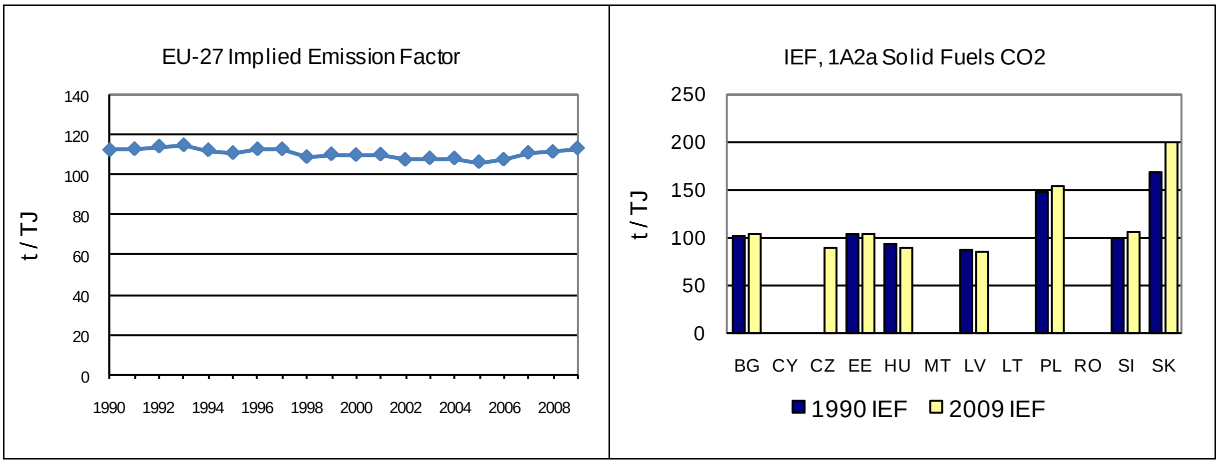



**Table 18.13** **1A2a Iron and Steel, gaseous fuels: $CO_2$ emissions of EU-27**

| Member State | $CO_2$ emissions in Gg | | | Share in EU27 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| EU-15 | 17,446 | 20,394 | 18,781 | 82.3% | -1,613 | -8% | 1,335 | 8% | | |
| Bulgaria | 1,032 | 615 | 617 | 2.7% | 2 | 0% | -414 | -40% | T1 | D |
| Cyprus | NO | NO | NO | - | - | - | - | - | NO | NO |
| Czech Republic | IE | 663 | 664 | 2.9% | 0 | 0% | 664 | - | T1 | D |
| Estonia | NO | 1 | 0 | 0.0% | -1 | -74% | 0 | - | T2 | GS |
| Hungary | 1,448 | 546 | 496 | 2.2% | -50 | -9% | -951 | -66% | T2 | D |
| Latvia | 234 | 226 | 228 | 1.0% | 1 | 1% | -7 | -3% | T2 | CS |
| Lithuania | NO | NO | NO | - | - | - | - | - | NO | NO |
| Malta | 4 | 10 | 10 | 0.04% | 0 | 1% | 6 | 161% | D,T1 | NA |
| Poland | 2,894 | 1,105 | 1,164 | 5.1% | 59 | 5% | -1,729 | -60% | T2 | D |
| Romania | IE | IE | IE | - | - | - | - | - | NA | NA |
| Slovakia | 1,301 | 921 | 679 | 3.0% | -242 | -26% | -623 | -48% | T2 | CS |
| Slovenia | 308 | 172 | 167 | 0.7% | -4 | -3% | -141 | -46% | T1 | CS |
| **EU-27** | **24,667** | **24,653** | **22,806** | **100.0%** | **-1,847** | **-7%** | **-1,861** | **-8%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

## 18.2.2.2 Non Ferrous Metals (1A2b) (EU-27)

**Figure 18.12 1A2b- Non ferrous Metals: Total, $CO_2$ emission and activity trends**

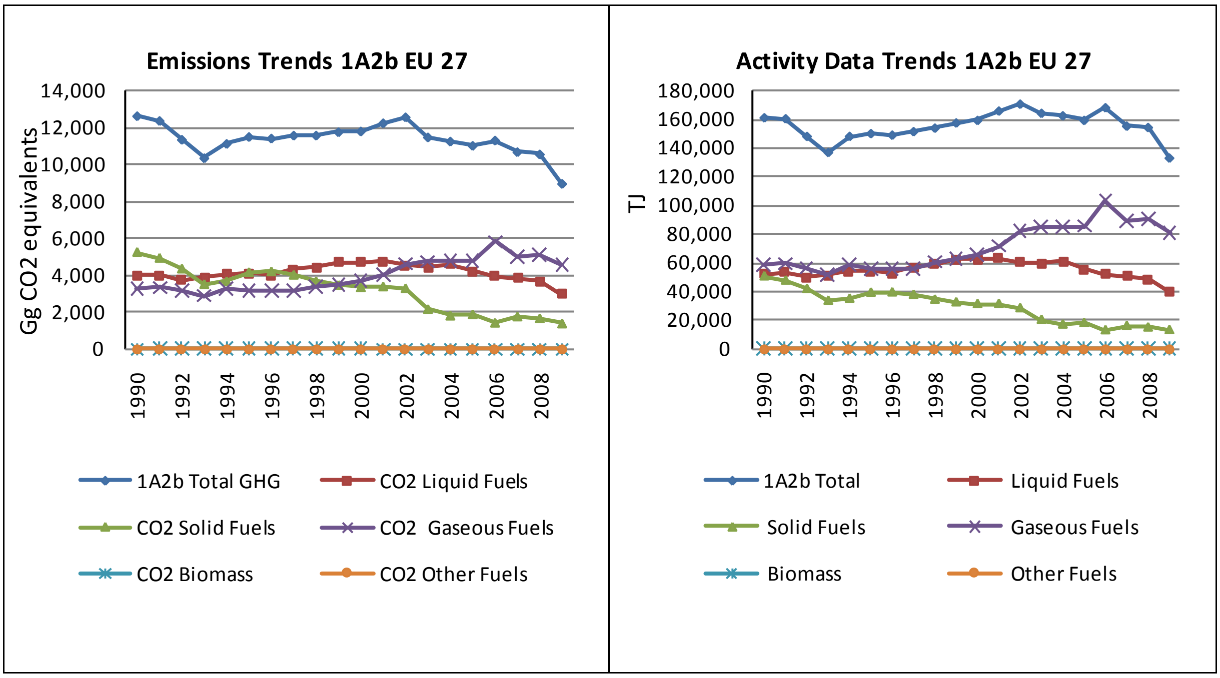



**Table 18.14 1A2b Non ferrous Metals, solid fuels: $CO_2$ emissions of EU-27**

| Member State | $CO_2$ emissions in Gg | | | Share in EU27 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| EU-15 | 3,351 | 420 | 668 | 37.3% | 248 | 59% | -2,682 | -80% | | |
| Bulgaria | 213 | 145 | 166 | 9.3% | 21 | 15% | -47 | -22% | T2 | CS,D |
| Cyprus | NO | NO | NO | - | - | - | - | - | NO | NO |
| Czech Republic | IE | 16 | 10 | 0.6% | -6 | -38% | 10 | - | T1 | CS |
| Estonia | NO | NO | 2 | - | 2 | - | 2 | - | T1 | D |
| Hungary | IE | IE | IE | - | - | - | - | - | NA | NA |
| Latvia | NO | NO | NO | - | - | - | - | - | NA | NA |
| Lithuania | NO | NO | NO | - | - | - | - | - | NO | NO |
| Malta | NA | NA | NA | - | - | - | - | - | NA | NA |
| Poland | 742 | 783 | 865 | 48.3% | 82 | 10% | 123 | 17% | T2 | CS,D |
| Romania | IE | IE | IE | - | - | - | - | - | NA | NA |
| Slovakia | 798 | 94 | 79 | 4.4% | -14 | -15% | -719 | -90% | T2 | CS |
| Slovenia | 152 | NO | NO | - | 0 | - | -152 | -100% | T1 | D |
| **EU-27** | **5,256** | **1,458** | **1,791** | **100.0%** | **333** | **23%** | **-3,465** | **-66%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

**Table 18.15** **1A2b Non ferrous Metals, gaseous fuels: $CO_2$ emissions of EU-27**

| Member State | $CO_2$ emissions in Gg | | | Share in EU27 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| EU-15 | 2,390 | 5,144 | 4,308 | 85.9% | -836 | -16% | 1,918 | 80% | | |
| Bulgaria | 23 | 39 | 37 | 0.7% | -1 | -4% | 14 | 61% | T1 | CS |
| Cyprus | NO | NO | NO | - | - | - | - | - | NA | NA |
| Czech Republic | IE | 134 | 136 | 2.7% | 3 | 2% | 136 | - | T1 | D |
| Estonia | NO | 1 | 4 | 0.1% | 3 | 288% | 4 | - | T2 | CS |
| Hungary | IE | IE | IE | - | - | - | - | - | NA | NA |
| Latvia | NO | 11 | 11 | 0.2% | 0 | -1% | 11 | - | T2 | CS |
| Lithuania | NO | NO | NO | - | - | - | - | - | NA | NA |
| Malta | NA | NA | NA | - | - | - | - | - | NA | NA |
| Poland | 257 | 384 | 376 | 7.5% | -8 | -2% | 120 | 47% | T2 | D |
| Romania | IE | IE | IE | - | - | - | - | - | NA | NA |
| Slovakia | 435 | 79 | 80 | 1.6% | 1 | 2% | -355 | -82% | T2 | CS |
| Slovenia | 163 | 47 | 62 | 1.2% | 15 | 33% | -101 | -62% | T1 | CS |
| **EU-27** | **3,267** | **5,838** | **5,014** | **100.0%** | **-824** | **-14%** | **1,747** | **53%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

## 18.2.2.3 Chemicals (1A2c) (EU-27)

**Figure 18.13** **1A2c- Chemicals: Total, $CO_2$ and $N_2O$ emission and activity trends**

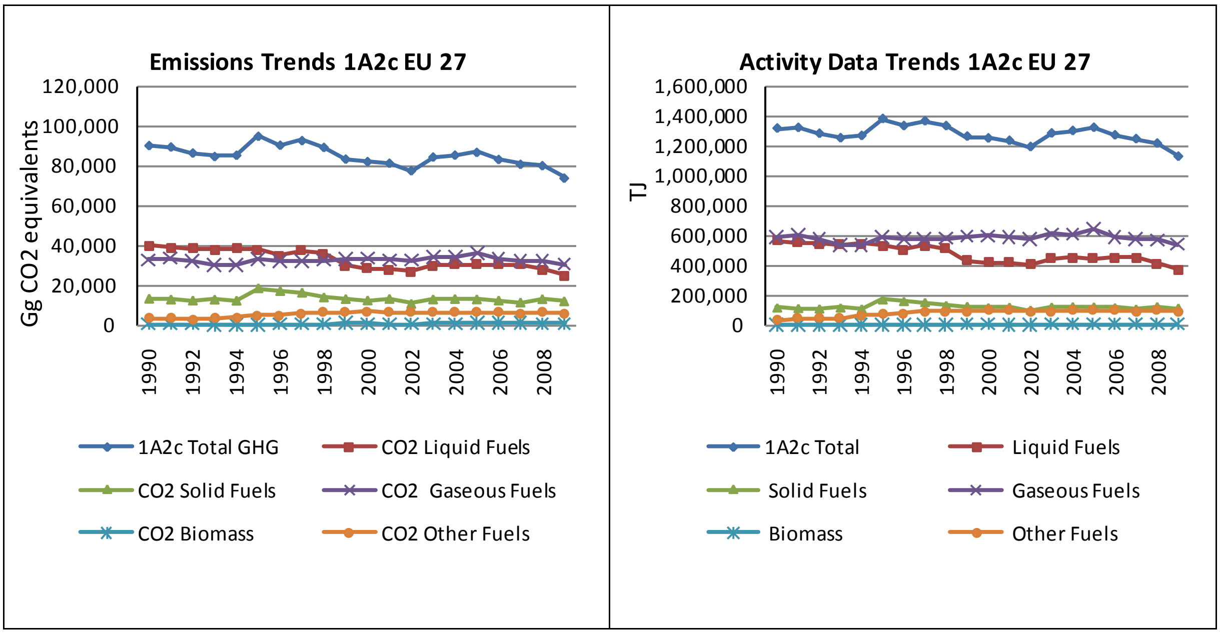


**Table 18.16 1A2c Chemicals, liquid fuels: $CO_2$ emissions of EU-27**

| Member State | $CO_2$ emissions in Gg | | | Share in EU27 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| EU-15 | 36,797 | 24,262 | 24,286 | 79.3% | 24 | 0% | -12,511 | -34% | | |
| Bulgaria | 930 | 653 | 813 | 2.7% | 160 | 25% | -117 | -13% | T1 | D |
| Cyprus | NE | NE | NE | - | - | - | - | - | NE | NE |
| Czech Republic | IE | 2,670 | 2,360 | 7.7% | -310 | -12% | 2,360 | - | T1 | D |
| Estonia | 13 | 6 | 6 | 0.0% | 1 | 11% | -6 | -49% | T1 | D |
| Hungary | 387 | 96 | 106 | 0.3% | 10 | 11% | -280 | -72% | T2 | D |
| Latvia | 277 | NO | NO | - | 0 | - | - | - | T1 | CS |
| Lithuania | 72 | 2 | 1 | 0.0% | -1 | -43% | -70 | -98% | T2 | CS |
| Malta | NA | NA | NA | - | - | - | - | - | NA | NA |
| Poland | 306 | 2,011 | 2,032 | 6.6% | 21 | 1% | 1,726 | 563% | T2 | D |
| Romania | IE | IE | IE | - | - | - | - | - | NA | NA |
| Slovakia | 1,363 | 1,049 | 993 | 3.2% | -56 | -5% | -370 | -27% | T2 | CS |
| Slovenia | 31 | 40 | 40 | 0.1% | 0 | -1% | 8 | 26% | T1 | D |
| **EU-27** | **40,176** | **30,789** | **30,638** | **100.0%** | **-151** | **0%** | **-9,538** | **-24%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

**Table 18.17 1A2c Chemicals, solid fuels: $CO_2$ emissions of EU-27**

| Member State | $CO_2$ emissions in Gg | | | Share in EU27 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| EU-15 | 7,523 | 4,314 | 4,798 | 41.7% | 484 | 11% | -2,725 | -36% | | |
| Bulgaria | 416 | 328 | 290 | 2.5% | -37 | -11% | -126 | -30% | T2 | CS,D |
| Cyprus | NO | NO | NO | - | - | - | - | - | NO | NO |
| Czech Republic | IE | 3,523 | 2,248 | 19.5% | -1,275 | -36% | 2,248 | - | T1 | CS |
| Estonia | 403 | NO | NO | - | 0 | - | -403 | -100% | T1,T2 | CS,D |
| Hungary | 61 | NO | NO | - | - | - | -61 | -100% | NA | NA |
| Latvia | NO | NO | NO | - | - | - | - | - | NA | NA |
| Lithuania | NO | NO | NO | - | - | - | - | - | T2 | D |
| Malta | NA | NA | NA | - | - | - | - | - | NA | NA |
| Poland | 3,358 | 4,045 | 3,919 | 34.1% | -126 | -3% | 561 | 17% | T2 | CS,D |
| Romania | IE | IE | IE | - | - | - | - | - | NA | NA |
| Slovakia | 1,584 | 278 | 252 | 2.2% | -26 | -9% | -1,331 | -84% | T2 | CS |
| Slovenia | 1 | NO | NO | - | - | - | -1 | -100% | NA | NA |
| **EU-27** | **13,346** | **12,487** | **11,508** | **100.0%** | **-980** | **-8%** | **-1,838** | **-14%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

**Table 18.18 1A2c Chemicals, gaseous fuels: $CO_2$ emissions of EU-27**

| Member State | $CO_2$ emissions in Gg | | | Share in EU27 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| EU-15 | 27,778 | 30,307 | 29,234 | 89.9% | -1,073 | -4% | 1,457 | 5% | | |
| Bulgaria | 1,597 | 522 | 386 | 1.2% | -136 | -26% | -1,211 | -76% | T1 | CS |
| Cyprus | NO | NO | NO | - | - | - | - | - | NO | NO |
| Czech Republic | IE | 659 | 646 | 2.0% | -13 | -2% | 646 | - | T1 | D |
| Estonia | 165 | 128 | 124 | 0.4% | -5 | -4% | -42 | -25% | T2 | GS |
| Hungary | 821 | 809 | 825 | 2.5% | 16 | 2% | 4 | 0% | T2 | D |
| Latvia | 23 | 27 | 21 | 0.1% | -5 | -21% | -2 | -10% | T2 | CS |
| Lithuania | 341 | 195 | 136 | 0.4% | -58 | -30% | -205 | -60% | T2 | CR |
| Malta | NA | NA | NA | - | - | - | - | - | NA | NA |
| Poland | 295 | 505 | 490 | 1.5% | -16 | -3% | 194 | 66% | T2 | D |
| Romania | IE | IE | IE | - | - | - | - | - | NA | NA |
| Slovakia | 1,753 | 124 | 538 | 1.7% | 414 | 334% | -1,215 | -69% | T2 | CS |
| Slovenia | 175 | 124 | 133 | 0.4% | 9 | 8% | -42 | -24% | T1 | CS |
| **EU-27** | **32,948** | **33,399** | **32,533** | **100.0%** | **-866** | **-3%** | **-415** | **-1%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

**Table 18.19 1A2c Chemicals, other fuels: $CO_2$ emissions of EU-27**

| Member State | $CO_2$ emissions in Gg | | | Share in EU27 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| EU-15 | 3,603 | 6,325 | 5,921 | 100.0% | -404 | -6% | 2,319 | 64% | | |
| Bulgaria | NO | NO | NO | - | - | - | - | - | NO | NO |
| Cyprus | NO | NO | NO | - | - | - | - | - | NO | NO |
| Czech Republic | NO | NO | NO | - | - | - | - | - | NA | NA |
| Estonia | NO | NO | NO | - | - | - | - | - | NO | NO |
| Hungary | NO | NO | NO | - | - | - | - | - | NA | NA |
| Latvia | NO | NO | NO | - | - | - | - | - | NA | NA |
| Lithuania | NO | NO | NO | - | - | - | - | - | NO | NO |
| Malta | NA | NA | NA | - | - | - | - | - | NA | NA |
| Poland | NA | NA | NA | - | - | - | - | - | NO | NO |
| Romania | IE | IE | IE | - | - | - | - | - | NA | NA |
| Slovakia | NO | NO | NO | - | - | - | - | - | NA | NA |
| Slovenia | 0.5 | 8 | 0.4 | 0.0% | -8 | -95% | -0.2 | -33% | T1 | PS |
| **EU-27** | **3,603** | **6,333** | **5,922** | **100.0%** | **-412** | **-6%** | **2,319** | **64%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

## 18.2.2.4 Pulp, Paper and Print (1A2d) (EU-27)

**Figure 18.14 1A2d- Pulp, Paper and Print: Total, $CO_2$ and $N_2O$ emission and activity trends**

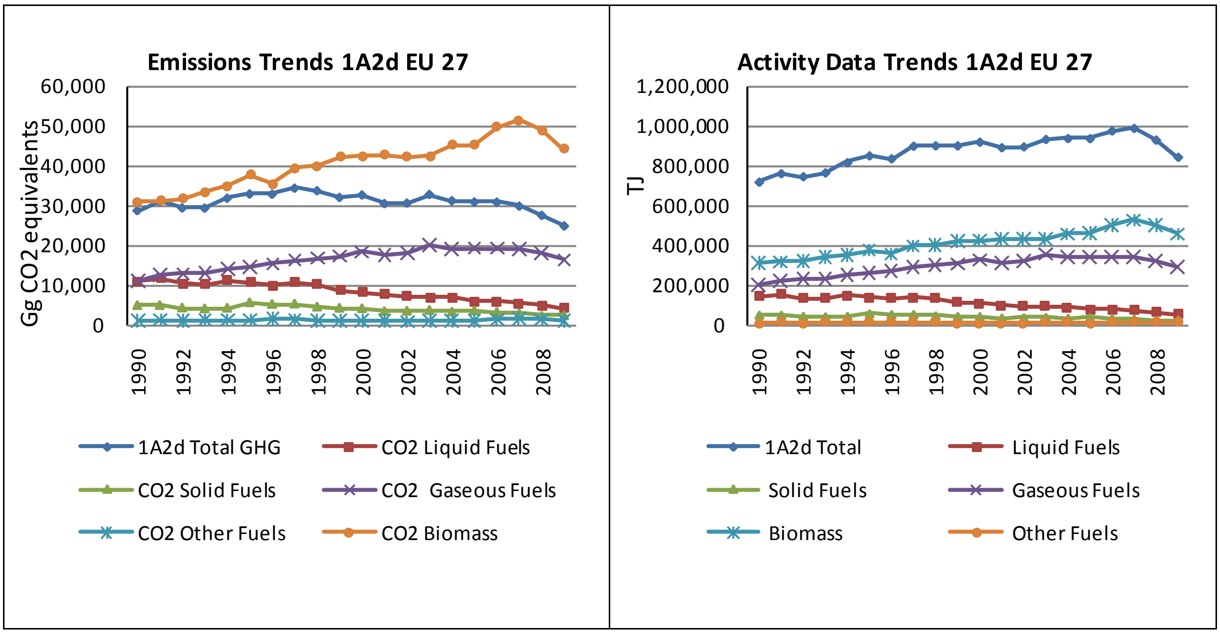



**Table 18.20 1A2d Pulp, Paper and Print, liquid fuels: $CO_2$ emissions of EU-27**

| Member State | $CO_2$ emissions in Gg | | | Share in EU27 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| EU-15 | 9,549 | 5,690 | 5,148 | 93.7% | -542 | -10% | -4,401 | -46% | | |
| Bulgaria | 15 | 37 | 77 | 1.4% | 40 | 109% | 61 | 398% | T1 | CS |
| Cyprus | NE | NE | NE | | - | - | - | - | NE | NE |
| Czech Republic | IE | 63 | 54 | 1.0% | -9 | -15% | 54 | - | T1 | D |
| Estonia | NO | 1 | 1 | 0.02% | 0.39 | 46% | 1 | - | T1 | D |
| Hungary | 86 | 20 | 28 | 0.51% | 8.22 | 42% | -59 | -68% | T2 | D |
| Latvia | 16 | NO | NO | - | - | - | -16 | -100% | NA | NA |
| Lithuania | 72 | 0.39 | 0.26 | 0.00% | -0.13 | -33% | -72 | -100% | T2 | CS |
| Malta | NO | NO | NO | - | - | - | - | - | NO | NA |
| Poland | 104 | 156 | 174 | 3.2% | 18 | 12% | 70 | 68% | T2 | D |
| Romania | IE | IE | IE | - | - | - | - | - | NA | NA |
| Slovakia | 985 | 26 | 5 | 0.1% | -21 | -81% | -980 | -99% | T2 | CS |
| Slovenia | 97 | 44 | 7 | 0.1% | -36 | -83% | -90 | -93% | T1 | D |
| **EU-27** | **10,924** | **6,037** | **5,495** | **100.0%** | **-542** | **-9%** | **-5,429** | **-50%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

**Table 18.21 1A2d Pulp, Paper and Print, solid fuels: $CO_2$ emissions of EU-27**

| Member State | $CO_2$ emissions in Gg | | | Share in EU27 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| EU-15 | 3,456 | 1,424 | 1,210 | 40.7% | -214 | -15% | -2,246 | -65% | | |
| Bulgaria | NO | NO | NO | - | - | - | - | - | NO | NO |
| Cyprus | NO | NO | NO | - | - | - | - | - | NO | NO |
| Czech Republic | IE | 261 | 309 | 10.4% | 48 | 18% | 309 | - | T1 | CS |
| Estonia | NO | NO | NO | - | - | - | - | - | T1,T2 | CS,D |
| Hungary | 24 | 0.3 | 0.1 | 0.0% | 0 | -67% | -24 | -100% | T2 | D |
| Latvia | 2 | 2 | NO | - | - | - | -2 | -100% | NA | NA |
| Lithuania | NO | NO | NO | - | - | - | - | - | NO | NO |
| Malta | NO | NO | NO | - | - | - | - | - | NO | NA |
| Poland | 174 | 1,116 | 912 | 30.7% | -204 | -18% | 739 | 425% | T2 | CS,D |
| Romania | IE | IE | IE | - | - | - | - | - | NA | NA |
| Slovakia | 1,142 | 397 | 380 | 12.8% | -17 | -4% | -761 | -67% | T2 | CS |
| Slovenia | 169 | 170 | 162 | 5.5% | -8 | -5% | -6 | -4% | T1 | D |
| **EU-27** | **4,967** | **3,372** | **2,974** | **100.0%** | **-398** | **-12%** | **-1,993** | **-40%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

**Table 18.22 1A2d Pulp, Paper and Print, gaseous fuels: $CO_2$ emissions of EU-27**

| Member State | $CO_2$ emissions in Gg | | | Share in EU27 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| EU-15 | 10,580 | 18,207 | 17,983 | 93.7% | -224 | -1% | 7,403 | 70% | | |
| Bulgaria | NO | 126 | 122 | 0.6% | -4 | -3% | 122 | - | T1 | D |
| Cyprus | NO | NO | NO | - | - | - | - | - | NO | NO |
| Czech Republic | IE | 209 | 212 | 1.1% | 3 | 1% | 212 | - | T1 | D |
| Estonia | NO | 5 | 4 | 0.0% | -1 | -13% | 4 | - | T2 | GS |
| Hungary | 51 | 189 | 167 | 0.9% | -22 | -12% | 116 | 227% | T2 | D |
| Latvia | 149 | 13 | 11 | 0.1% | -2 | -15% | -138 | -93% | T2 | CS |
| Lithuania | 193 | 2 | 3 | 0.0% | 0 | 12% | -190 | -99% | T2 | CR |
| Malta | NO | NO | NO | - | - | - | - | - | NO | NA |
| Poland | 6 | 166 | 228 | 1.2% | 62 | 37% | 222 | 3947% | T2 | D |
| Romania | IE | IE | IE | - | - | - | - | - | NA | NA |
| Slovakia | 152 | 209 | 186 | 1.0% | -23 | -11% | 34 | 22% | T2 | CS |
| Slovenia | 109 | 257 | 283 | 1.5% | 26 | 10% | 174 | 160% | T1 | CS |
| **EU-27** | **11,240** | **19,383** | **19,199** | **100.0%** | **-184** | **-1%** | **7,959** | **71%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

### 18.2.2.5 Food Processing, Beverages and Tobacco (1A2e) (EU-27)

**Figure 18.15** 1A2e- Food Processing, Beverages and Tobacco: Total, $CO_2$ and $N_2O$ emission and activity trends

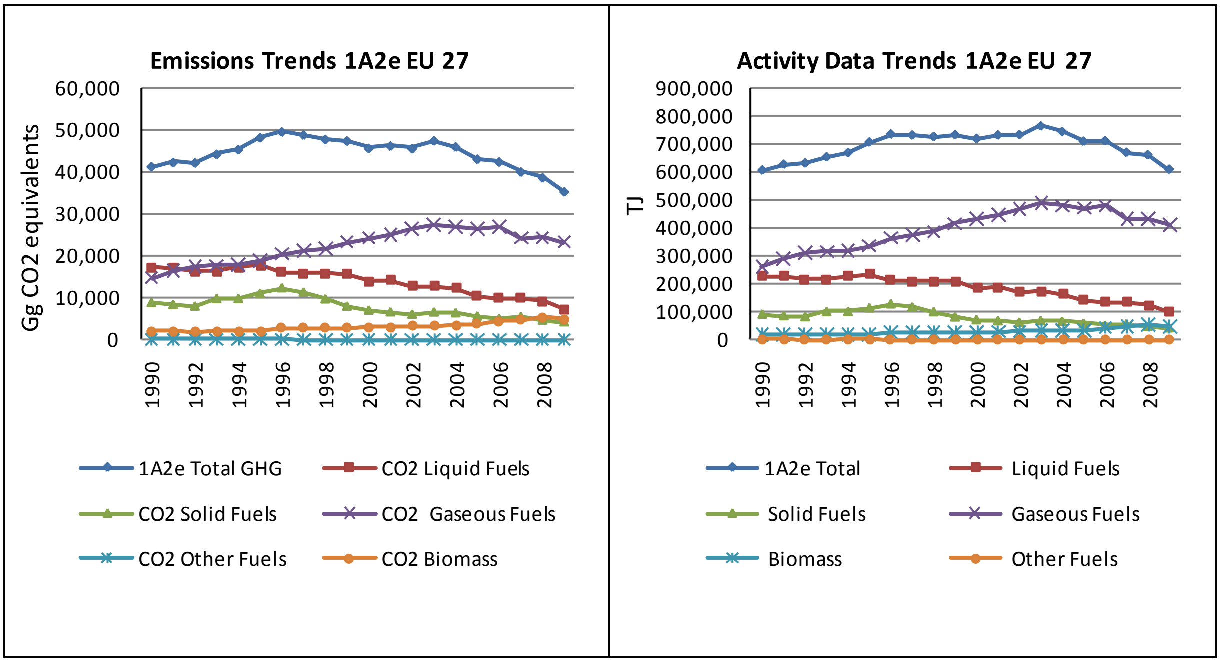



**Table 18.23** 1A2e Food Processing, Beverages and Tobacco, liquid fuels: $CO_2$ emissions of EU-27

| Member State | $CO_2$ emissions in Gg | | | Share in EU27 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| EU-15 | 13,947 | 8,566 | 8,773 | 87.8% | 207 | 2% | -5,173 | -37% | | |
| Bulgaria | 405 | 205 | 227 | 2.3% | 22 | 11% | -178 | -44% | T1 | D |
| Cyprus | 47 | 168 | 138 | 1.4% | -30 | -18% | 91 | 194% | T1 | D |
| Czech Republic | IE | 130 | 76 | 0.8% | -55 | -42% | 76 | - | T1 | D |
| Estonia | 439 | 3 | 5 | 0.0% | 2 | 59% | -434 | -99% | T1,T2 | CS,D |
| Hungary | 817 | 73 | 41 | 0.4% | -32 | -44% | -776 | -95% | T2 | D |
| Latvia | 798 | 75 | 59 | 0.6% | -16 | -22% | -739 | -93% | T1 | CS |
| Lithuania | 183 | 47 | 53 | 0.5% | 6 | 13% | -130 | -71% | T2 | D,CS |
| Malta | NO | NO | NO | - | - | - | - | - | NA | NA |
| Poland | 228 | 629 | 569 | 5.7% | -61 | -10% | 341 | 149% | T2 | D |
| Romania | IE | IE | IE | - | - | - | - | - | NA | NA |
| Slovakia | 359 | 45 | 2 | 0.0% | -43 | -95% | -357 | -99% | T2 | CS |
| Slovenia | 144 | 112 | 55 | 0.6% | -57 | -51% | -89 | -62% | T1 | D |
| **EU-27** | **17,366** | **10,055** | **9,998** | **100.0%** | **-57** | **-1%** | **-7,368** | **-42%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

**Table 18.24 1A2e Food Processing, Beverages and Tobacco, solid fuels: $CO_2$ emissions of EU-27**

| Member State | $CO_2$ emissions in Gg | | | Share in EU27 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| EU-15 | 4,841 | 1,634 | 2,151 | 39.2% | 517 | 32% | -2,690 | -56% | | |
| Bulgaria | 33 | 99 | 48 | 0.9% | -51 | -51% | 16 | 48% | T2 | CS,D |
| Cyprus | NO | NO | NO | - | - | - | - | - | NO | NO |
| Czech Republic | IE | 166 | 176 | 3.2% | 10 | 6% | 176 | - | T1 | CS |
| Estonia | 5 | 0.2 | NA | - | -0.2 | - | -5 | -100% | T1,T2 | CS,D |
| Hungary | 194 | 15 | 13 | 0.2% | -3 | -17% | -181 | -93% | T2 | CS |
| Latvia | 91 | 10 | 7 | 0.1% | -2 | -24% | -84 | -92% | T1 | CS |
| Lithuania | 33 | 10 | 10 | 0.2% | -1 | -6% | -24 | -71% | T2 | CR,D |
| Malta | NO | NO | NO | - | - | - | - | - | NA | NA |
| Poland | 3,387 | 3,016 | 3,042 | 55.4% | 26 | 1% | -345 | -10% | T2 | CS,D |
| Romania | IE | IE | IE | - | - | - | - | - | NA | NA |
| Slovakia | 312 | 32 | 40 | 0.7% | 7 | 22% | -272 | -87% | T2 | CS |
| Slovenia | 9 | 4 | NO | - | - | - | -9 | -100% | NA | NA |
| **EU-27** | **8,905** | **4,987** | **5,486** | **100.0%** | **499** | **10%** | **-3,419** | **-38%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

**Table 18.25 1A2e Food Processing, Beverages and Tobacco, gaseous fuels: $CO_2$ emissions of EU-27**

| Member State | $CO_2$ emissions in Gg | | | Share in EU27 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| EU-15 | 12,682 | 23,452 | 20,750 | 85.2% | -2,702 | -12% | 8,068 | 64% | | |
| Bulgaria | 11 | 200 | 217 | 0.9% | 17 | 8% | 206 | 1811% | T1 | D |
| Cyprus | NO | NO | NO | - | - | - | - | - | NO | NO |
| Czech Republic | IE | 876 | 863 | 3.5% | -13 | -1% | 863 | - | T1 | D |
| Estonia | 15 | 6 | 6 | 0.0% | 0 | 7% | -8 | -56% | T2 | GS |
| Hungary | 804 | 697 | 584 | 2.4% | -113 | -16% | -220 | -27% | T2 | D |
| Latvia | 174 | 180 | 148 | 0.6% | -31 | -17% | -26 | -15% | T2 | CS |
| Lithuania | 484 | 220 | 240 | 1.0% | 20 | 9% | -244 | -50% | T2 | CR |
| Malta | NO | NO | NO | - | - | - | - | - | NA | NA |
| Poland | 110 | 1,040 | 1,151 | 4.7% | 111 | 11% | 1,041 | 946% | T2 | D |
| Romania | IE | IE | IE | - | - | - | - | - | NA | NA |
| Slovakia | 470 | 347 | 327 | 1.3% | -20 | -6% | -143 | -30% | T2 | CS |
| Slovenia | 65 | 86 | 76 | 0.3% | -10 | -12% | 11 | 17% | T1 | CS |
| **EU-27** | **14,814** | **27,104** | **24,362** | **100.0%** | **-2,742** | **-10%** | **9,548** | **64%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

## 18.2.2.6 Other (1A2f) (EU-27)

**Figure 18.16 1A2f- Other, liquid fuels: Total, $CO_2$ and $N_2O$ emission and activity trends**

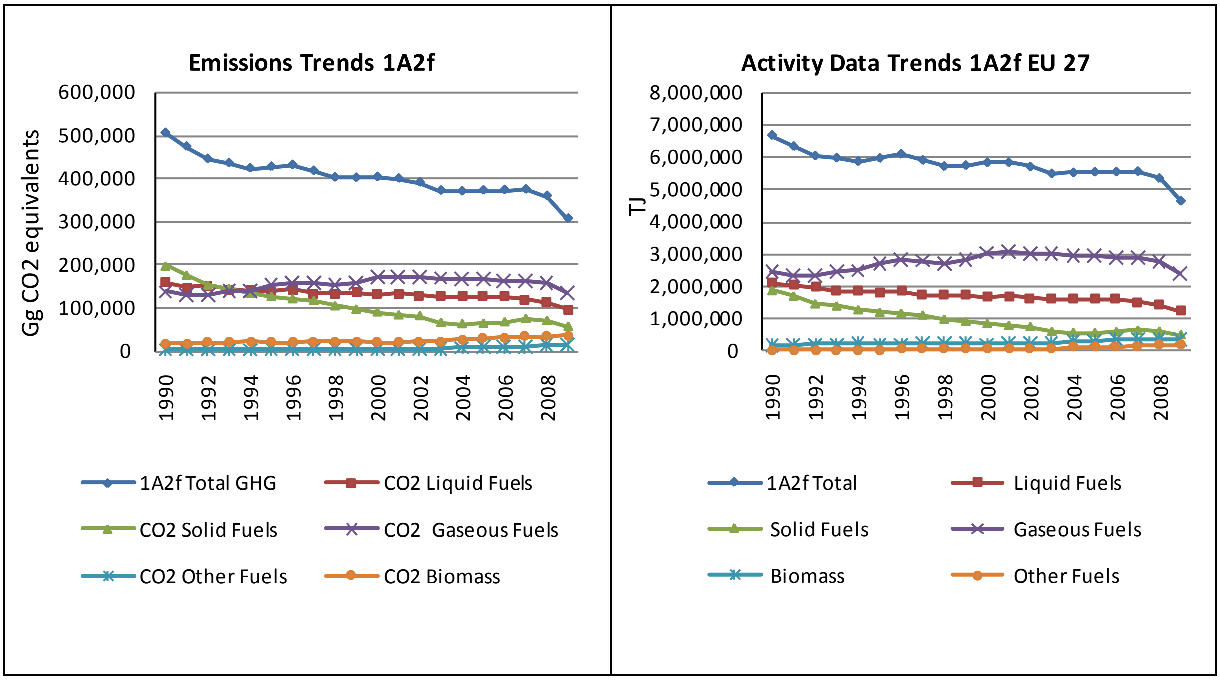



**Table 18.26 1A2f Other, liquid fuels: $CO_2$ emissions of EU-27**

| Member State | $CO_2$ emissions in Gg | | | Share in EU27 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| EU-15 | 122,484 | 114,018 | 107,844 | 89.6% | -6,175 | -5% | -14,640 | -12% | | |
| Bulgaria | 9,224 | 1,936 | 1,954 | 1.6% | 18 | 1% | -7,270 | -79% | T1 | D |
| Cyprus | 520 | 800 | 783 | 0.7% | -17 | -2% | 263 | 50% | T1,T3 | CS |
| Czech Republic | 9,110 | 1,167 | 1,322 | 1.1% | 155 | 13% | -7,788 | -85% | T1 | D |
| Estonia | 325 | 121 | 148 | 0.1% | 27 | 22% | -177 | -55% | T1,T2 | CS,D |
| Hungary | 1,149 | 697 | 590 | 0.5% | -107 | -15% | -559 | -49% | T1,T2 | D |
| Latvia | 945 | 174 | 171 | 0.1% | -4 | -2% | -774 | -82% | T1 | CS |
| Lithuania | 3,341 | 138 | 118 | 0.1% | -20 | -15% | -3,222 | -96% | T2 | D,CS |
| Malta | NA | NA | NA | - | - | - | - | - | NA | NA |
| Poland | 2,199 | 2,245 | 1,809 | 1.5% | -436 | -19% | -390 | -18% | T2 | D |
| Romania | 8,958 | 4,960 | 4,936 | 4.1% | -23 | 0% | -4,021 | -45% | T1 | D |
| Slovakia | 1,286 | 176 | 193 | 0.2% | 18 | 10% | -1,092 | -85% | T2 | CS |
| Slovenia | 696 | 611 | 457 | 0.4% | -155 | -25% | -240 | -34% | T1 | D |
| **EU-27** | **160,237** | **127,044** | **120,324** | **100.0%** | **-6,719** | **-5%** | **-39,912** | **-25%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

**Figure 18.17** **1A2f Other, liquid fuels: Activity Data and Implied Emission Factors for $CO_2$**

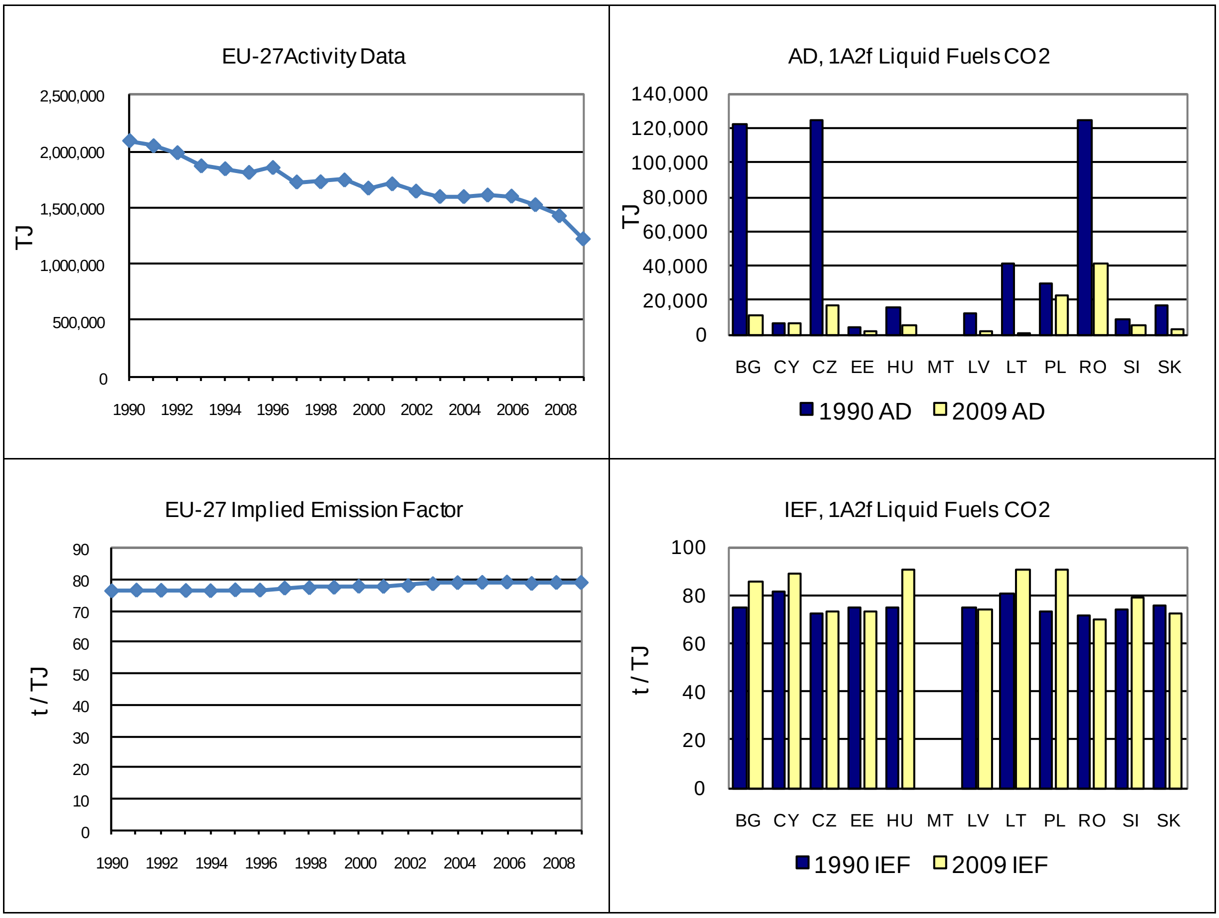



**Table 18.27** **1A2f Other, solid fuels: $CO_2$ emissions of EU-27**

| Member State | $CO_2$ emissions in Gg | | | Share in EU27 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| EU-15 | 138,805 | 50,097 | 56,061 | 74.8% | 5,964 | 12% | -82,744 | -60% | | |
| Bulgaria | 2,179 | 1,107 | 1,581 | 2.1% | 474 | 43% | -598 | -27% | T2 | CS,D |
| Cyprus | 113 | 149 | 117 | 0.2% | -32 | -22% | 5 | 4% | T3 | CS |
| Czech Republic | 31,522 | 1,032 | 1,164 | 1.6% | 132 | 13% | -30,358 | -96% | T1 | D |
| Estonia | 792 | 287 | 705 | 0.9% | 418 | 146% | -88 | -11% | T1,T2 | CS,D |
| Hungary | 948 | 488 | 439 | 0.6% | -48 | -10% | -508 | -54% | T1,T2 | D |
| Latvia | 38 | 114 | 174 | 0.2% | 60 | 53% | 136 | 355% | T1 | CS |
| Lithuania | 143 | 521 | 541 | 0.7% | 20 | 4% | 398 | 278% | T2 | CR,D |
| Malta | NA | NA | NA | - | - | - | - | - | NA | NA |
| Poland | 13,830 | 6,384 | 7,458 | 10.0% | 1,074 | 17% | -6,372 | -46% | T2 | CS,D |
| Romania | 6,552 | 6,043 | 5,698 | 7.6% | -346 | -6% | -854 | -13% | T1 | D |
| Slovakia | 2,897 | 829 | 793 | 1.1% | -36 | -4% | -2,104 | -73% | T2 | CS |
| Slovenia | 199 | 158 | 196 | 0.3% | 38 | 24% | -3 | -1% | T1 | D |
| **EU-27** | **198,017** | **67,209** | **74,927** | **100.0%** | **7,718** | **11%** | **-123,090** | **-62%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

**Figure 18.18 1A2f Other, solid fuels: Activity Data and Implied Emission Factors for $CO_2$**

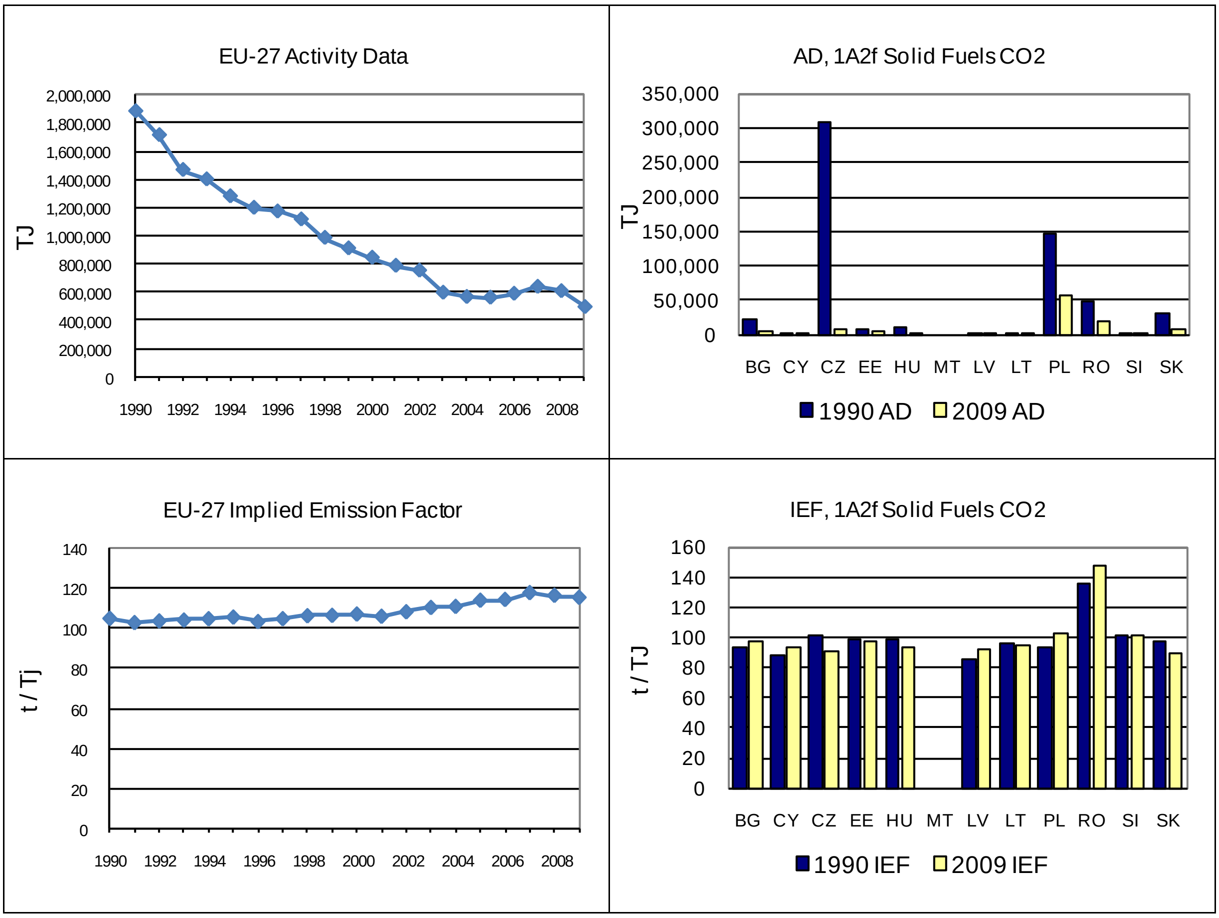
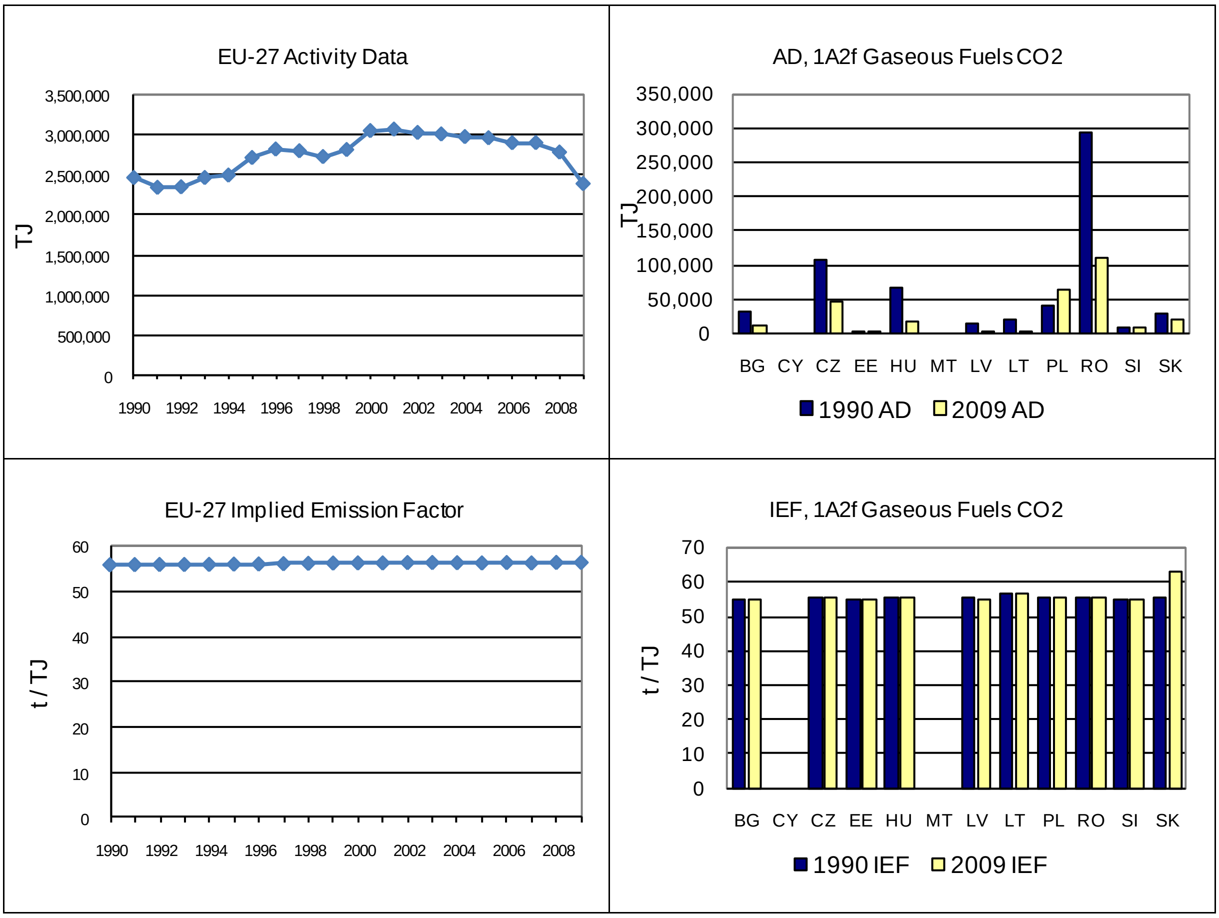



**Table 18.28 1A2f Other, gaseous fuels: $CO_2$ emissions of EU-27**

| Member State | $CO_2$ emissions in Gg | | | Share in EU27 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| EU-15 | 103,558 | 142,213 | 142,658 | 87.4% | 444 | 0% | 39,100 | 38% | | |
| Bulgaria | 1,764 | 1,089 | 1,083 | 0.7% | -6 | -1% | -681 | -39% | T1 | D |
| Cyprus | NO | NO | NO | - | - | - | - | - | NO | NO |
| Czech Republic | 5,984 | 3,210 | 3,369 | 2.1% | 159 | 5% | -2,615 | -44% | T1 | D |
| Estonia | 99 | 104 | 110 | 0.1% | 6 | 6% | 11 | 11% | T2 | GS |
| Hungary | 3,717 | 1,175 | 1,125 | 0.7% | -50 | -4% | -2,592 | -70% | T1,T2 | D |
| Latvia | 835 | 276 | 292 | 0.2% | 16 | 6% | -543 | -65% | T2 | CS |
| Lithuania | 1,093 | 327 | 331 | 0.2% | 4 | 1% | -762 | -70% | T2 | CR |
| Malta | NA | NA | NA | - | - | - | - | - | NA | NA |
| Poland | 2,245 | 3,631 | 3,708 | 2.3% | 76 | 2% | 1,463 | 65% | T2 | D |
| Romania | 16,449 | 8,300 | 7,864 | 4.8% | -436 | -5% | -8,584 | -52% | T1 | D |
| Slovakia | 1,613 | 2,377 | 2,033 | 1.2% | -345 | -15% | 419 | 26% | T2 | CS |
| Slovenia | 530 | 619 | 587 | 0.4% | -33 | -5% | 57 | 11% | T1 | CS |
| **EU-27** | **137,887** | **163,322** | **163,158** | **100.0%** | **-163** | **0%** | **25,272** | **18%** | | |

**Figure 18.19 1A2f Other, gaseous fuels: Activity Data and Implied Emission Factors for $CO_2$**



## 18.2.3 Transport (CRF Source Category 1A3) (EU-27)

### 18.2.3.1 Civil Aviation (1A3a) (EU-27)

**Figure 18.20 1A3a- Civil Aviation: Total, $CO_2$ and $N_2O$ emission and activity trends**

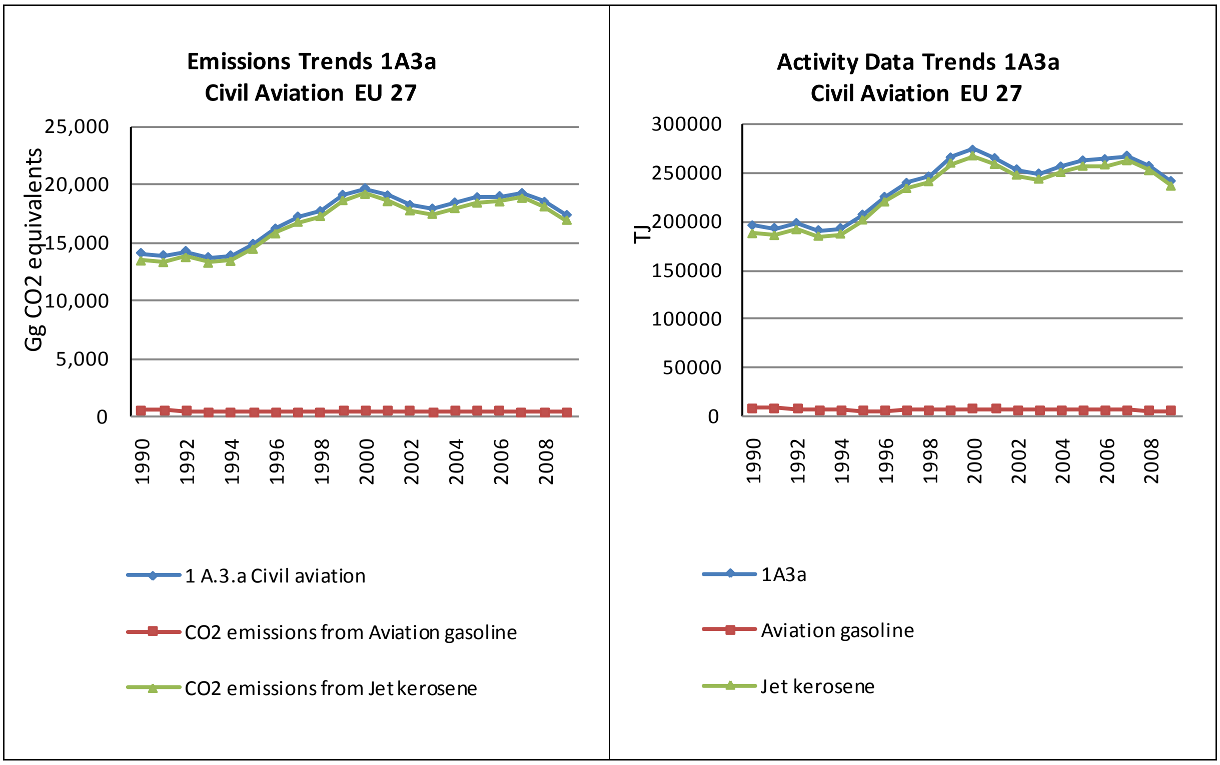



**Table 18.29 1A3a Civil Aviation, jet kerosine: $CO_2$ emissions of EU-27**

| Member State | $CO_2$ emissions in Gg | | | Share in EU27 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| EU-15 | 13,237 | 18,408 | 18,603 | 98.5% | 196 | 1% | 5,366 | 41% | | |
| Bulgaria | 114 | 74 | 123 | 0.7% | 49 | 67% | 9 | 8% | T1 | D |
| Cyprus | NA | NA | NA | - | - | - | - | - | NE | NE |
| Czech Republic | 86 | 10 | 26 | 0.14% | 16.1 | 167% | -61 | -70% | T1 | D |
| Estonia | NO | NO | NO | - | - | - | - | - | T2 | D |
| Hungary | NO | NO | NO | - | - | - | - | - | NA | NA |
| Latvia | 0.05 | 1 | 1.20 | 0.01% | 0.2 | 19% | 1.15 | 2094% | T2 | D |
| Lithuania | NE | 1 | 3 | 0.01% | 1.6 | 138% | 3 | - | T1 | CS |
| Malta | NA | NA | NA | - | - | - | - | - | NA | NA |
| Poland | 30 | 65 | 68 | 0.4% | 3 | 4% | 38 | 126% | T1 | D |
| Romania | 25 | 12 | 53 | 0.28% | 42 | 354% | 29 | 117% | T1 | D |
| Slovakia | 7 | 11 | 13 | 0.07% | 2 | 16% | 6 | 86% | T2 | D |
| Slovenia | NO | NO | NO | - | - | - | - | - | NA | NA |
| **EU-27** | **13,499** | **18,582** | **18,891** | **100.0%** | **309** | **2%** | **5,392** | **40%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

## 18.2.3.2 Road Transportation (1A3b) (EU-27)

**Figure 18.21 1A3b- Road Transport, $CO_2$ and $N_2O$ emission and activity trends**

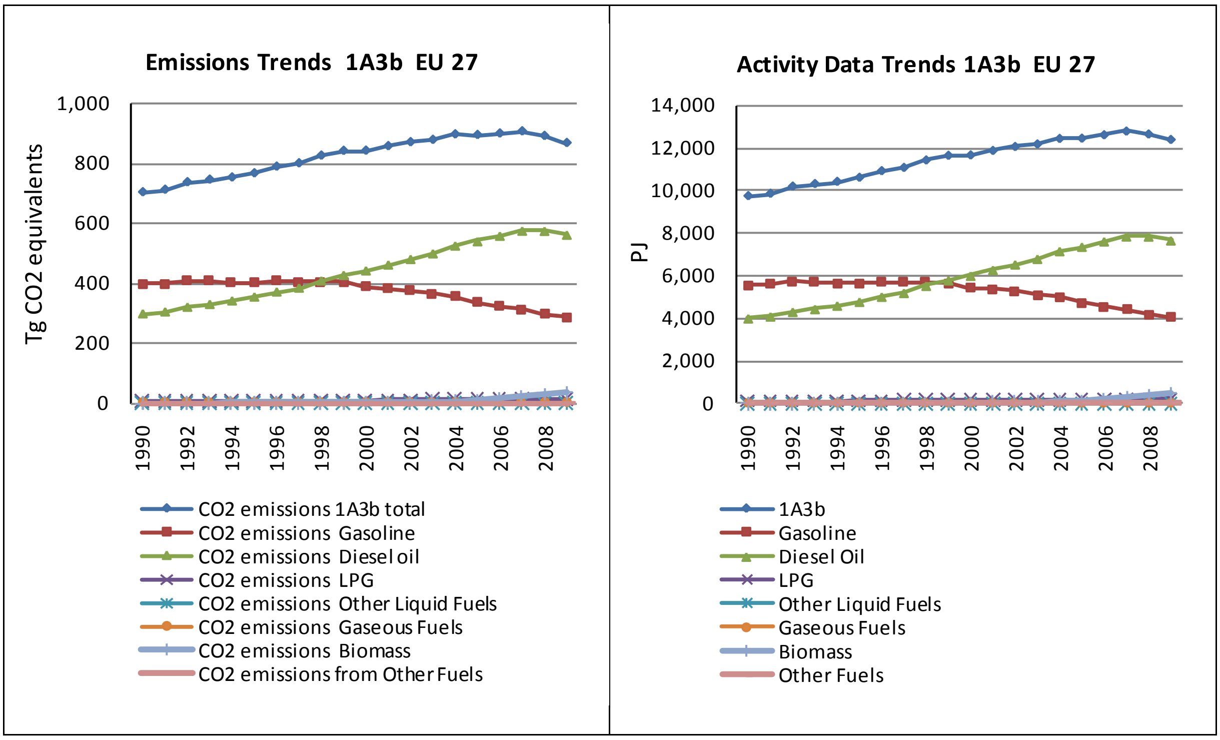



**Table 18.30 1A3b Road Transport, diesel oil: $CO_2$ emissions of EU-27**

| Member State | $CO_2$ emissions in Gg | | | Share in EU27 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| EU-15 | 266,862 | 499,769 | 512,355 | 88.7% | 12,586 | 3% | 245,493 | 92% | | |
| Bulgaria | 1,547 | 4,456 | 4,213 | 0.7% | -243 | -5% | 2,666 | 172% | T1 | D |
| Cyprus | 642 | 1,068 | 1,120 | 0.2% | 52 | 5% | 478 | 74% | T1 | D |
| Czech Republic | 2,823 | 10,573 | 11,158 | 1.9% | 585 | 6% | 8,335 | 295% | T1 | D |
| Estonia | 697 | 1,175 | 1,255 | 0.2% | 80 | 7% | 558 | 80% | T1 | CS |
| Hungary | 2,485 | 7,321 | 7,599 | 1.3% | 277 | 4% | 5,113 | 206% | T1 | D |
| Latvia | 616 | 1,868 | 2,182 | 0.4% | 314 | 17% | 1,566 | 254% | M | CS |
| Lithuania | 2,134 | 2,317 | 2,833 | 0.5% | 516 | 22% | 699 | 33% | T2 | CS |
| Malta | 150 | 288 | 283 | 0.0% | -5 | -2% | 133 | 89% | D,T1 | D |
| Poland | 11,161 | 18,189 | 19,844 | 3.4% | 1,655 | 9% | 8,684 | 78% | T2 | CS |
| Romania | 3,388 | 7,534 | 7,609 | 1.3% | 75 | 1% | 4,220 | 125% | T1 | D |
| Slovakia | 3,108 | 3,557 | 4,234 | 0.7% | 677 | 19% | 1,126 | 36% | M | D |
| Slovenia | 895 | 2,535 | 3,166 | 0.5% | 630 | 25% | 2,270 | 254% | M | M |
| **EU-27** | **296,508** | **560,651** | **577,851** | **100.0%** | **17,200** | **3.1%** | **281,342** | **95%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

**Figure 18.22 1A3b Road Transport, diesel oil: Activity Data and Implied Emission Factors for $CO_2$**

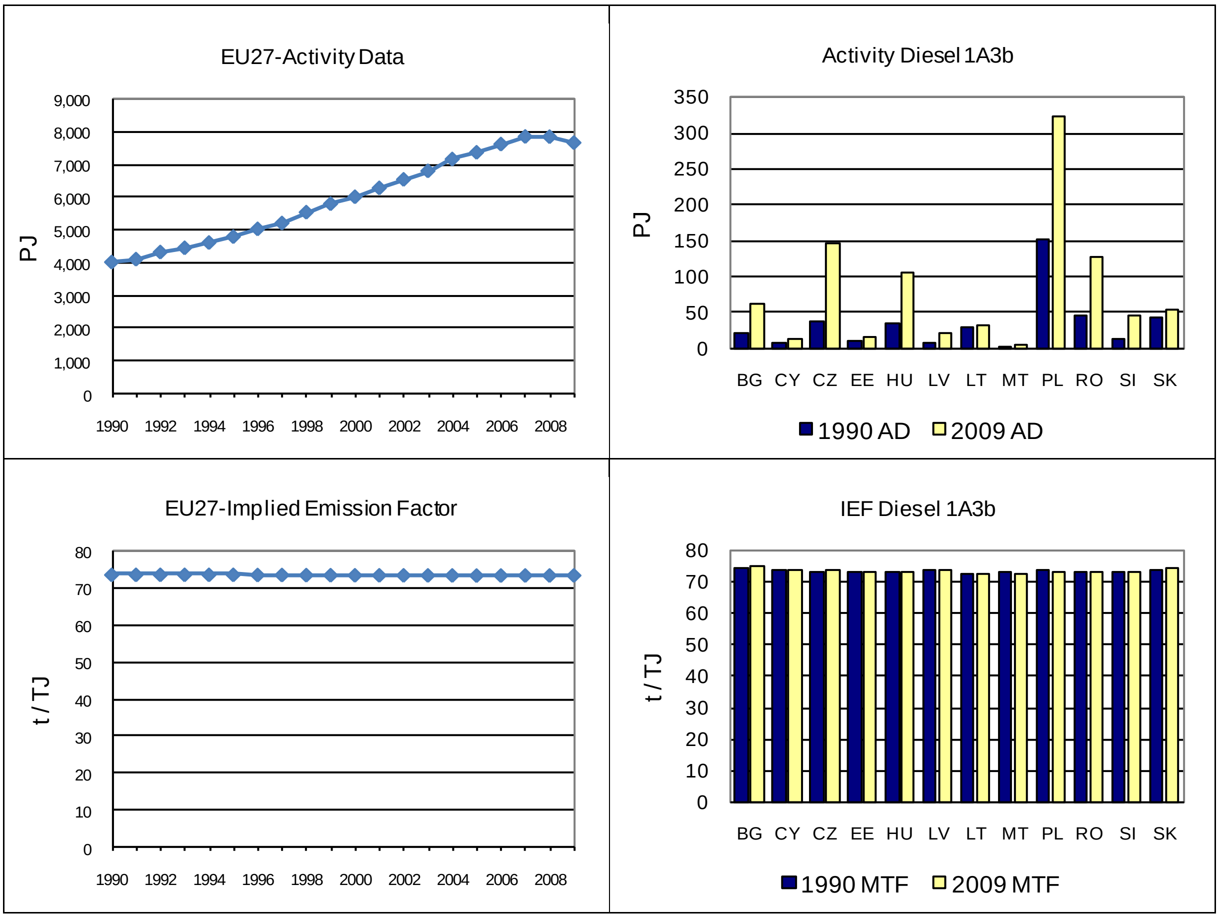



**Table 18.31 1A3b Road Transport, gasoline: $CO_2$ emissions of EU-27**

| Member State | $CO_2$ emissions in Gg | | | Share in EU27 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| EU-15 | 362,786 | 285,985 | 275,442 | 87.7% | -10,543 | -4% | -87,344 | -24% | | |
| Bulgaria | 4,390 | 1,882 | 1,856 | 0.6% | -25 | -1% | -2,533 | -58% | T1 | D |
| Cyprus | 119 | 985 | 1,073 | 0.3% | 88 | 9% | 954 | 803% | T1 | D |
| Czech Republic | 3,367 | 6,363 | 6,637 | 2.1% | 274 | 4% | 3,270 | 97% | T1 | D |
| Estonia | 1,563 | 973 | 1,020 | 0.3% | 48 | 5% | -542 | -35% | T1 | CS |
| Hungary | 4,985 | 4,672 | 4,545 | 1.4% | -127 | -3% | -440 | -9% | T1 | D |
| Latvia | 1,689 | 1,119 | 1,225 | 0.4% | 106 | 9% | -465 | -27% | M | CS |
| Lithuania | 3,053 | 1,126 | 1,356 | 0.4% | 230 | 20% | -1,697 | -56% | T2 | CS |
| Malta | 183 | 204 | 212 | 0.1% | 8 | 4% | 28 | 15% | D,T1 | D |
| Poland | 10,130 | 12,831 | 12,632 | 4.0% | -198 | -2% | 2,502 | 25% | T2 | CS |
| Romania | 3,073 | 4,290 | 4,208 | 1.3% | -82 | -2% | 1,135 | 37% | T1 | D |
| Slovakia | 1,393 | 1,923 | 2,022 | 0.6% | 99 | 5% | 629 | 45% | M | D |
| Slovenia | 1,711 | 1,981 | 1,923 | 0.6% | -58 | -3% | 212 | 12% | M | M |
| **EU-27** | **398,442** | **324,332** | **314,151** | **100.0%** | **-10,181** | **-3.1%** | **-84,290** | **-21%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

**Figure 18.23 1A3b Road Transport, gasoline: Activity Data and Implied Emission Factors for $CO_2$**

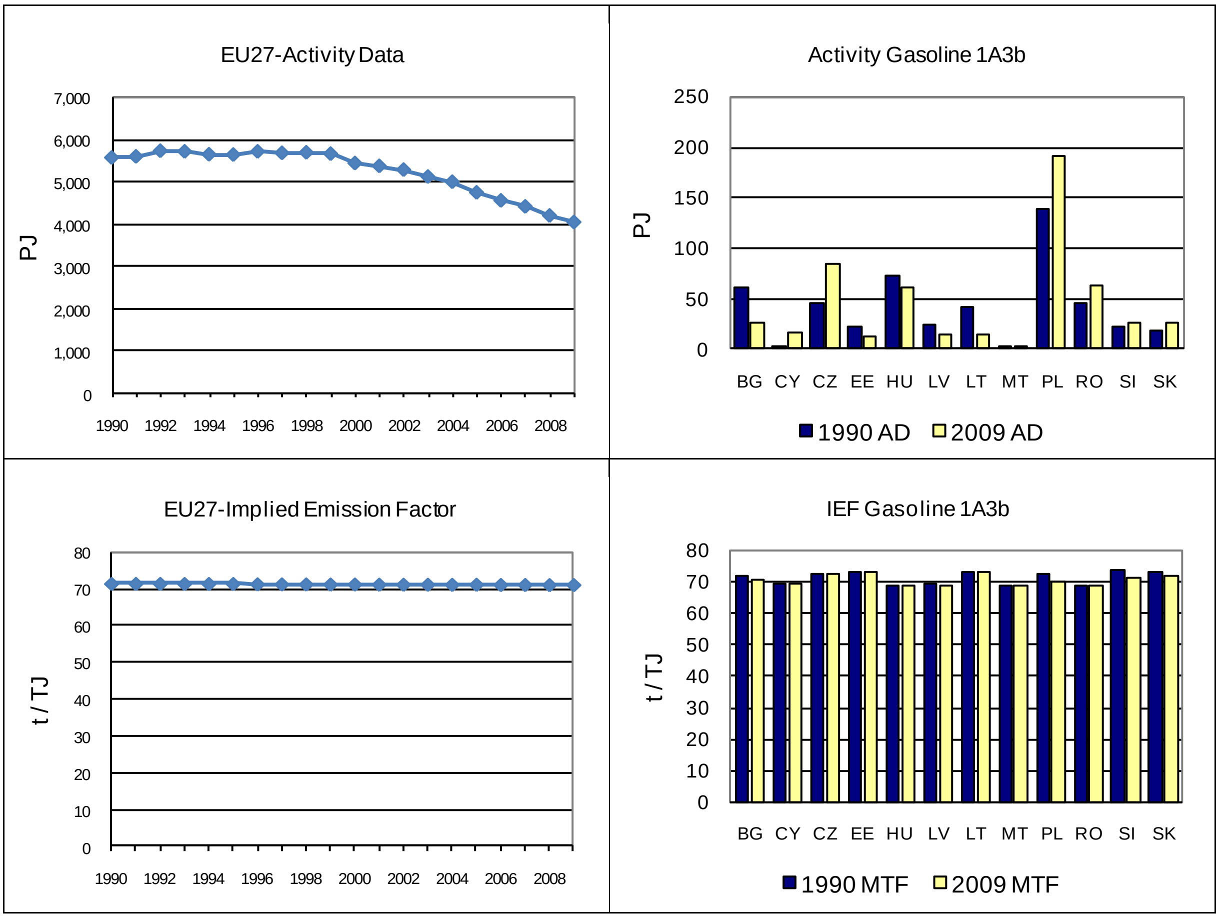



**Table 18.32 1A3b Road Transport, LPG: Member $CO_2$ emissions of EU-27**

| Member State | $CO_2$ emissions in Gg | | | Share in EU27 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| EU-15 | 7,283 | 5,479 | 5,479 | 42.2% | -1 | 0% | -1,805 | -25% | | |
| Bulgaria | NO | 1,101 | 1,052 | 8.1% | -48 | -4% | 1,052 | - | T1 | D |
| Cyprus | NO | NO | NO | - | - | - | - | - | NO | NO |
| Czech Republic | NO | 218 | 233 | 1.8% | 15 | 7% | 233 | - | T1 | D |
| Estonia | 9 | 0.3 | 0.1 | 0.001% | -0.1 | -51% | -9 | -99% | T1 | D |
| Hungary | NA | 72 | 84 | 0.7% | 12.5 | 17% | 84 | - | T1 | D |
| Latvia | 37 | 74 | 68 | 0.5% | -6 | -8% | 31 | 85% | M | CS |
| Lithuania | 60 | 642 | 635 | 4.9% | -7 | -1% | 575 | 955% | T2 | CS |
| Malta | NO | NO | NO | - | - | - | - | - | NA | NA |
| Poland | NO | 5,206 | 5,267 | 40.6% | 61 | 1% | 5,267 | - | T2 | CS |
| Romania | NA | 48 | 95 | 0.7% | 48 | 100% | 95 | - | T1 | D |
| Slovakia | NO | 75 | 66 | 0.5% | -9 | -13% | 66 | - | M | D |
| Slovenia | NO | NO | NO | - | 0 | - | 0 | - | M | M |
| **EU-27** | **7,389** | **12,914** | **12,979** | **100.0%** | **65** | **1%** | **5,590** | **76%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

**Table 18.33 1A3b Road Transport, diesel oil: $N_2O$ emissions of EU-27**

| Member State | $N_2O$ emissions (Gg $CO_2$ equivalents) | | | Share in EU27 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| EU-15 | 1,647 | 4,439 | 4,499 | 84.9% | 60 | 1% | 2,852 | 173% | | |
| Bulgaria | 16 | 28 | 28 | 0.5% | 0 | 1% | 12 | 79% | T1 | D |
| Cyprus | 10 | 17 | 18 | 0.3% | 1 | 5% | 8 | 74% | T1 | D |
| Czech Republic | 29 | 198 | 211 | 4.0% | 12 | 6% | 182 | 624% | T2 | CS |
| Estonia | 5 | 7 | 8 | 0.2% | 1 | 15% | 3 | 54% | T3 | CS |
| Hungary | 41 | 122 | 126 | 2.4% | 5 | 4% | 85 | 208% | T2 | D |
| Latvia | 6 | 12 | 14 | 0.3% | 2 | 20% | 9 | 148% | M | M |
| Lithuania | 36 | 39 | 48 | 0.9% | 9 | 22% | 12 | 33% | T2 | D |
| Malta | 0.38 | 1 | 1 | 0.0% | -0.01 | -2% | 0.34 | 89% | D,T1 | D |
| Poland | 151 | 249 | 274 | 5.2% | 25 | 10% | 123 | 82% | T2 | D |
| Romania | 9 | 19 | 19 | 0.4% | 0 | 1% | 11 | 125% | T1 | D |
| Slovakia | 61 | 20 | 23 | 0.4% | 3 | 15% | -38 | -62% | M | D |
| Slovenia | 11 | 24 | 31 | 0.6% | 7 | 30% | 21 | 195% | M | M |
| **EU-27** | **2,022** | **5,176** | **5,302** | **100.0%** | **126** | **2%** | **3,280** | **162%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

**Table 18.34 1A3b Road Transport, gasoline: $N_2O$ emissions of EU-27**

| Member State | $N_2O$ emissions (Gg $CO_2$ equivalents) | | | Share in EU27 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| EU-15 | 3,573 | 3,651 | 3,208 | 74.1% | -443 | -12% | -364 | -10% | | |
| Bulgaria | 55 | 42 | 39 | 0.9% | -3.03 | -7% | -16 | -29% | T1 | D |
| Cyprus | 7 | 35 | 38 | 0.9% | 3 | 8% | 31 | 441% | 0.0 | 0.0 |
| Czech Republic | 103 | 493 | 512 | 11.8% | 19 | 4% | 409 | 398% | T2 | CS |
| Estonia | 14 | 11 | 11 | 0.3% | 0 | -3% | -3 | -24% | T3 | CS |
| Hungary | 58 | 264 | 254 | 5.9% | -10 | -4% | 196 | 337% | T2 | D |
| Latvia | 14 | 18 | 17 | 0.4% | -1 | -5% | 3 | 25% | M | M |
| Lithuania | 26 | 10 | 12 | 0.3% | 1.96 | 20% | -14 | -56% | T2 | CS |
| Malta | 0.50 | 1 | 1 | 0.0% | 0.02 | 4% | 0 | 15% | D,T1 | D |
| Poland | 72 | 145 | 146 | 3.4% | 1 | 1% | 74 | 103% | T2 | D |
| Romania | 8 | 12 | 11 | 0.3% | -0.22 | -2% | 3 | 37% | T1,NA | D,NA |
| Slovakia | 11 | 34 | 32 | 0.7% | -2 | -5% | 22 | 206% | M | D |
| Slovenia | 28 | 56 | 51 | 1.2% | -5 | -8% | 23 | 83% | M | M |
| **EU-27** | **3,969** | **4,771** | **4,332** | **100.0%** | **-439** | **-9%** | **363** | **9%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

### 18.2.3.3 Railways (1A3c) (EU-27)

**Figure 18.24 1A3c- Railways, $CO_2$ and $N_2O$ emission and activity trends**

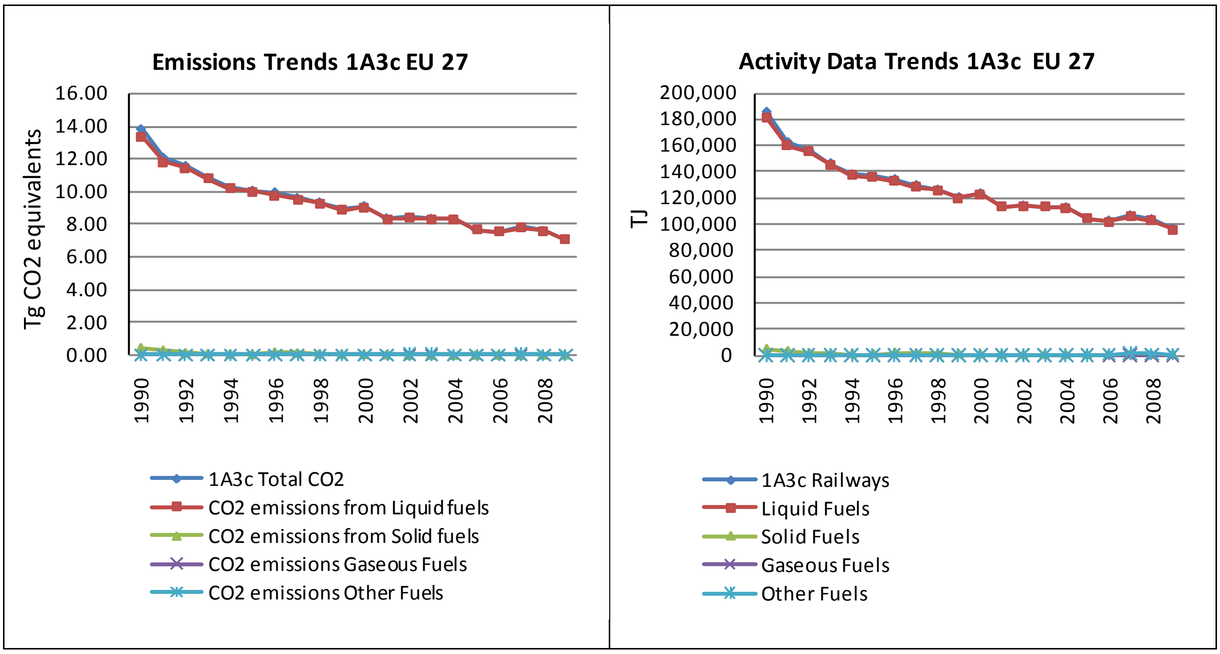



**Table 18.35 1A3c Railways, liquid fuels: $CO_2$ emissions of EU-27**

| Member State | $CO_2$ emissions in Gg | | | Share in EU27 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| EU-15 | 7,783 | 5,532 | 5,432 | 69.9% | -99 | -2% | -2,350 | -30% | | |
| Bulgaria | 318 | 89 | 77 | 1.0% | -11 | -13% | -241 | -76% | T1 | D |
| Cyprus | NO | NO | NO | - | - | - | - | - | NO | NO |
| Czech Republic | 648 | 301 | 298 | 3.8% | -3 | -1% | -350 | -54% | T1 | D |
| Estonia | 143 | 136 | 112 | 1.4% | -24 | -18% | -31 | -22% | T1 | CS |
| Hungary | 513 | 185 | 185 | 2.4% | 0 | 0% | -328 | -64% | T1 | D |
| Latvia | 531 | 226 | 245 | 3.2% | 19 | 8% | -286 | -54% | T1 | D |
| Lithuania | 350 | 218 | 226 | 2.9% | 8 | 4% | -124 | -35% | T2 | CS |
| Malta | NO | NA | NA | - | - | - | - | - | NA | NA |
| Poland | 1,770 | 463 | 482 | 6.2% | 19 | 4% | -1,288 | -73% | T1 | D |
| Romania | 904 | 223 | 566 | 7.3% | 343 | 154% | -337 | -37% | T1 | D |
| Slovakia | 377 | 113 | 109 | 1.4% | -5 | -4% | -268 | -71% | T1 | D |
| Slovenia | 64 | 37 | 37 | 0.5% | 0 | 0% | -27 | -42% | T1 | D |
| **EU-27** | **13,401** | **7,524** | **7,771** | **100.0%** | **247** | **3%** | **-5,630** | **-42%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

### 18.2.3.4 Navigation (1A3d) (EU-27)

**Figure 18.25** **1A3d- Navigation, $CO_2$ and $N_2O$ emission and activity trends**

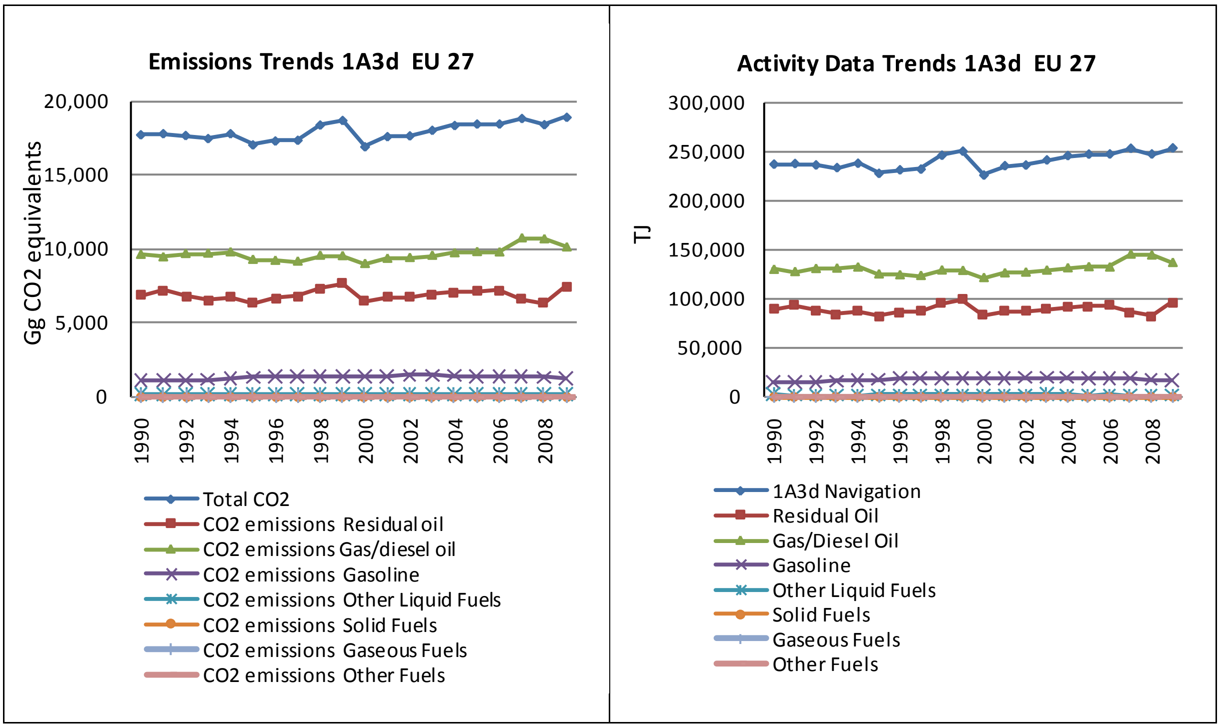



**Table 18.36** **1A3d Navigation, residual oil: $CO_2$ emissions of EU-27**

| Member State | $CO_2$ emissions in Gg | | | Share in EU27 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| EU-15 | 6,698 | 7,190 | 6,615 | 99.7% | -575 | -8% | -83 | -1% | | |
| Bulgaria | IE | IE | IE | - | - | - | - | - | IE | IE |
| Cyprus | NO | NO | NO | - | - | - | - | - | NE | NE |
| Czech Republic | NO | NO | NO | - | - | - | - | - | T1 | D |
| Estonia | NO | NO | NO | - | - | - | - | - | NO | NO |
| Hungary | 2 | NO | NO | - | - | - | -2 | -100% | NA | NA |
| Latvia | NO | NO | NO | - | - | - | - | - | T1 | D |
| Lithuania | NO | 1 | 1 | 0.01% | 0 | -36% | 1 | - | T2 | CS |
| Malta | NA | NA | NA | - | - | - | - | - | NA | NA |
| Poland | 58 | 3 | 3 | 0.05% | 0 | 1% | -55 | -94% | T1 | D |
| Romania | 146 | 1 | 13 | 0.19% | 11 | 988% | -133 | -91% | T1 | D |
| Slovakia | NO | NO | NO | - | - | - | - | - | NA | NA |
| Slovenia | NO | NO | NO | - | - | - | - | - | NA | NA |
| **EU-27** | **6,903** | **7,195** | **6,632** | **100.0%** | **-564** | **-8%** | **-271** | **-4%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

**Table 18.37 1A3d Navigation, gas/diesel oil: $CO_2$ emissions of EU-27**

| Member State | $CO_2$ emissions in Gg | | | Share in EU27 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| EU-15 | 9,323 | 9,645 | 10,544 | 98.0% | 899 | 9% | 1,221 | 13% | | |
| Bulgaria | 56 | IE | IE | - | - | - | -56 | -100% | IE | IE |
| Cyprus | NO | NO | NO | - | - | - | - | - | NE | NE |
| Czech Republic | 56 | 19 | 16 | 0.1% | -3 | -17% | -40 | -72% | T1 | D |
| Estonia | 22 | 34 | 54 | 0.5% | 20 | 59% | 32 | 148% | T1 | CS |
| Hungary | 28 | 4 | 3 | 0.0% | -1 | -14% | -25 | -89% | T1 | D |
| Latvia | 1 | 0 | 3 | 0.0% | 3 | 912% | 2 | 282% | T1 | D |
| Lithuania | 15 | 18 | 17 | 0.2% | -1 | -5% | 2 | 11% | T2 | CS |
| Malta | 8 | 23 | 26 | 0.2% | 3 | 11% | 17 | 207% | D,T1 | D |
| Poland | 76 | 11 | 17 | 0.2% | 6 | 58% | -60 | -78% | T1 | D |
| Romania | 39 | 38 | 75 | 0.7% | 37 | 96% | 35 | 90% | T1 | D |
| Slovakia | 0.02 | 0.03 | 0.04 | 0.0% | 0 | 10% | 0 | 64% | CS | D |
| Slovenia | IE | IE | IE | - | - | - | - | - | NA | NA |
| **EU-27** | **9,625** | **9,791** | **10,754** | **100.0%** | **963** | **10%** | **1,129** | **12%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

### 18.2.3.5 Other (1A3e) (EU-27)

**Table 18.38 1A3e Other: $CO_2$ emissions of EU-27**

| Member State | $CO_2$ emissions in Gg | | | Share in EU27 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | |
|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) |
| EU-15 | 6,461 | 7,574 | 7,171 | 77.5% | -403 | -5% | 710 | 11% |
| Bulgaria | 132 | 594 | 321 | 3.5% | -273 | -46% | 189 | 144% |
| Cyprus | NA | NA | NA | - | - | - | - | - |
| Czech Republic | 494 | 148 | 153 | 1.7% | 6 | 4% | -341 | -69% |
| Estonia | NO | NO | NO | - | - | - | - | - |
| Hungary | NO | NO | NO | - | - | - | - | - |
| Latvia | NO | NO | NA,NO | - | - | - | - | - |
| Lithuania | 1,765 | 254 | 209 | 2.3% | -45 | -18% | -1,557 | -88% |
| Malta | NA | NA | NA | - | - | - | - | - |
| Poland | 1,299 | 1,425 | 1,378 | 14.9% | -47 | -3% | 79 | 6% |
| Romania | 7 | 48 | 20 | 0.2% | -28 | -59% | 12 | 172% |
| Slovakia | 7 | 2 | 2 | 0.0% | -0.5 | -26% | -5 | -78% |
| Slovenia | NO | NO | NO | - | - | - | - | - |
| **EU-27** | **10,166** | **10,044** | **9,253** | **100.0%** | **-791** | **-8%** | **-912** | **-9%** |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

## 18.2.4 Other Sectors (CRF Source Category 1A4) (EU-27)

### 18.2.4.1 Commercial/Institutional (1A4a) (EU-27)

**Figure 18.26 1A4a Commercial/Institutional, $CO_2$ and $N_2O$ emission and activity trends**

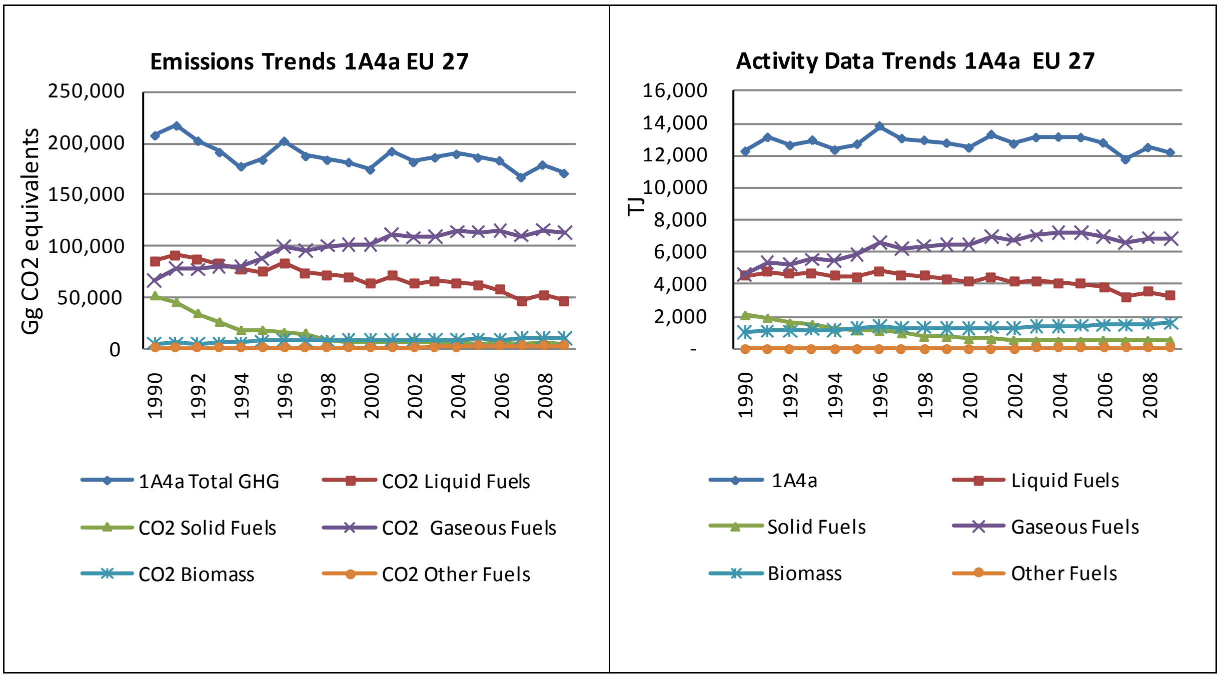



**Table 18.39 1A4a Commercial/Institutional, liquid fuels: $CO_2$ emissions of EU-27**

| Member State | $CO_2$ emissions in Gg | | | Share in EU27 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| EU-15 | 75,892 | 53,528 | 42,208 | 90.6% | -11,320 | -21% | -33,684 | -44% | | |
| Bulgaria | 2,954 | 205 | 148 | 0.3% | -56 | -28% | -2,806 | -95% | T1 | D |
| Cyprus | 27 | 106 | 85 | 0.2% | -22 | -20% | 57 | 211% | T1 | D |
| Czech Republic | 1,786 | 87 | 83 | 0.2% | -4 | -4% | -1,703 | -95% | T1 | D |
| Estonia | 19 | 6 | 10 | 0.0% | 5 | 78% | -8 | -44% | T1,T2 | CS,D |
| Hungary | 1,296 | 103 | 275 | 0.6% | 172 | 168% | -1,021 | -79% | T1 | D |
| Latvia | 1,131 | 164 | 138 | 0.3% | -26 | -16% | -993 | -88% | T1 | CS |
| Lithuania | 976 | 8 | 10 | 0.0% | 3 | 37% | -966 | -99% | T2 | D,CS |
| Malta | 55 | IE | IE | - | - | - | -55 | -100% | NA | NA |
| Poland | NO | 2,128 | 1,666 | 3.6% | -462 | -22% | 1,666 | - | T2 | D |
| Romania | 926 | 877 | 1,536 | 3.3% | 659 | 75% | 610 | 66% | T1 | D |
| Slovakia | 384 | 25 | 4 | 0.0% | -20 | -83% | -379 | -99% | T2 | CS |
| Slovenia | 267 | 597 | 448 | 1.0% | -149 | -25% | 180 | 67% | T1 | D |
| **EU-27** | **85,715** | **57,833** | **46,613** | **100.0%** | **-11,221** | **-19%** | **-39,102** | **-46%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

**Table 18.40 1A4a Commercial/Institutional, solid fuels: $CO_2$ emissions of EU-27**

| Member State | $CO_2$ emissions in Gg | | | Share in EU27 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| EU-15 | 27,789 | 1,942 | 2,404 | 42.3% | 462 | 24% | -25,385 | -91% | | |
| Bulgaria | 60 | 25 | 12 | 0.2% | -13 | -53% | -48 | -80% | T2 | CS,D |
| Cyprus | NO | NO | NO | - | - | - | - | - | NO | NO |
| Czech Republic | 6,274 | 726 | 211 | 3.7% | -516 | -71% | -6,064 | -97% | T1 | CS |
| Estonia | 8 | 1 | 3 | 0.1% | 2 | 177% | -5 | -64% | T1,T2 | CS,D |
| Hungary | 650 | 19 | 15 | 0.3% | -4 | -23% | -635 | -98% | T1 | D |
| Latvia | 1,332 | 106 | 105 | 1.9% | 0 | 0% | -1,227 | -92% | T1 | CS |
| Lithuania | 1,186 | 299 | 222 | 3.9% | -77 | -26% | -964 | -81% | T2 | D,CR,CS |
| Malta | NA | NA | NA | - | - | - | - | - | NA | NA |
| Poland | 11,727 | 3,063 | 2,660 | 46.8% | -403 | -13% | -9,067 | -77% | T2 | CS,D |
| Romania | 400 | 15 | 7 | 0.1% | -8 | -53% | -393 | -98% | T1 | D |
| Slovakia | 1,729 | 60 | 40 | 0.7% | -21 | -34% | -1,689 | -98% | T2 | CS |
| Slovenia | 200 | NO | NO | - | - | - | -200 | -100% | NA | NA |
| **EU-27** | **51,355** | **6,257** | **5,678** | **100.0%** | **-579** | **-9%** | **-45,677** | **-89%** | | |

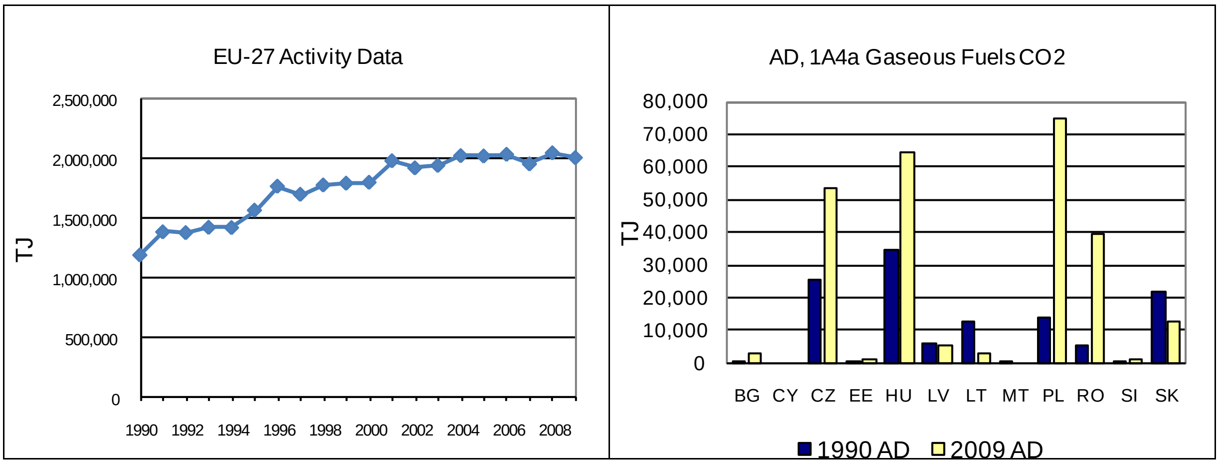
*Abbreviations explained in the Chapter 'Units and abbreviations'.*

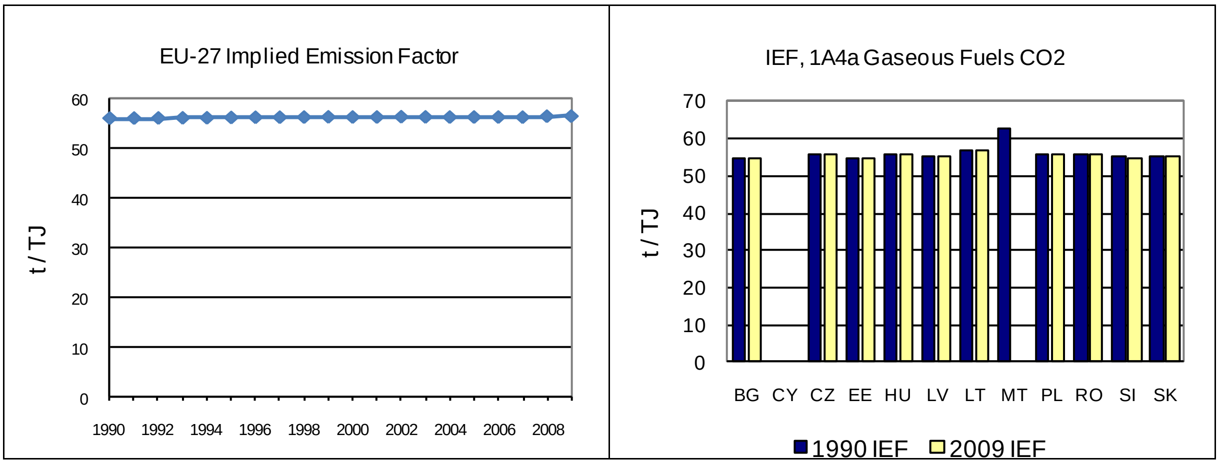
**Table 18.41 1A4a Commercial/Institutional, gaseous fuels: $CO_2$ emissions of EU-27**

| Member State | $CO_2$ emissions in Gg | | | Share in EU27 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| EU-15 | 60,114 | 97,971 | 96,106 | 87.3% | -1,865 | -2% | 35,992 | 60% | | |
| Bulgaria | 39 | 148 | 161 | 0.1% | 13 | 9% | 123 | 316% | T1 | D |
| Cyprus | NO | NO | NO | - | - | - | - | - | NO | NO |
| Czech Republic | 1,428 | 3,044 | 2,908 | 2.6% | -136 | -4% | 1,480 | 104% | T1 | D |
| Estonia | 20 | 33 | 65 | 0.1% | 32 | 96% | 45 | 221% | T2 | CS |
| Hungary | 1,928 | 5,048 | 3,560 | 3.2% | -1,488 | -29% | 1,633 | 85% | T1 | D |
| Latvia | 337 | 277 | 315 | 0.3% | 38 | 14% | -23 | -7% | T2 | CS |
| Lithuania | 730 | 128 | 172 | 0.2% | 44 | 34% | -558 | -76% | T2 | CR |
| Malta | 7 | IE | IE | - | - | - | -7 | -100% | NA | NA |
| Poland | 770 | 3,510 | 3,620 | 3.3% | 110 | 3% | 2,850 | 370% | T2 | D |
| Romania | 313 | 3,768 | 2,551 | 2.3% | -1,217 | -32% | 2,238 | 715% | T1 | D |
| Slovakia | 1,215 | 759 | 653 | 0.6% | -107 | -14% | -563 | -46% | T2 | CS |
| Slovenia | 29 | 32 | 27 | 0.0% | -6 | -18% | -2 | -8% | T1 | CS |
| **EU-27** | **66,929** | **114,719** | **110,138** | **100.0%** | **-4,582** | **-4%** | **43,208** | **65%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

**Figure 18.27 1A4a Commercial/Institutional, gaseous fuels: Activity Data and Implied Emission Factors for $CO_2$**






### 18.2.4.2 Residential (1A4b) (EU-27)

**Figure 18.28 1A4b Residential, $CO_2$ and $N_2O$ emission and activity trends**

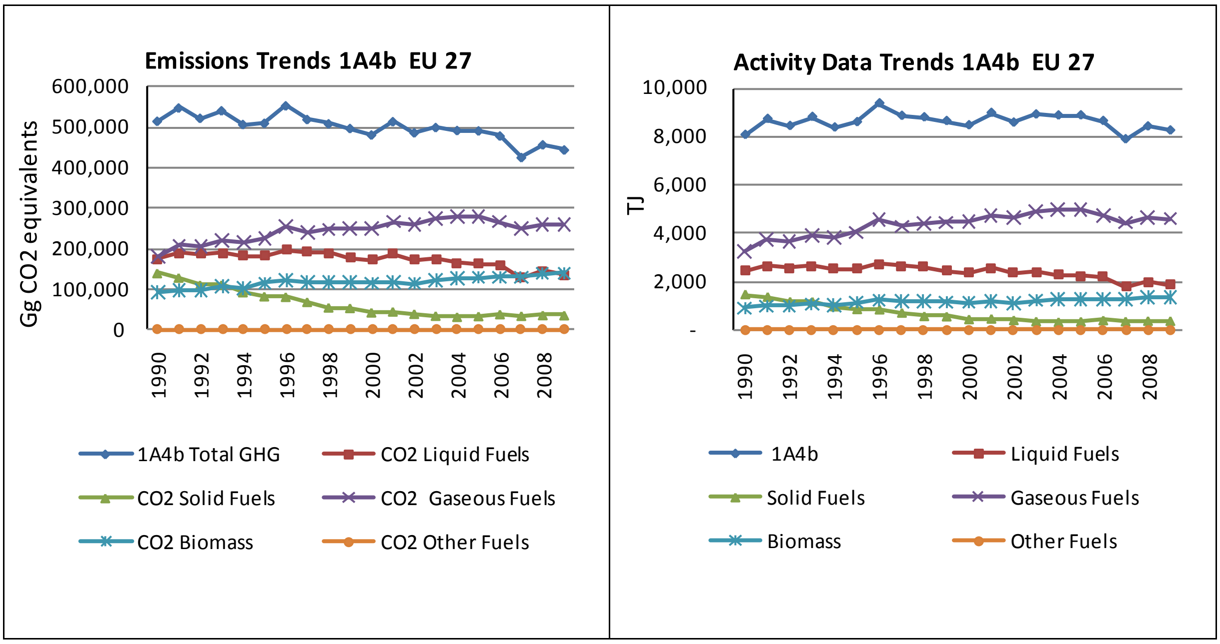


**Table 18.42 1A4b Residential, liquid fuels: $CO_2$ emissions of EU-27**

| Member State | $CO_2$ emissions in Gg | | | Share in EU27 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| EU-15 | 169,468 | 153,305 | 121,821 | 95.2% | -31,484 | -21% | -47,648 | -28% | | |
| Bulgaria | 156 | 75 | 66 | 0.1% | -8 | -11% | -90 | -58% | T1 | D |
| Cyprus | 222 | 237 | 208 | 0.2% | -30 | -13% | -15 | -7% | T1 | D |
| Czech Republic | 490 | 99 | 85 | 0.1% | -14 | -14% | -405 | -83% | T1 | D |
| Estonia | 550 | 44 | 39 | 0.0% | -4 | -10% | -511 | -93% | T1,T2 | CS,D |
| Hungary | 3,423 | 430 | 246 | 0.2% | -184 | -43% | -3,177 | -93% | T1 | D |
| Latvia | 330 | 104 | 93 | 0.1% | -11 | -11% | -237 | -72% | T1 | CS |
| Lithuania | 399 | 153 | 106 | 0.1% | -47 | -31% | -293 | -74% | T2 | CS |
| Malta | 3 | 0 | 0 | 0.0% | 0 | -24% | -2 | -90% | D,T1 | D |
| Poland | 106 | 2,698 | 2,727 | 2.1% | 29 | 1% | 2,621 | 2466% | T2 | D |
| Romania | 867 | 1,211 | 1,697 | 1.3% | 486 | 40% | 830 | 96% | T1 | D |
| Slovakia | NO | NO | NO | - | - | - | - | - | NA | NA |
| Slovenia | 434 | 1,127 | 860 | 0.7% | -267 | -24% | 425 | 98% | T1 | D |
| **EU-27** | **176,448** | **159,484** | **127,947** | **100.0%** | **-31,537** | **-20%** | **-48,501** | **-27%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

**Figure 18.29 1A4b Residential, liquid fuels: Activity Data and Implied Emission Factors for $CO_2$**

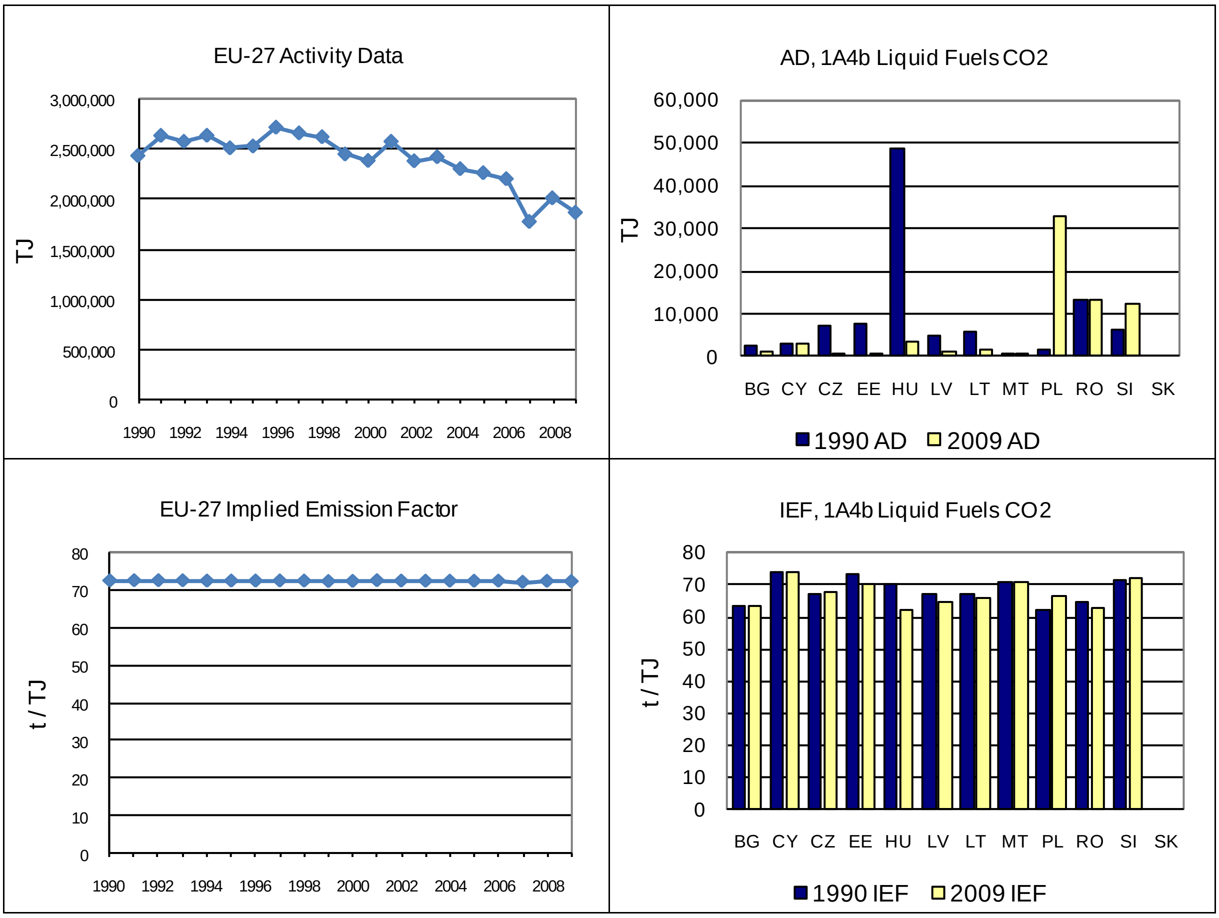


**Table 18.43 1A4b Residential, solid fuels: $CO_2$ emissions of EU-27**

| Member State | $CO_2$ emissions in Gg | | | Share in EU27 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| EU-15 | 74,513 | 10,431 | 10,698 | 30.1% | 267 | 3% | -63,815 | -86% | | |
| Bulgaria | 2,635 | 1,010 | 857 | 2.4% | -153 | -15% | -1,778 | -67% | T2 | CS,D |
| Cyprus | NO | NO | NO | - | - | - | - | - | NO | NO |
| Czech Republic | 17,373 | 3,345 | 1,984 | 5.6% | -1,362 | -41% | -15,389 | -89% | T1 | CS |
| Estonia | 669 | 74 | 43 | 0.1% | -31 | -42% | -626 | -94% | T1,T2 | CS,D |
| Hungary | 7,981 | 956 | 540 | 1.5% | -416 | -44% | -7,441 | -93% | T1 | CS,D |
| Latvia | 585 | 75 | 75 | 0.2% | 0 | 0% | -511 | -87% | T1 | CS |
| Lithuania | 1,458 | 206 | 206 | 0.6% | -1 | 0% | -1,252 | -86% | T2 | D,CR,CS |
| Malta | NA | NA | NA | - | - | - | - | - | NA | NA |
| Poland | 26,299 | 22,831 | 20,756 | 58.5% | -2,076 | -9% | -5,543 | -21% | T2 | CS,D |
| Romania | 2,040 | 40 | 42 | 0.1% | 3 | 7% | -1,997 | -98% | T1 | D |
| Slovakia | 5,949 | 578 | 289 | 0.8% | -289 | -50% | -5,660 | -95% | T2 | CS |
| Slovenia | 338 | NO | NO | - | - | - | -338 | -100% | NA | NA |
| **EU-27** | **139,840** | **39,546** | **35,490** | **100.0%** | **-4,057** | **-10%** | **-104,350** | **-75%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

**Table 18.44 1A4b Residential, gaseous fuels: $CO_2$ emissions of EU-27**

| Member State | $CO_2$ emissions in Gg | | | Share in EU27 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| EU-15 | 161,940 | 235,299 | 221,620 | 88.6% | -13,680 | -6% | 59,679 | 37% | | |
| Bulgaria | NO | 56 | 75 | 0.0% | 19 | 34% | 75 | - | T2 | CS |
| Cyprus | NO | NO | NO | - | - | - | - | - | NO | NO |
| Czech Republic | 2,746 | 5,318 | 4,758 | 1.9% | -559 | -11% | 2,012 | 73% | T1 | D |
| Estonia | 116 | 104 | 111 | 0.0% | 7 | 7% | -4 | -4% | T2 | CS |
| Hungary | 3,937 | 8,516 | 7,932 | 3.2% | -585 | -7% | 3,995 | 101% | T1 | D |
| Latvia | 220 | 239 | 254 | 0.1% | 14 | 6% | 34 | 16% | T2 | CS |
| Lithuania | 526 | 334 | 351 | 0.1% | 17 | 5% | -175 | -33% | T2 | CR |
| Malta | 32 | 48 | 49 | 0.0% | 0 | 1% | 17 | 53% | D,T1 | D |
| Poland | 6,821 | 7,741 | 7,403 | 3.0% | -338 | -4% | 582 | 9% | T2 | D |
| Romania | 2,785 | 6,014 | 4,880 | 2.0% | -1,134 | -19% | 2,095 | 75% | T1 | D |
| Slovakia | 1,586 | 2,975 | 2,565 | 1.0% | -410 | -14% | 979 | 62% | T2 | CS |
| Slovenia | 25 | 219 | 196 | 0.1% | -22 | -10% | 171 | 686% | T1 | CS |
| **EU-27** | **180,733** | **266,864** | **250,194** | **100.0%** | **-16,670** | **-6%** | **69,461** | **38%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

**Figure 18.30 1A4b Residential, gaseous fuels: Activity Data and Implied Emission Factors for $CO_2$**

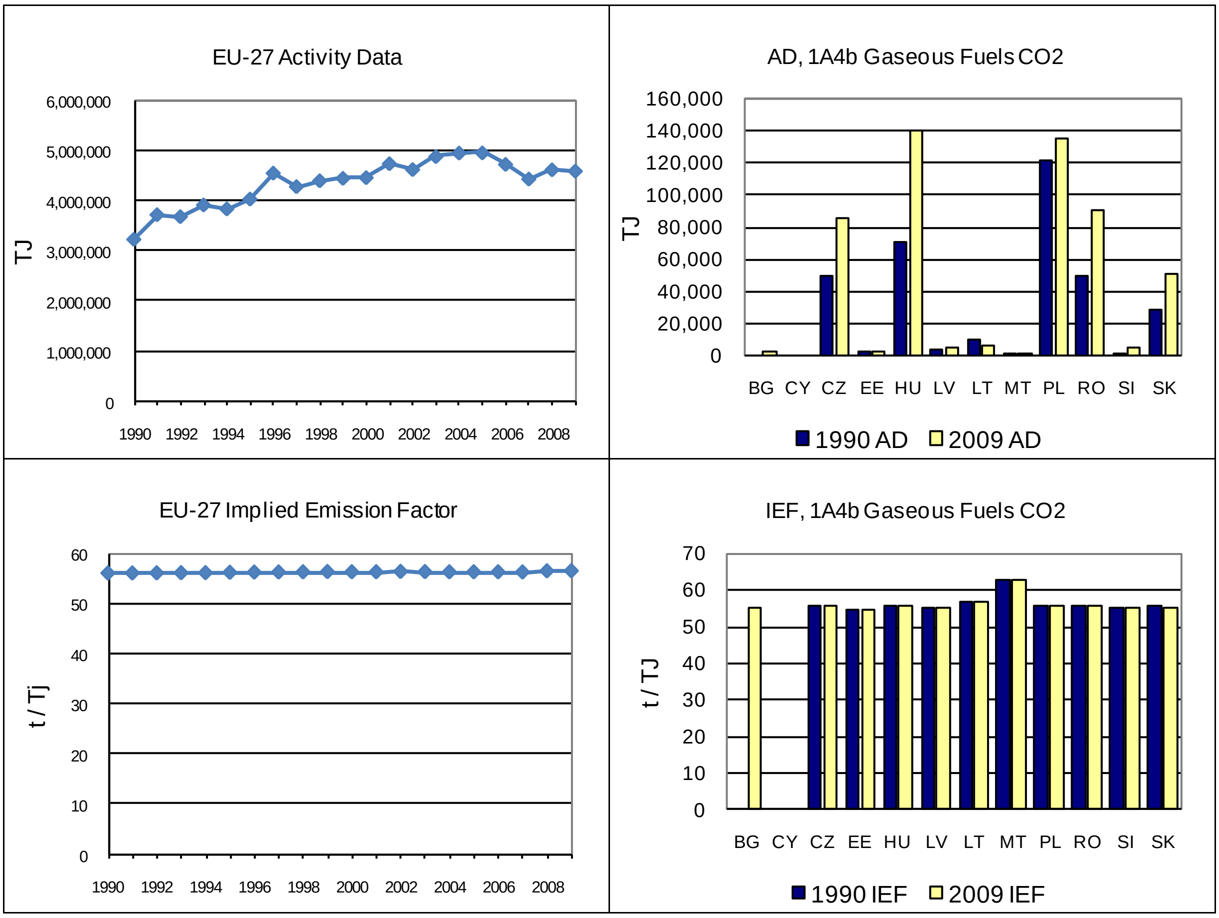



**Table 18.45 1A4b Residential, biomass: $CH_4$ emissions of EU-27**

| Member State | $CH_4$ emissions (Gg $CO_2$ equivalents) | | | Share in EU27 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | |
|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) |
| EU-15 | 5,924 | 4,248 | 4,165 | 63.2% | -83 | -2% | -1,760 | -30% |
| Bulgaria | 45 | 167 | 160 | 2.4% | -7 | -4% | 115 | 252% |
| Cyprus | NA | 1 | 1 | 0.0% | 0.68 | 117% | 1 | - |
| Czech Republic | 37 | 253 | 294 | 4.5% | 41 | 16% | 257 | 692% |
| Estonia | 6 | 13 | 17 | 0.3% | 3.94 | 31% | 11 | 197% |
| Hungary | 46 | 153 | 69 | 1.0% | -84 | -55% | 23 | 49% |
| Latvia | 126 | 197 | 192 | 2.9% | -5 | -2% | 66 | 52% |
| Lithuania | 57 | 114 | 106 | 1.6% | -8.03 | -7% | 49 | 86% |
| Malta | NA | NA | NA | - | - | - | - | - |
| Poland | 216 | 658 | 643 | 9.7% | -16 | -2% | 426 | 197% |
| Romania | 139 | 678 | 707 | 10.7% | 29 | 4% | 568 | 407% |
| Slovakia | 30 | 167 | 155 | 2.3% | -12 | -7% | 125 | 413% |
| Slovenia | 86 | 86 | 86 | 1.3% | 0.00 | 0% | 0.00 | 0% |
| **EU-27** | **6,713** | **6,733** | **6,593** | **100.0%** | **-141** | **-2%** | **-120** | **-2%** |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

### 18.2.4.3 Agriculture/Forestry/Fisheries (1A4c) (EU-27)

**Figure 18.31** **1A4c Agriculture/Forestry/Fisheries, $CO_2$ and $N_2O$ emission and activity trends**

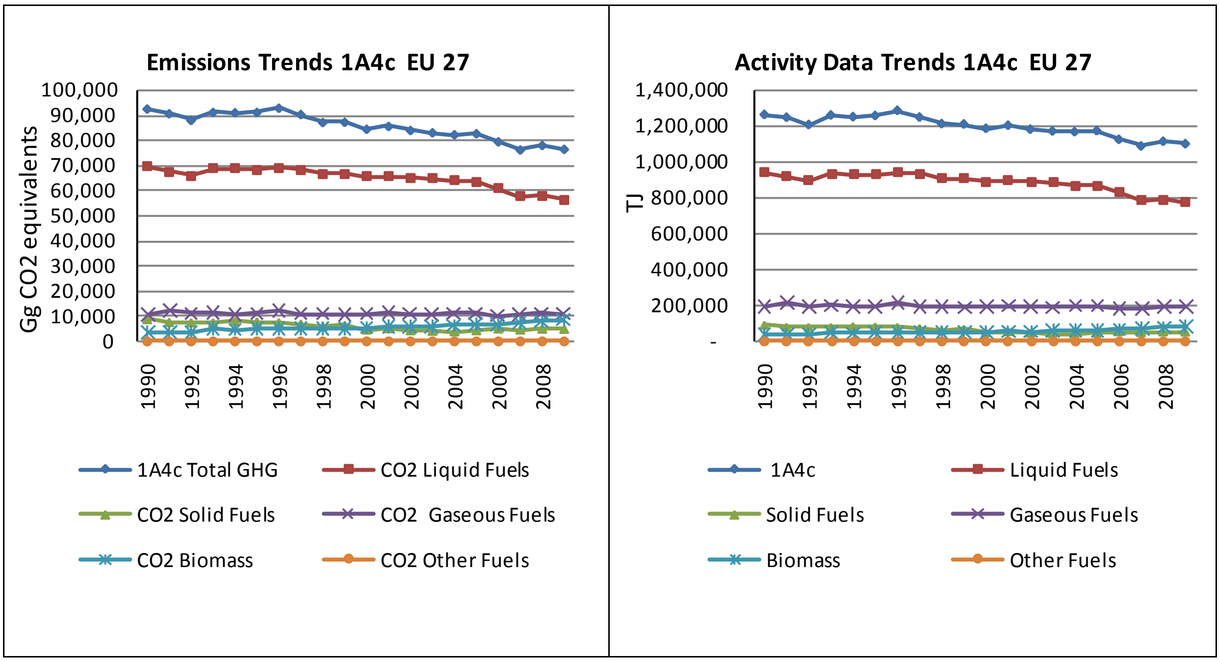



**Table 18.46** **1A4c Agriculture/Forestry/Fisheries, liquid fuels: $CO_2$ emissions of EU-27**

| Member State | $CO_2$ emissions in Gg | | | Share in EU27 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| EU-15 | 56,758 | 52,493 | 50,249 | 87.0% | -2,244 | -4% | -6,509 | -11% | | |
| Bulgaria | 1,482 | 728 | 629 | 1.1% | -99 | -14% | -854 | -58% | T1 | D |
| Cyprus | 32 | 64 | 59 | 0.1% | -5 | -8% | 27 | 84% | T1 | D |
| Czech Republic | 342 | 56 | 31 | 0.1% | -26 | -45% | -311 | -91% | T1 | D |
| Estonia | 477 | 184 | 194 | 0.3% | 10 | 5% | -283 | -59% | T1,T2 | CS,D |
| Hungary | 2,134 | 819 | 723 | 1.3% | -95 | -12% | -1,411 | -66% | T1 | D |
| Latvia | 694 | 336 | 336 | 0.6% | 0 | 0% | -358 | -52% | T1 | CS |
| Lithuania | 103 | 16 | 19 | 0.0% | 3 | 20% | -84 | -82% | T2 | D,CS |
| Malta | NE | 3 | 3 | 0.0% | 0 | -2% | 3 | - | D,T1 | D |
| Poland | 3,620 | 5,436 | 4,864 | 8.4% | -572 | -11% | 1,244 | 34% | T2 | D |
| Romania | 3,558 | 487 | 388 | 0.7% | -99 | -20% | -3,170 | -89% | T1 | D |
| Slovakia | 3 | 15 | 3 | 0.0% | -12 | -80% | 0 | 2% | T2 | CS |
| Slovenia | 329 | 229 | 228 | 0.4% | -1 | -1% | -101 | -31% | T1 | D |
| **EU-27** | **69,533** | **60,867** | **57,726** | **100.0%** | **-3,141** | **-5%** | **-11,807** | **-17%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

**Table 18.47 1A4c Agriculture/Forestry/Fisheries, solid fuels: $CO_2$ emissions of EU-27**

| Member State | $CO_2$ emissions in Gg | | | Share in EU27 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| EU-15 | 3,712 | 457 | 541 | 12.0% | 84 | 18% | -3,171 | -85% | | |
| Bulgaria | 147 | 24 | 32 | 0.7% | 8 | 33% | -115 | -78% | T2 | CS,D |
| Cyprus | NO | NO | NO | - | - | - | - | - | NO | NO |
| Czech Republic | 1,493 | 81 | 52 | 1.1% | -29 | -36% | -1,441 | -97% | T1 | CS |
| Estonia | 16 | 0 | 3 | 0.1% | 2 | 1886% | -14 | -84% | T1,T2 | CS,D |
| Hungary | 212 | 12 | 11 | 0.3% | -1 | -5% | -200 | -95% | T1 | D |
| Latvia | 95 | 5 | 5 | 0.1% | 0 | 0% | -90 | -95% | T1 | CS |
| Lithuania | 148 | 6 | 3 | 0.1% | -2 | -44% | -145 | -98% | T2 | CR,D |
| Malta | NE | NA | NA | - | - | - | - | - | NA | NA |
| Poland | 2,904 | 4,378 | 3,878 | 85.6% | -500 | -11% | 973 | 34% | T2 | CS,D |
| Romania | 69 | 1 | 0 | 0.01% | -1 | -76% | -68 | -100% | T1 | D |
| Slovakia | 1 | 5 | 3 | 0.1% | -1 | -31% | 2 | 132% | T2 | CS |
| Slovenia | NO | NO | NO | - | - | - | - | - | NA | NA |
| **EU-27** | **8,797** | **4,969** | **4,529** | **100.0%** | **-440** | **-9%** | **-4,269** | **-49%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

**Table 18.48 1A4c Agriculture/Forestry/Fisheries, gaseous fuels: $CO_2$ emissions of EU-27**

| Member State | $CO_2$ emissions in Gg | | | Share in EU27 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| EU-15 | 8,716 | 9,116 | 9,472 | 90.7% | 355 | 4% | 756 | 9% | | |
| Bulgaria | 3 | 74 | 75 | 0.7% | 1 | 1% | 71 | 2186% | T1 | D |
| Cyprus | NO | NO | NO | - | - | - | - | - | NO | NO |
| Czech Republic | 415 | 152 | 154 | 1.5% | 2 | 2% | -261 | -63% | T1 | D |
| Estonia | 4 | 0 | 1 | 0.0% | 0 | 240% | -3 | -82% | T2 | CS |
| Hungary | 627 | 453 | 355 | 3.4% | -98 | -22% | -272 | -43% | T1 | D |
| Latvia | 779 | 45 | 42 | 0.4% | -2 | -5% | -736 | -95% | T2 | CS |
| Lithuania | 168 | 90 | 94 | 0.9% | 4 | 5% | -74 | -44% | T2 | CR |
| Malta | NE | NA | NA | - | - | - | - | - | NA | NA |
| Poland | 25 | 83 | 103 | 1.0% | 19 | 23% | 78 | 311% | T2 | D |
| Romania | 73 | 70 | 59 | 0.6% | -11 | -15% | -13 | -18% | T1 | D |
| Slovakia | 41 | 90 | 84 | 0.8% | -6 | -6% | 43 | 106% | T2 | CS |
| Slovenia | NO | NO | NO | - | - | - | - | - | NA | NA |
| **EU-27** | **10,850** | **10,173** | **10,438** | **100.0%** | **266** | **3%** | **-411** | **-4%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

## 18.2.5 Other (CRF Source Category 1A5) (EU-27)

### 18.2.5.1 Stationary (1A5a) (EU-27)

**Table 18.49 1A5a Stationary, solid fuels: $CO_2$ emissions of EU-27**

| Member State | $CO_2$ emissions in Gg | | | Share in EU27 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| EU-15 | 4,667 | 19 | 12 | 62.1% | -7 | -35% | -4,654 | -100% | | |
| Bulgaria | 29 | NO | NO | - | - | - | -29 | -100% | NO | NO |
| Cyprus | NA | NA | NA | - | - | - | - | - | NO | NO |
| Czech Republic | NO | NO | NO | - | - | - | - | - | NA | NA |
| Estonia | NO | NO | NO | - | - | - | - | - | NO | NO |
| Hungary | NO | NO | NO | - | - | - | - | - | NA | NA |
| Latvia | NO | NO | NO | - | - | - | - | - | NA | NA |
| Lithuania | IE,NO | IE,NO | IE,NO | - | - | - | - | - | NO | NO |
| Malta | NA | NA | NA | - | - | - | - | - | NA | NA |
| Poland | IE | IE | IE | - | - | - | - | - | NO | NO |
| Romania | NE | NE | NE | - | - | - | - | - | NA | NA |
| Slovakia | 198 | 10 | 8 | 37.9% | -2 | -21% | -190 | -96% | T2 | CS |
| Slovenia | NA | NA | NA | - | - | - | - | - | NA | NA |
| **EU-27** | 4,894 | 29 | 20 | **100.0%** | **-9** | **-30%** | **-4,874** | **-100%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

### 18.2.5.2 Mobile (1A5b) (EU-27)

**Table 18.50 1A5b Mobile, liquid fuels: $CO_2$ emissions of EU-27**

| Member State | $CO_2$ emissions in Gg | | | Share in EU27 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| EU-15 | 13,672 | 5,697 | 5,559 | 82.6% | -138 | -2% | -8,113 | -59% | | |
| Bulgaria | NO | NO | NO | - | - | - | - | - | NO | NO |
| Cyprus | 17 | 28 | 29 | 0.4% | 1 | 4% | 12 | 70% | T1 | D |
| Czech Republic | 1,601 | 1,082 | 1,094 | 16.3% | 12 | 1% | -507 | -32% | T1 | D |
| Estonia | 44 | 32 | 31 | 0.5% | -1 | -3% | -13 | -30% | T2 | CS |
| Hungary | NO | NO | NO | - | - | - | - | - | NA | NA |
| Latvia | NO | 9 | 4 | 0.1% | -5 | -53% | 4 | - | T1,T2 | CS,D |
| Lithuania | NE,NO | 12 | 15 | 0.2% | 4 | 33% | 15 | - | T1 | CS |
| Malta | NA | NA | NA | - | - | - | - | - | NA | NA |
| Poland | NO | NO | NO | - | - | - | - | - | NO | NO |
| Romania | NA | NA | NA | - | - | - | - | - | NA | NA |
| Slovakia | NA | NA | NA | - | - | - | - | - | NA | NA |
| Slovenia | NA | NA | NA | - | 0.00 | - | 0.00 | - | T1 | D |
| **EU-27** | **15,334** | **6,859** | **6,733** | **100.0%** | **-127** | **-2%** | **-8,601** | **-56%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

## 18.2.6 *Fugitive emissions from fuels (CRF Source Category 1.B) (EU-27)*

### 18.2.6.1 Fugitive emissions from Solid Fuels (1B1) (EU-27)

**Table 18.51 1B1a Coal Mining: $CH_4$ emissions of EU-27**

| Member State | $CH_4$ emissions (Gg $CO_2$ equivalents) | | | Share in EU27 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| EU-15 | 44,022 | 8,613 | 7,619 | 32.7% | -994 | -12% | -36,402 | -83% | | |
| Bulgaria | 1,555 | 1,440 | 1,357 | 5.8% | -84 | -6% | -198 | -13% | T1 | D |
| Cyprus | NO | NO | NO | - | - | - | - | - | NO | NO |
| Czech Republic | 7,600 | 4,459 | 4,011 | 17.2% | -449 | -10% | -3,589 | -47% | T2 | CS |
| Estonia | NO | NO | NO | - | - | - | - | - | NO | NO |
| Hungary | 659 | 20 | 14 | 0.1% | -6 | -30% | -645 | -98% | NA | NA |
| Latvia | NO | NO | NO | - | - | - | - | - | NA | NA |
| Lithuania | NO | NO | NO | - | - | - | - | - | NO | NO |
| Malta | NA | NA | NA | - | - | - | - | - | NA | NA |
| Poland | 13,092 | 8,047 | 7,282 | 31.2% | -765 | -10% | -5,810 | -44% | CS | CS |
| Romania | 3,661 | 2,711 | 2,433 | 10.4% | -278 | -10% | -1,228 | -34% | T1 | D |
| Slovakia | 571 | 335 | 355 | 1.5% | 20 | 6% | -216 | -38% | T2 | CS |
| Slovenia | 303 | 254 | 249 | 1.1% | -5.15 | -2% | -54 | -18% | T3 | CS |
| **EU-27** | **71,463** | **25,879** | **23,320** | **100.0%** | **-2,559** | **-10%** | **-48,142** | **-67%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

### 18.2.6.2 Fugitive emissions from oil and natural gas (1B2) (EU-27)

**Table 18.52 1B2a Fugitive $CO_2$ emissions from oil: $CO_2$ emissions of EU-27**

| Member State | $CO_2$ emissions in Gg | | | Share in EU27 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| EU-15 | 8,514 | 9,421 | 9,439 | 98.0% | 17 | 0% | 925 | 11% | | |
| Bulgaria | 1 | 0.32 | 0.34 | 0.0% | 0.01 | 4% | -0.47 | -58% | T1 | D |
| Cyprus | NA,NE,NO | NA,NE,NO | NA,NE,NO | - | - | - | - | - | NE | NE |
| Czech Republic | 0.02 | 0.08 | 0.07 | 0.0% | -0.01 | -9% | 0.05 | 270% | T1 | D |
| Estonia | NO | NO | NO | - | - | - | - | - | NO | NO |
| Hungary | IE,NO | IE,NO | IE,NO | - | - | - | - | - | NA | NA |
| Latvia | NO | NO | NO | - | - | - | - | - | NA | NA |
| Lithuania | 0.051 | 0.073 | 0.067 | 0.001% | -0.005 | -7% | 0.017 | 33% | T1 | D |
| Malta | NA,NE | NA,NE | NA,NE | - | - | - | - | - | NA | NA |
| Poland | 42 | 204 | 183 | 1.9% | -21 | -10% | 141 | 333% | T1 | CS,D |
| Romania | 22 | 13 | 13 | - | - | - | - | - | NA | NA3 |
| Slovakia | 0.0012 | 0.0005 | 0.0007 | 0.0% | 0.000217 | 44% | -0.000442 | -38% | T1 | CS |
| Slovenia | NO | NO | NO | - | - | - | - | - | NA | NA |
| **EU-27** | **8,579** | **9,639** | **9,635** | **100.0%** | **-4** | **0%** | **1,056** | **12%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

**Table 18.53 1B2b Fugitive $CH_4$ emissions from natural gas: $CH_4$ emissions of EU-27**

| Member State | $CH_4$ emissions (Gg $CO_2$ equivalents) | | | Share in EU27 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| EU-15 | 25,379 | 19,230 | 19,122 | 56.4% | -108 | -1% | -6,257 | -25% | | |
| Bulgaria | 726 | 539 | 343 | 1.0% | -197 | -36% | -384 | -53% | T1 | D |
| Cyprus | NO | NO | NO | - | - | - | - | - | NE | NE |
| Czech Republic | 878 | 623 | 666 | 2.0% | 42 | 7% | -212 | -24% | T2 | CS |
| Estonia | 787 | 494 | 334 | 1.0% | -161 | -33% | -454 | -58% | T1 | D |
| Hungary | 908 | 1,469 | 1,514 | 4.5% | 45 | 3% | 606 | 67% | D | OTH |
| Latvia | 236 | 106 | 100 | 0.3% | -7 | -6% | -137 | -58% | CS | PS |
| Lithuania | IE,NO | IE,NO | IE,NO | - | - | - | - | - | NO | NO |
| Malta | NA,NO | NA,NO | NA,NO | - | - | - | - | - | NA | NA |
| Poland | 3,076 | 4,343 | 4,256 | 12.6% | -87 | -2% | 1,179 | 38% | T1 | CS |
| Romania | 19,027 | 7,775 | 6,857 | 20.2% | -918 | -12% | -12,170 | -64% | T1 | D |
| Slovakia | 448 | 660 | 681 | 2.0% | 21 | 3% | 232 | 52% | T1 | CS |
| Slovenia | 58 | 31 | 29 | 0.1% | -1.47 | -5% | -28 | -49% | T1,T3 | CS,D |
| **EU-27** | **51,523** | **35,271** | **33,901** | **100.0%** | **-1,371** | **-4%** | **-17,623** | **-34%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

**Table 18.54 1B2c Fugitive $CO_2$ emissions from venting and flaring: $CO_2$ emissions of EU-27**

| Member State | $CO_2$ emissions in Gg | | | Share in EU27 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| EU-15 | 6,449 | 5,735 | 5,677 | 97.6% | -58 | -1% | -772 | -12% | | |
| Bulgaria | 4 | 17 | 2 | 0.0% | -14 | -85% | -2 | -38% | T1 | D |
| Cyprus | NO | NO | NO | - | - | - | - | - | NE | NE |
| Czech Republic | 4 | 18 | 17 | 0.3% | -1.58 | -9% | 13 | 340% | T1 | D |
| Estonia | NO | NO | NO | - | - | - | - | - | NO | NO |
| Hungary | 173 | 97 | 100 | 1.7% | 4 | 4% | -72 | -42% | D | D,PS |
| Latvia | NO | NO | NO | - | - | - | - | - | NA | NA |
| Lithuania | 1 | 10 | 9 | 0.2% | -1 | -10% | 8 | 875% | T1 | D |
| Malta | NA | NA | NA | - | - | - | - | - | NA | NA |
| Poland | 0 | 0 | 0 | 0.0% | -0.001 | -9% | 0.005 | 329% | T1 | D |
| Romania | 20 | 12 | 11 | - | - | - | - | - | NA | NA3 |
| Slovakia | 0.02 | 0.01 | 0.02 | 0.0% | 0.006 | 51% | 0.002 | 16% | T1 | CS |
| Slovenia | NO | NO | NO | - | - | - | - | - | NA | NA |
| **EU-27** | **6,650** | **5,889** | **5,817** | **100.0%** | **-72** | **-1%** | **-833** | **-13%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

## 18.3 Reference approach (new Member States)

**Table 18.55 Comparison between Eurostat and national reference approach for fuel combustion for the new MS (CRF 1.A) (47);**

| 2009 | Liquid fuels | | | Solid fuels | | | Gaseous fuels | | | Total fuels | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | National | Eurostat | Difference | National | Eurostat | Difference | National | Eurostat | Difference | National | Eurostat | Difference |
| | PJ | PJ | % | PJ | PJ | % | PJ | PJ | % | PJ | PJ | % |
| AT | 518 | 508 | 2% | 122 | 121 | 0% | 316 | 300 | 5% | 956 | 930 | 3% |
| BE | 971 | 982 | -1% | 136 | 126 | 8% | 634 | 633 | 0% | 1,742 | 1,741 | 0% |
| DK | 282 | 295 | -5% | 184 | 168 | 9% | 163 | 163 | 0% | 629 | 626 | 0% |
| FI | 376 | 391 | -4% | 226 | 218 | 3% | 146 | 146 | 0% | 748 | 755 | -1% |
| FR | 3,298 | 3,463 | -5% | 471 | 466 | 1% | 1,607 | 1,610 | 0% | 5,376 | 5,540 | -3% |
| DE | 4,314 | 4,415 | -2% | 3,023 | 2,999 | 1% | 2,944 | 3,206 | -8% | 10,281 | 10,620 | -3% |
| GR | 703 | 671 | 5% | 341 | 353 | -3% | 122 | 124 | -2% | 1,166 | 1,148 | 2% |
| IE | 305 | 298 | 2% | 89 | 90 | -2% | 180 | 179 | 1% | 574 | 568 | 1% |
| IT | 3,045 | 2,847 | 7% | 538 | 534 | 1% | 2,674 | 2,675 | 0% | 6,256 | 6,056 | 3% |
| LU | 98 | 97 | 1% | 4 | 3 | 32% | 47 | 47 | 0% | 149 | 146 | 1% |
| NL | 1,238 | 1,282 | -3% | 313 | 310 | 1% | 1,466 | 1,464 | 0% | 3,018 | 3,057 | -1% |
| PT | 493 | 482 | 2% | 120 | 120 | 0% | 177 | 177 | 0% | 789 | 779 | 1% |
| ES | 2,496 | 2,477 | 1% | 444 | 441 | 1% | 1,312 | 1,309 | 0% | 4,252 | 4,227 | 1% |
| SE | 535 | 499 | 7% | 76 | 81 | -5% | 46 | 51 | -10% | 657 | 630 | 4% |
| GB | 2,649 | 2,636 | 0% | 1,230 | 1,226 | 0% | 3,267 | 3,271 | 0% | 7,147 | 7,133 | 0.2% |
| EU15 | 21,321 | 21,344 | 0% | 7,316 | 7,258 | 1% | 15,102 | 15,356 | -2% | 43,740 | 43,958 | -0.5% |

**Table 18.56 Comparison between Eurostat and national reference approach for $CO_2$ from fuel combustion for the new MS (CRF 1.A);**

| 2009 | Liquid fuels | | | Solid fuels | | | Gaseous fuels | | | Total fuels | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | National | Eurostat | Difference | National | Eurostat | Difference | National | Eurostat | Difference | National | Eurostat | Difference |
| | PJ | PJ | % | PJ | PJ | % | PJ | PJ | % | PJ | PJ | % |
| EU15 | 21,321 | 21,344 | 0% | 7,316 | 7,258 | 1% | 15,102 | 15,356 | -2% | 43,740 | 43,958 | -0.5% |
| BG | 177 | 175 | 1% | 267 | 266 | 0% | 90 | 90 | 0% | 534 | 532 | 0.4% |
| CY | 100 | 100 | 0% | 1 | 1 | -10% | NA | - | - | 101 | 101 | 0.0% |
| CZ | 377 | 382 | -1% | 728 | 727 | 0% | 282 | 282 | 0% | 1,386 | 1,391 | -0.3% |
| EE | 20 | 36 | -46% | 127 | 128 | -1% | 21 | 22 | -3% | 168 | 186 | -10% |
| HU | 287 | 282 | 2% | 109 | 109 | 0% | 383 | 383 | 0% | 780 | 775 | 1% |
| LV | 50 | 50 | 1% | 4 | 4 | -1% | 51 | 51 | 0% | 105 | 105 | 1% |
| LT | 103 | 98 | 6% | 7 | 7 | 1% | 91 | 91 | 0% | 201 | 196 | 3% |
| MT | 35 | 31 | 14% | NA | - | - | NA | - | - | 36 | 31 | 17% |
| PL | 1,020 | 1,008 | 1% | 2,170 | 2,154 | 1% | 504 | 503 | 0% | 3,694 | 3,665 | 1% |
| RO | 406 | 366 | 11% | 310 | 316 | -2% | 446 | 444 | 0% | 1,161 | 1,126 | 3% |
| SK | 136 | 126 | 8% | 159 | 164 | -3% | 186 | 185 | 0% | 481 | 475 | 1% |
| SI | 109 | 108 | 1% | 58 | 60 | -2% | 35 | 35 | 0% | 202 | 202 | -0.2% |
| EU27 | 24,140 | 24,106 | 0% | 11,255 | 11,193 | 1% | 17,191 | 17,442 | -1% | 52,589 | 52,742 | -0.3% |

(47) Minus means that Member State-based estimates are lower than the Eurostat-based estimates.

# 19 INDUSTRIAL PROCESSES (CRF SECTOR 2)

## 19.1 Overview of sector (EU-27)

CRF Sector 2 Industrial Processes is the third largest sector contributing 7 % to total EU-27 GHG emissions in 2009. The most important GHGs from this sector are $CO_2$ (4 % of total GHG emissions), HFCs (2 %) and $N_2O$ (1 %). The emissions from this sector decreased by 30 % from 484 Tg in 1990 to 321 Tg in 2009 (Figure 19.1). In 2009, the emissions decreased by 17 % compared to 2008, as a consequence of the economic recession. Cement production dominates the trend until 1997. Factors for declining emissions in the early 1990s were low economic activity and cement imports from Eastern European countries. Between 1997 and 1999 the trend is dominated by reduction measures in the adipic acid production in Germany, France and the UK. In addition, between 1998 and 1999 large reductions were achieved in the UK due to reduction measures in HCFC production. The large decrease in 2009 mainly occurred in cement production and iron and steel production.

**Figure 19.1 CRF Sector 2 Industrial Processes: EU-27 GHG emissions for 1990–2008 in $CO_2$ equivalents (Tg)**

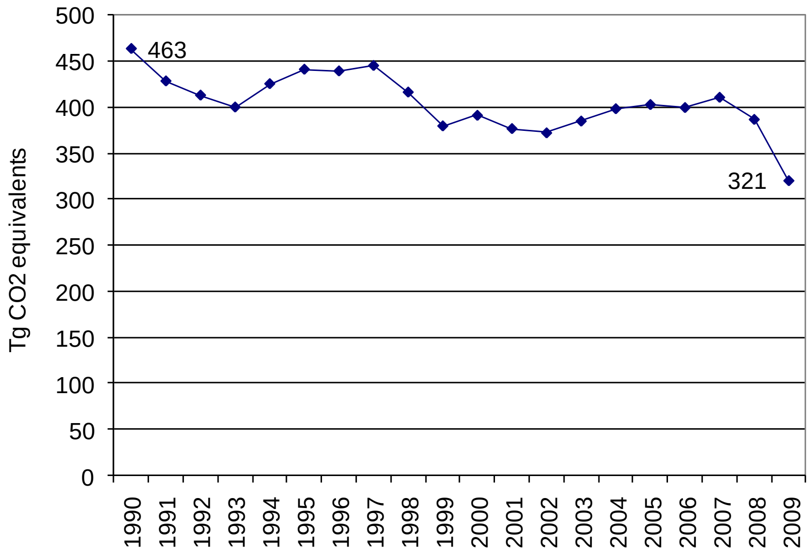
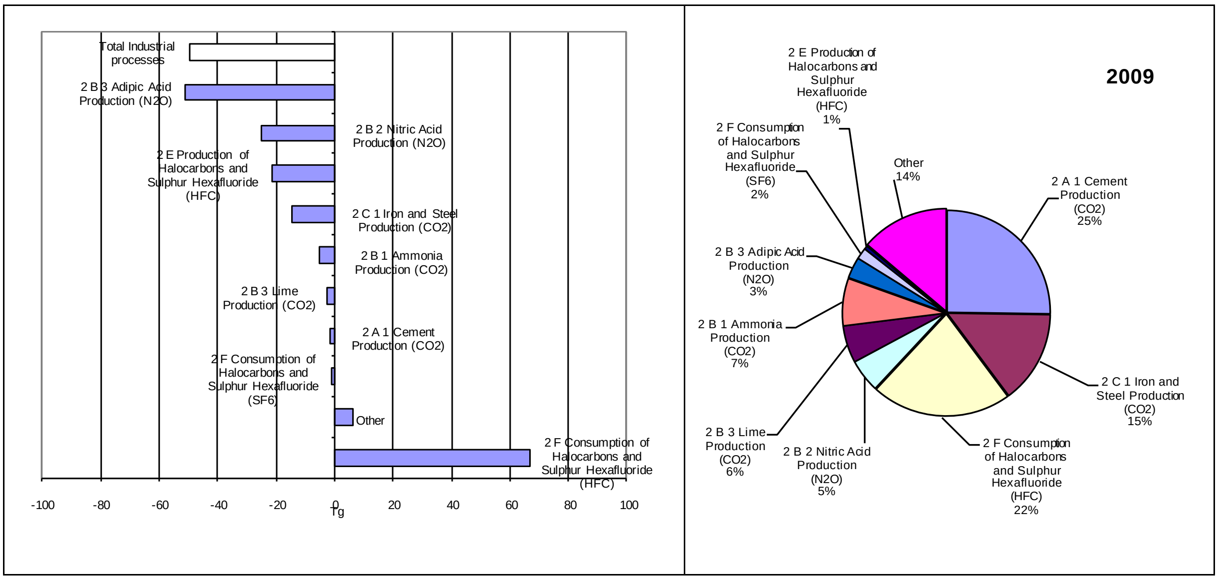



Figure 19.2 shows that large emission reductions occurred in adipic acid production ($N_2O$) mainly due to reduction measures in Germany, France, the UK and Italy, and in production of halocarbons and $SF_6$ (HFCs). Additional $N_2O$ emission reductions were achieved in nitric acid production. Large HFC emission increases can be observed from consumption of halocarbons and $SF_6$. The contribution of the new Member States to a possible change of the share in total process-related GHG emissions is small; again the three largest key sources account for about two thirds of total process-related GHG emissions in the EU-27 (Figure 19.2).

**Figure 19.2** **CRF Sector 2 Industrial processes: Absolute change of GHG emissions by large key source categories 1990–2009 in $CO_2$ equivalents (Tg) and share of largest key source categories in 2009**




## 19.2 Source categories (EU-27)

### 19.2.1 Mineral products (CRF Source Category 2A) (EU-27)

The source category 2A Mineral Products includes three key sources: $CO_2$ from 2A1 Cement Production, $CO_2$ from 2A2 Lime Production and $CO_2$ from 2A3 Limestone and Dolomite Use. In source category 2A1 Cement Production by-product $CO_2$ emissions in cement production are reported that occur during the production of clinker, an intermediate component in the cement manufacturing process. Source category 2A2 Lime Production accounts for $CO_2$ emitted through the calcination of the calcium carbonate in limestone or dolomite for lime production. Source category 2A3 Limestone and Dolomite Use covers a number of industrial applications generating $CO_2$ through the heating of limestone or dolomite, such as in metallurgy (iron and steel), glass manufacture, agriculture, construction or environmental pollution control.

#### 19.2.1.1 2A1 Cement Production

In 2009, $CO_2$ emissions from 2A1 Cement production were 20 % below 1990 levels in the EU-27; for the EU-15 the decrease of $CO_2$ emissions from Cement production was -18 % during 1990 and 2009. $CO_2$ emissions decreased by 19 % during 2008 and 2009 in the EU-27 (-17 % in EU-15). In this period, all new Member States decreased their emissions from cement production, except for Latvia. In this MS a new cement production plant started its operation in 2009. This cement production plant was erected during the economical development period and has a threefold maximum capacity compared to the already existing plant. Furthermore, both plants were operating in 2009.

Table 19.1 provides information on emission trends of the key source $CO_2$ from 2A1 Cement Production for EU-12. Among the new Member States Poland and Romania are the largest emitters accounting for 11 % of EU-27 emissions, followed by the Czech Republic (2 %).

Romania and Lithuania had large reductions in absolute terms between 1990 and 2009. The largest drop in Romanian emissions occurred in 2008-2009, where the production of clinker decreased by 25 %. In the early nineties a significant decrease in Lithuanian emissions (-95 % during 1990 and 1993) was caused by a decrease of the production rate of clinker due to economic changes. The large drop in emissions in Bulgaria was caused by a significant reduction of clinker production – about -75 % in one of the plants, more than -50 % in other two plants and around -20% in the last two plants.

**Table 19.1 2A1 Cement production: $CO_2$ emissions of EU-27**

| Member State | $CO_2$ emissions in Gg | | | Share in EU27 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| EU-15 | 80,174 | 79,401 | 65,523 | 81.0% | -13,878 | -17% | -14,651 | -18% | | |
| Bulgaria | 2,100 | 1,862 | 1,000 | 1.2% | -863 | -46% | -1,101 | -52% | T2 | PS |
| Cyprus | 614 | 818 | 673 | 0.8% | -145 | -18% | 59 | 10% | T3 | CS |
| Czech Republic | 2,489 | 1,996 | 1,566 | 1.9% | -430 | -22% | -923 | -37% | T3 | PS |
| Estonia | 483 | 603 | 257 | 0.3% | -346 | -57% | -226 | -47% | T2 | PS |
| Hungary | 1,797 | 1,261 | 973 | 1.2% | -288 | -23% | -825 | -46% | T2 | PS |
| Latvia | 366 | 168 | 179 | 0.2% | 11 | 7% | -187 | -51% | T2 | PS |
| Lithuania | 1,668 | 454 | 287 | 0.4% | -167 | -37% | -1,381 | -83% | T2 | PS |
| Malta | NO | NO | NO | - | - | - | - | - | NA | NA |
| Poland | 5,453 | 6,693 | 5,757 | 7.1% | -936 | -14% | 304 | 6% | T1 | CS |
| Romania | 4,416 | 4,143 | 3,093 | 3.8% | -1,050 | -25% | -1,323 | -30% | CS,T2 | PS |
| Slovakia | 1,438 | 1,582 | 1,199 | 1.5% | -383 | -24% | -239 | -17% | T3 | PS |
| Slovenia | 482 | 608 | 433 | 0.5% | -175 | -29% | -49 | -10% | T2 | CS |
| **EU-27** | **101,481** | **99,588** | **80,939** | **100.0%** | **-18,649** | **-19%** | **-20,541** | **-20%** | | |

Table 19.2 shows information on methods applied, activity data, emission factors for $CO_2$ emissions from 2A1 Cement production in the new Member States for 1990 and 2009. The table shows that all EU-12 MS use clinker production as activity data for calculating $CO_2$ emissions and it also suggests that almost 63 % of EU-12 emissions are estimated with higher Tier methods.

The EU-27 IEF (excluding UK, as the British activity data is confidential and thus no IEF is provided) in 2009 is 0.53 t $CO_2$/t of clinker produced. The implied emission factors per tonne of clinker produced vary slightly from 0.51 t $CO_2$/t for Slovakia to 0.55 t $CO_2$/t for Lithuania; all new MS use country-specific and plant-specific emission factors. No significant changes of IEFs during 1990 and 2009 could be observed for any MS. Only for Hungary a decline of IEF during 1990 and 2009 could be found (-8 %). Explanations for changes of the implied emission factors are given in the following overview:

***Implied Emission Factor, Hungary***

- *The decrease of IEF from 2002 onwards reflects the dependency on the used limestone and produced clinker quality volume.*

**Table 19.2** **2A1 Cement Production: Information on methods applied and emission factors for $CO_2$ emissions**

| Member State | Method applied | Emission factor | 1990 | | | | 2009 | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Activity data | | Implied emission factor (t/t) | $CO_2$ emissions (Gg) | Activity data | | Implied emission factor (t/t) | $CO_2$ emissions (Gg) |
| | | | Description | (kt) | | | Description | (kt) | | |
| EU15 | | | EU15 w/o UK (91%) | 136839 | 0.53 | 72878 | EU15 w/o UK (94%) | 116537 | 0.53 | 61802 |
| Bulgaria | T2 | PS | Clinker production | 3987 | 0.53 | 2100 | Clinker production | 1859 | 0.54 | 1000 |
| Cyprus | T3 | CS | Clinker production | 1140 | 0.54 | 614 | Clinker production | 1264 | 0.53 | 673 |
| Czech | T3 | PS | Clinker production | 4726 | 0.53 | 2489 | Clinker production | 2923 | 0.54 | 1566 |
| Estonia | T2 | PS | Clinker production | 910 | 0.53 | 483 | Clinker production | 477 | 0.54 | 257 |
| Hungary | T2 | PS | Clinker production | 3210 | 0.56 | 1797 | Clinker production | 1883 | 0.52 | 973 |
| Lithuania | T2 | PS | Clinker production | 3058 | 0.55 | 1668 | Clinker production | 522 | 0.55 | 287 |
| Latvia | T2 | PS | Clinker production | 669 | 0.55 | 366 | Clinker production | 341 | 0.52 | 179 |
| Malta | NA | NA | | NO | NO | NO | | NO | NO | NO |
| Poland | T1 | CS | Clinker production | 10309 | 0.53 | 5453 | Clinker production | 10659 | 0.54 | 5757 |
| Romania | CS,T2 | PS | Clinker production | 8379 | 0.53 | 4416 | Clinker production | 5802 | 0.53 | 3093 |
| Slovenia | T2 | CS | Clinker production | 891 | 0.54 | 482 | Clinker production | 801 | 0.54 | 433 |
| Slovakia | T3 | PS | Clinker production | 2836 | 0.51 | 1438 | Clinker production | 2348 | 0.51 | 1199 |
| **EU27** | | | **EU27 w/o UK (93%)** | **176,953** | **0.53** | **94,186** | **EU27 w/o UK (95%)** | **145,416** | **0.53** | **77,219** |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

Table 19.3 summarizes the methodological information for cement production provided by EU-12 Member States in their national inventory reports. The majority of the new Member States uses data collected from plants under the EU emission trading scheme (Bulgaria, Cyprus, the Czech Republic, Hungary Poland, Slovakia and Slovenia).

**Table 19.3 2A1 Cement Production: Summary of methodological information provided by Member States**

| Cement Production new MS | |
|---|---|
| **Member State** | **Methodology comment** |
| **Bulgaria** | The GHG emissions from the sector are calculated by using a clinker production data and a country specific method, similar to a Tier 2 Method according to item 3.1.1 from the IPCC GPG. The aggregated national clinker production (CP) data in t/y are provided by the NSI. The 2009 CO2 emissions are taken from the operators EU ETS reports. The aggregated national clinker production (CP) data provided by the NSI and plants cover the period from 1988 to 2009. [NIR 2011] |
| **Cyprus** | Emissions factors used for the estimation of CO2 from cement and ceramics have been obtained by the ETS reports submitted by the industries for 2005-2009. [NIR 2011] |
| **Czech Republic** | CO2 emissions from 2A1 Cement production can be calculated according to the 2000 GPG from the production of cement (Tier 1) or clinker (Tier 2). New IPCC Guidelines (IPCC, 2006) describes a new approach based on direct data from individual operators of cement kilns (Tier 3). Since 2006 submission methodology equal to the Tier 3 has been employed. CO2 emissions are based on data submitted by the cement kiln operators for preparation and standard operation of the EU ETS system, which includes all the cement kilns in Czech Republic. Information from individual kilns is reported to the competent authority. This data covers years 1990, 1996, 1998 - 2002 and 2005 - 2009. For other years the EF was extrapolated. Data on cement clinker production is published by the Czech Cement Association (CCA) (CCA, 2009), which associates all Czech cement producers. Clinker production data together with extrapolated EF was used for years without direct data from cement kiln operators. IEF, which is calculated based on CO2 emissions and clinker production, varies from 0.5267 to 0.5534 t CO2 / t clinker. [NIR 2011] |
| **Estonia** | Emissions from cement production were calculated using Tier 2 methodology. Emission factors used in calculating the emissions from cement production are plant-specific provided by the industry. In calculating the emissions from cement production the amount of clinker produced annually is used as activity data. The clinker production data was received directly from the plant - AS Kunda Nordic Cement – throughout the time series. Data on the cement kiln dust was also provided by the plant. [NIR 2011] |
| **Hungary** | Emissions were estimated using a country specific method similar to the IPPC Tier 2 methodology. In 2009 four factories were operating in Hungary. Production data for the whole time series were obtained directly from the factories and from the EU Emission Trading System (ETS). The reported quantities of CO2 emitted between 2005 and 2009 are based on reports of the factories. For the preceding years, raw material consumption was used for emission calculation instead of cement or clinker production. [NIR 2011] |
| **Latvia** | Tier1 method from IPCC GPG 2000 was used to estimate clinker production data from final cement production amount when clinker / cement ratio for different types of cement is known. For CO2 emission factor as well as emission estimations IPCC GPG 2000 Tier2 method is used. CO2 emission factor is calculated for all years in time series 1990–2009 according to CaO content in used limestone that is measured in laboratory of cement production facility. The produced clinker is not weighed in cement production plant but clinker production is estimated from final cement type by multiplying it with cement/clinker ration according to cement producer GHG report.[NIR 2011] |
| **Lithuania** | Cement is produced in a single company UAB "Akmenes Cementas". CO2 emission was calculated by Tier 2 method using specific production data provided by the production company. CO2 emissions were calculated from material mass balance assuming that all carbon contained in raw materials (limestone) was released to the atmosphere as CO2. Actual CO2 emission was calculated from the data on clinker production and composition In addition it was assumed that CO2 was released from calcinated fraction of kiln dust. The data on MgO content in clinker were available only for the period 2000 to 2009. The data on generation of cement kiln dust (CKD) (fraction not recycled to the kiln) were provided only for 2005-2009. Average value was used for the period when specific data were not available. According to the UAB "Akmenes Cementas", only about 5% of the CKD is calcinated.[NIR 2011] |
| **Malta** | Not occuring. |
| **Poland** | CO2 emission from clinker production is the sum of the process emissions given in the verified reports for 2009 for installation of clinker production, which participate in the EU ETS [KASHUE 2010]. Data on clinker production for the entire inventoried period was taken from [GUS 1989b-2010b]. CO2 emission from clinker production was taken from the verified reports for the years: 2005-2009 for installations which participate in EU ETS. For other years emissions were estimated based on clinker production and emission factors. [NIR 2011] |
| **Romania** | The method for calculating emissions of CO2 from cement is in line with the IPCC GPG 2000 (Tier 2). The AD necessary to estimate emissions from this source category are provided by economic agents (clinker production data) and National Institute for Statistics (cement production). For the period 1989-2007 Romania cement industry has monitored its CO2 emissions compliance with the CO2 Protocol developed by WBCSD (World Business Council for Sustainable Development). According with this Protocol the EF used is 0.525 t CO2/t clinker; the same EF was recommended within the IPCC Methodology.Starting with 2008, analyses have been made for CaO and MgO content and can be considered as representative in order to be used for calculating CO2 emissions or plant specific clinker EF. CO2 emissions from clinker are estimated using a combined Tier 2 with country specific method. [NIR 2011] |
| **Slovak Republic** | In the Slovak Statistical Yearbook only mass of produced Portland cement and Portland cement clinker are published. The cement plants in the Slovak Republic (4 plants), where cement clink is produced, are included into the ETS and the verification reports from the ETS were used for CO2 emission inventory. Production of cement from clink is based on milling the clink with solid additives. Therefore it is meaningful to balance only clink production. On the basis of the information provided into the verified ETS reports, Tier 3 methodology according to the IPCC 2006 Guidelines has been applied since 2002 based on plant specific information. The calculations provided by the cement clinker producers in the ETS reports balanced CO2 emissions on the basis of cement clink production and CaO and MgO contents.<br><br>The Faculty of Chemical and Food Technology of the Slovak Technical University has taken the responsibility for the preparation of emission balance according to the instructions of IPCC methodology and Good Practice Guidance 2000. The information was obtained also from other sources (the Statistical Office of the Slovak Republic, the Ministry of Economy, the Union of Slovak Chemical Industry, plant operators, producers, etc). The ETS reports elaborated directly from the sources included in the National Allocation Plans (I and II) have been the most important sources of activity data since 2005. [NIR 2011] |
| **Slovenia** | The Tier 2 method has been applied. Activity data are data on the annual production of clinker. Clinker production data were obtained from the Statistical Office of the Republic of Slovenia for the period 1986–1998, and directly from the two plants that produce cement for the years 1999–2008. EFs from both before and after 2005 based on plant specific production conditions. There are two producers of cement in Slovenia and the data for both periods were obtained from these two cement works. The same sources of raw material and methodology were used for calculation both before and after 2005 EFs. To calculate emissions from cement production after 2005 we have been using data obtained by EU ETS. Data on clinker production and plant specific emission factors for both cement factories have been annually verified by independent verifiers. [NIR 2011] |

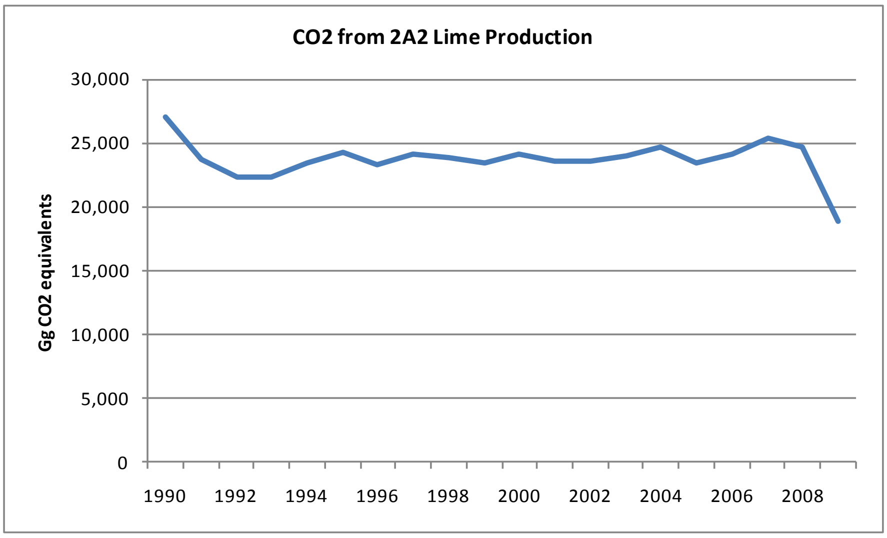
*Source: NIR 2011.*

### 19.2.1.2 2A2 Lime Production

$CO_2$ emissions from 2A2 Lime Production account for 0.41 % of EU-27 total GHG emissions in 2009. Between 1990 and 2009, $CO_2$ emissions from this source decreased by 30 % in the EU-27, and in the EU-15 emissions decreased by 20 % in the same period, thus emphasizing the large emission reductions in the new Member States (Table 19.4).

Romania and Poland are the largest emitters accounting for 15 % of EU-27 emissions, followed by Bulgaria (3 %). The decrease of $CO_2$ emissions between 1990 and 2009 was mainly caused by reductions during 1990 and 1993 (-17%) occurring in Bulgaria (-66%), the Czech Republic (-42 %), Hungary (-43 %), Romania (-35 %) and Slovenia (-51 %), due to a decreased production of lime and dolomite in that period (Figure 4.3).

**Figure 19.3 2A2 Lime Production: EU-27 $CO_2$ emissions**




An increase of $CO_2$ emissions from lime production between 1990 and 2009 could only be found for Cyprus. Nevertheless this offset does not contribute to the emission trend due to the negligible share of Cyprus in EU-27 emissions (Table 19.4). Largest emission reductions in absolute terms during 2008 and 2009 could be found for Romania, where a significant decrease of lime production starting with the economic crisis could be observed. In relative terms $CO_2$ emissions decreased mostly in Lithuania in that time period. Data provided by the Statistics Lithuania showed a strong influence of the economic crisis and contraction of construction activities.

The table suggests that about 30 % of EU-12 $CO_2$ emissions from 2A2 Lime Production are estimated with higher Tier methods.

**Table 19.4** **2A2 Lime Production: $CO_2$ emissions of EU-27**

| Member State | $CO_2$ emissions in Gg | | | Share in EU27 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| EU-15 | 17,194 | 17,358 | 13,784 | 72.8% | -3,573 | -21% | -3,409 | -20% | | |
| Bulgaria | 1,035 | 1,007 | 641 | 3.4% | -366 | -36% | -395 | -38% | T2 | D |
| Cyprus | 4 | 10 | 8 | 0.0% | -2 | -18% | 5 | 126% | T1 | D |
| Czech Republic | 1,337 | 742 | 625 | 3.3% | -117 | -16% | -711 | -53% | T1 | CS |
| Estonia | 131 | 25 | 16 | 0.1% | -9 | -37% | -115 | -88% | T1 | PS |
| Hungary | 653 | 318 | 206 | 1.1% | -113 | -35% | -447 | -68% | D,T2 | D |
| Latvia | 8 | 12 | 7 | 0.0% | -5 | -40% | -1 | -15% | T1 | D |
| Lithuania | 216 | 40 | 4 | 0.0% | -36 | -89% | -212 | -98% | T1 | D |
| Malta | NE | NO | NO | - | - | - | - | - | NA | NA |
| Poland | 2,453 | 1,496 | 1,315 | 6.9% | -181 | -12% | -1,138 | -46% | T1 | D |
| Romania | 3,080 | 2,662 | 1,566 | 8.3% | -1,096 | -41% | -1,514 | -49% | D | D |
| Slovakia | 770 | 860 | 689 | 3.6% | -171 | -20% | -81 | -11% | T3 | PS |
| Slovenia | 206 | 110 | 71 | 0.4% | -39 | -35% | -135 | -66% | D | CS |
| **EU-27** | **27,087** | **24,641** | **18,933** | **100.0%** | **-5,707** | **-23%** | **-8,154** | **-30%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

Table 19.3 summarizes the methodological information for lime production provided by EU-12 Member States in their national inventory reports. Latvia, Slovenia and Slovakia included an explicit reference to the use of plant-specific data under the EU ETS

**Table 19.5 2A2 Lime Production: Summary of methodological information provided by Member States**

| Lime Production new MS | |
|---|---|
| **Member State** | **Methodology comment** |
| **Bulgaria** | The emissions from the sector are calculated using country specific data on the total amount of lime produced provided by NSI. Default emission factor is applied. The emissions are estimated following the general approach recommended in 1996 IPCC Guidelines and using the following equation from 2000 GPG (p.3.19). Country specific data on the total lime production (quicklime) are provided by NSI. [NIR 2011] |
| **Cyprus** | The emission factor for lime production is the same as used in previous submissions. [NIR 2011] |
| **Czech Republic** | Emissions from lime production were calculated in accordance with 2000 GPG. Only CO2 emissions generated in the process of the calcination step of lime treatment are considered under category 2A2. CO2 emissions from combustion processes (heating of kilns and furnaces) are reported under category 1A2f. National EF reflects the production of lime and quick lime (0.7884 t CO2 / t lime) (Vácha, 2004). Activity data are based on statistics from the Czech Lime Association (CLA, 2009), which publishes data on pure lime production, so that these data were considered to be more accurate in comparison with data from the Czech Statistical Office, which do not differentiate between lime and hydrated lime. [NIR 2011] |
| **Estonia** | Emissions from lime production are calculated by multiplying emission factors with activity data. Activity data are collected mainly directly from the industry but in the earlier years (1990–1996) industrial statistics have also been used. Emission factors are calculated by the industry or are based on IPCC's default factors. The methods for calculating emissions from lime production are consistent with the IPCC Tier 1 level method. [NIR 2011] |
| **Hungary** | The amount of CO2 generated by this sub-sector was calculated according to the method recommended by the Revised Guidelines. The emissions were calculated using the production data received from the manufacturers and the proper stoichiometric ratio (0.785). Naturally, the corresponding stoichiometric ratio was used for slack lime (Ca(OH)2) production data as well. [NIR 2011] |
| **Latvia** | CO2 emissions from lime production in steel production plant are estimated with Tier1 method based on total produced quicklime data and default emission factor. Default CO2 emission factor from IPCC GPG was used by steel production plant as per tonne of high calcium quicklime – 0.785 tCO2/t lime. Activity data of produced lime in steel production company is taken from plant's GHG reports within ETS. [NIR 2011] |
| **Lithuania** | The data on lime production were provided by the Statistics Lithuania. The data on hydrated lime production are provided by the Statistics Lithuania from 2002. Actual hydrated lime production data were used for emission calculation in 2002-2009 and it was assumed that hydrated lime production was zero in 1990 to 2001. CO2 emission was calculated by Tier 2 method using production data provided by the Statistics Lithuania and limestone composition data provided by the AB "Naujasis Kalcitas". CO2 emissions were calculated from material mass balance assuming that all carbon contained in raw materials (limestone) was released to the atmosphere as CO2. [NIR 2011] |
| **Malta** | Lime production was commonplace in Malta in the past. Nowadays the industry has stopped operating and any lime used in Malta is imported. The activity data utilised (quantity of lime produced) was compiled by Gauci [5] from data provided by the National Office of Statistics. The CO2 emissions from this activity during the period 1995-1998 have been reported. For the years 1990 till 1994 no emissions have been reported, since at the time only two lime production plants were operational and hence the quantities of lime produced were confidential data and were not available at the National Statistics Office. For the local scenario, an emission factor of 712kg CO2 per tonne of quicklime produced has been applied.[NIR 2011] |
| **Poland** | Emission of CO2 from lime production was calculated based on data on lime production from [GUS 2010b]. The applied emission factor is estimated according to IPCC recomendations [IPCC 2000]. Emission for entire period 1988-2009 was estimated based on emission factors. Data about production was taken from statistical yearbooks [GUS 1989b-2010b] (figure 4.2.4). The same value of emission factor equal 767 kg CO2/Mg of lime was used for all years. [NIR 2011] |
| **Romania** | Total CO2 emissions from lime production were estimated using production data and the emission factors, in line with the Good Practice Guidance - IPCC GPG 2000. The ADs necessary to estimate emissions from this source category (quicklime and dolomite lime) are provided by the National Statistics. The data set in case of dolomite lime production is not complete; the data for 1989-1991 are missing. A linear extrapolation was used to estimate dolomite lime production for 1989-1991 in order to complete the time series. [NIR 2011] |
| **Slovak Republic** | Tier 3 according to the IPCC 2006 GL has been applied since 2003 with the combination of plant specific activity data and emission factors estimated for each plant. The calculations provided by the lime producers in the ETS reports balanced CO2 emissions on the basis of raw material used for production (Calmit lime plant) or produced lime (other lime plants) and CaCO3 and MgCO3 contents (Calmit lime plant) and CaO and MgO contents (other lime plants). The emission factor of CO2 using the data on the purity of lime is 0.752 t CO2/t of lime. [NIR 2011] |
| **Slovenia** | CO2 emission was calculated according to IPCC methodology. The EFs for lime production for the period 2005-2009 are based on EU ETS data, whereas for the period 1986 -1989 the average EF for 1999-2004 was applied. Upon ERT recommendation year-specific EFs were used for the period 1999 -2004 instead of average EF. The EFs for the years 2005-2009 were derived from emissions and activity data on annual production of quicklime reported under EU ETS scheme. Similar to cement production, for allocation plan purposes more detailed data directly from producers for 1999 -2004 were obtained. Data on fraction of CaO and MgO in lime for the period 1999-2004 enabled us to determine our own emission factor. [NIR 2011] |

*Source: NIR 2011.*

### 19.2.1.3 2A3 Limestone and Dolomite Use

$CO_2$ emissions from 2A3 Limestone and Dolomite Use account for 0.18 % of total EU-27 GHG emissions in 2009. Between 1990 and 2009, $CO_2$ emissions in the EU-27 decreased by 17 %. The increase of emissions in five new Member States (Poland, the Czech Republic, Slovenia, Slovakia and Hungary) offset emission reductions achieved in EU-15 MS by 8 % (Table 19.6). The Czech Republic and Poland were responsible for 20 % of the emissions from this source, followed by Romania with 5 %.

Emission reductions of more than 80 % during 1990 and 2008 occurred in some MS (Lithuania, Latvia) but due to their low share in EU-27 emissions (0.0 % and 0.2 %, respectively), no significant effect could be observed. Due to Romanian share of 5 % in EU-27 emissions in 2009, decreases in Romania significantly contributed to the overall reduction (highest reduction in absolute terms); the decline was due to a significant decrease of limestone and dolomite consumption level in 2008 and 2009. The low level of 2009 consumption was determined by the economic crisis. The changes of activity data contributed with 100 % to the change of the emission trends. In absolute terms Poland had the largest increase of emissions from 2A3. In this source category, the MS include limestone and dolomite used in sulphur removal installations in power industry which participated in EU ETS between 2005 and 2009. The rest of emissions from limestone and dolomite used was included into other categories where these minerals are used. Table 19.6 suggests that about 44 % of EU-12 $N_2O$ emissions from 2A3 Limestone and Dolomite Use are estimated with higher Tier methods for 2009 (Tier 2 and Tier 3).

**Table 19.6 2A3 Limestone and Dolomite Use: $CO_2$ emissions of EU-27**

| Member State | $CO_2$ emissions in Gg | | | Share in EU27 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| EU-15 | 7,444 | 7,644 | 5,598 | 69.0% | -2,046 | -27% | -1,847 | -25% | | |
| Bulgaria | IE | IE | IE | - | - | - | - | - | IE | IE |
| Cyprus | NA | NA | NA | - | - | - | - | - | NO | NO |
| Czech Republic | 678 | 1,017 | 945 | 11.6% | -72 | -7% | 267 | 39% | CS | CS |
| Estonia | IE | IE | IE | - | - | - | - | - | IE | IE |
| Hungary | 202 | 316 | 272 | 3.3% | -44 | -14% | 69 | 34% | D,T2 | D |
| Latvia | 141 | 21 | 17 | 0.2% | -3 | -16% | -124 | -88% | T2,T3 | D,PS |
| Lithuania | 4 | 0.5 | 0.2 | 0.0% | 0 | -57% | -4 | -96% | T2 | D |
| Malta | NO | NO | NO | - | - | - | - | - | NA | NA |
| Poland | NA | 635 | 707 | 8.7% | 72 | 11% | 707 | - | T3 | PS |
| Romania | 1,221 | 668 | 364 | 4.5% | -304 | -46% | -857 | -70% | OTH 1 | D |
| Slovakia | 42 | 149 | 119 | 1.5% | -30 | -20% | 77 | 184% | T3 | PS |
| Slovenia | 1 | 89 | 92 | 1.1% | 3 | 3% | 91 | 10937% | D | D |
| **EU-27** | **9,734** | **10,539** | **8,113** | **100.0%** | **-2,426** | **-23%** | **-1,620** | **-17%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*
*Emissions of Bulgaria are included in 2A1, 2A2, 2A7 (glass and FGD) and 2C1*
*Emissions of Estonia are included in 2A1, 2A2 and 2A7*

Table 19.3 summarizes the methodological information for limestone and dolomite use provided by EU-12 Member States in their national inventory reports. The Czech Republic, Latvia and Poland use plant-specific data reported and verified under the EU ETS.

**Table 19.7** **2A3 Limestone and Dolomite Use: Summary of methodological information provided by Member States**

| Limestone and dolomite use new MS | |
|---|---|
| **Member State** | **Methodology comment** |
| **Bulgaria** | The emissions from the limestone and dolomite usage are reported under the specific production industries, e.i. Cement Production, Lime Production, Glass Production, Desulphurisation, etc..[NIR 2011] |
| **Cyprus** | Not occuring. |
| **Czech Republic** | CO2 emissions from sulphur removal were calculated from coal consumption for electricity production, the sulphur content and the effectiveness of sulphur removal units between 1996, when the first sulphur removal units came into operation, and 2005. In 2005, these data were verified by comparison with data from the individual power plants, which were collected for EU ETS preparation and which cover the years 1999 – 2005. The EU ETS data form has been used since 2006. Emissions from limestone and dolomite use in sintering plants were new source, in 2006 submission, which was identified in the process of preparation of the EU Emission Trading Scheme. Only 2 sintering plants have existed in the CR in recent times. CO2 emissions from this category are calculated on the basis of data from statistics (The Steel Federation, Inc - production of agglomerate / sinter) and the EF value, which was derived from EU ETS CO2 emission data based on the limestone and dolomite compositions and consumptions (0.08 t CO2 / t sinter). [NIR 2011] |
| **Estonia** | The emissions are reported in 2A1, 2A2 and 2A7. [NIR 2011] |
| **Hungary** | The emissions were calculated according to the Revised Guidelines and using the correct stochiometric ratios. Identification of the activity data was complicated by the fact that the national data published by KSH also include other uses of limestone and dolomite (e.g., road construction). Since the emissions from most of the limestone used for purposes other than construction were already taken into consideration in the previous calculations, only limestone and dolomite used during various phases of iron production and limestone quantities used during the separation of sulphur were calculated here. These values were obtained on the basis of the data received from the manufacturers. For those years when such data were not available, the default value (250 kg dolomite/t iron) was used. Separation of sulphur has been carried out in one power plant since 2002 and in two since 2004. [NIR 2011] |
| **Latvia** | CO2 emissions from Limestone and Dolomite Use in Glass and Metal industry, limestone use in sugar production and Soda Ash Use in Glass Production are estimated with Tier2 method basing on plant specific activity data and default IPCC 1996 emission factors. CO2 emissions from Lime production in two direct lime production plants are calculated basing on data of carbonates – dolomite and limestone use. Purity factor from IPCC GPG 2000 is taken into account in estimation of CO2 emissions from dolomite use in lime production calculation. Tier3 method is used in CO2 emission from dolomite use in lime production processes estimation as plant specific activity data as well as plant specific CO2 emission factors are used in estimation. Activity data were taken from industrial production plants. Industrial producers are participants of the ETS the GHG reports of these enterprises have to be freely available according to EU ETS regulations. [NIR 2011] |
| **Lithuania** | Specific CO2 emissions caused by thermal degradation of limestone and dolomite are covered in sections dealing with cement, lime, glass, mineral wool, brick and tile production. This section covers limestone flux use in iron foundries. Consumption of limestone flux in iron foundries was calculated as one tent of iron production in accordance with the information provided by the foundries. CO2 emission was calculated by Tier 2 method iron production data provided by the Statistics Lithuania. CO2 emissions were calculated from material mass balance assuming that all carbon contained in raw materials (limestone) used as flux was released to the atmosphere as CO2. [NIR 2011] |
| **Malta** | Not occuring. |
| **Poland** | In this subcategory there were used only emissions from limestone and dolomite use in sulphur removal installations in power industry installation that participate in EU ETS. Emissions for this subcategory in GHG inventory correspond to emissions from the EU ETS verified reports. It should be noted that this emission constitutes only part of total emission from limestone and dolomite use. The rest of it was included into other categories where these minerals are used. CO2 emissions concerning limestone and dolomite use in production of glass, ceramics and paper includes only the emission from installations covered by EU ETS. [NIR 2011] |
| **Romania** | The IPCC methodology has been followed for estimating the CO2 emissions from limestone and dolomite used. The method estimates the amount of limestone and dolomite used in the iron and steel production, pulp and paper production, sugar mills production, ceramics plants, for all time series. The activity data were provided directly by the plants (iron and steel producers, pulp and paper producers, sugar mills producers, ceramics producers). In order to estimate CO2 emissions from limestone and dolomite used subsector it was made a questionnaire which it was sent to the local environmental protection agencies. The completed questionnaire has been sent to NEPA where the data are aggregated. [NIR 2011] |
| **Slovak Republic** | The limestone used in the Slovak Republic often contains a small amount of MgCO3. Emissions are calculated on the basis of carbonates using Tier 3 method according to the IPCC 2000 GPG and the plant specific emission factors from 2004. Emission factor is based on the stoichiometry of limestone and dolomite in mixtures and it was 0.442 t per ton of used carbonates in 2009. [NIR 2011] |
| **Slovenia** | Consumption of limestone and dolomite in production of iron and steel produces CO2 emissions. Primary production from ore existed only in the 1986 and 1987, after 1990 steel production is based on utilization of scrap iron and steel. Activity data on CaCO3 consumption were obtained directly from iron and steel producers. CO2 emissions have been calculated according to IPCC methodology. Default emission factor, 440 kg CO2/ton limestone, has been applied for the whole period. [NIR 2011] |

*Source: NIR 2011.*

### 19.2.2 Chemical industry (CRF Source Category 2B) (EU-27)

$CO_2$ emissions from 2B1 Ammonia Production account for 0.52 % of total EU-27 GHG emissions in 2009. Between 1990 and 2009, $CO_2$ emissions from this source decreased by 26 %, contributing to additional 5 % to the reduction in EU-15 (-21 %) (Table 19.8). Poland and Romania are responsible for 22 % of emissions from ammonia production in the EU-27, followed by Lithuania (5 %). Bulgaria and Romania had large reductions in absolute terms between 1990 and 2009.

Between 2008 and 2009, the $CO_2$ emissions decreased by 14 % in the EU-27. The country's share in the EU-27 emission change 2008-2009 – for the new MS that had greatest reductions in absolute terms – was 10 % for Bulgaria and 5 % for Romania. Emission reductions are mainly driven by activity data: in Bulgaria the production of ammonia decreased due to the world economical crisis in 2009 which led to a reduction of the production processes rates: One of the plants decreased its production of about 20 %, the other of about 60 %, which gives a total reduction in the sector production of about 40 %.

For the whole time series besides Poland, Lithuania however increased its emissions from Ammonia Production during 1990 and 2009. In Lithuania, the increase of ammonia produced and natural gas consumed of more than 100 % occurred during 2006 and 2007 due to a new production line that was put into operation by the producing company. Nevertheless, a reduced demand for the product caused by the global economic crisis led to a drop in emissions in Lithuania 2008-2009. Table 19.8 shows that no Member States uses default methodologies for the estimation of $CO_2$ emissions from ammonia production and that 73 % of EU-12 emissions are estimated with higher Tier methods for 2009 instead.

**Table 19.8 2B1 Ammonia Production: $CO_2$ emissions of EU-27**

| Member State | $CO_2$ emissions in Gg | | | Share in EU27 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| EU-15 | 19,450 | 17,022 | 15,381 | 63.8% | -1,641 | -10% | -4,068 | -21% | | |
| Bulgaria | 3,087 | 970 | 577 | 2.4% | -393 | -41% | -2,510 | -81% | T2 | PS |
| Cyprus | NO | NO | NO | - | - | - | - | - | NO | NO |
| Czech Republic | 807 | 616 | 634 | 2.6% | 18 | 3% | -172 | -21% | T1 | CS |
| Estonia | 420 | 271 | 30 | 0.1% | -241 | -89% | -390 | -93% | T1a | PS |
| Hungary | 1,056 | 393 | 433 | 1.8% | 39 | 10% | -623 | -59% | T2 | D |
| Latvia | NO | NO | NO | - | - | - | - | - | NA | NA |
| Lithuania | 1,190 | 1,907 | 1,252 | 5.2% | -655 | -34% | 62 | 5% | T2 | PS |
| Malta | NO | NO | NO | - | - | - | - | - | NA | NA |
| Poland | 2,811 | 4,276 | 3,493 | 14.5% | -783 | -18% | 682 | 24% | T2 | CS |
| Romania | 3,267 | 1,913 | 1,709 | 7.1% | -204 | -11% | -1,559 | -48% | T1b | D |
| Slovakia | 617 | 557 | 618 | 2.6% | 62 | 11% | 1 | 0% | T2 | PS |
| Slovenia | NO | NO | NO | - | - | - | - | - | NA | NA |
| **EU-27** | **32,704** | **27,924** | **24,127** | **100.0%** | **-3,798** | **-14%** | **-8,578** | **-26%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

$CO_2$ emissions from 2B5 Other were not reported by any new MS, except for Poland that reports $CO_2$ emissions from ethylene production under this source category. However the share in EU-27 emissions in 2009 is only minor, amounting to 0.001 % (Table 19.9). $CO_2$ emissions increased especially during 2005 and 2006 (+89 %) due to changes in ethylene production.

**Table 19.9** **2B5 Other: $CO_2$ emissions of EU-27**

| Member State | $CO_2$ emissions in Gg | | | Share in EU27 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| EU-15 | 10,406 | 14,331 | 13,881 | 100.0% | -451 | -3% | 3,475 | 33% | | |
| Bulgaria | NO | NO | NO | - | - | - | - | - | NO | NO |
| Cyprus | 0.000 | 0.000 | 0.000 | 0.0% | 0.000 | - | 0.000 | - | NE | NE |
| Czech Republic | IE,NA | IE,NA | IE,NA | - | - | - | - | - | NA | NA |
| Estonia | NA | NA | NA | - | - | - | - | - | NA | NA |
| Hungary | NO | NO | NO | - | - | - | - | - | NA | NA |
| Latvia | NO | NO | NO | - | - | - | - | - | NA | NA |
| Lithuania | NO | NO | NO | - | - | - | - | - | NA | NA |
| Malta | NO | NO | NO | - | - | - | - | - | NA | NA |
| Poland | 0.09 | 0.16 | 0.15 | 0.0% | -0.007 | -4% | 0.062 | 68% | T1 | D |
| Romania | NE | NE | NE,NO | - | - | - | - | - | NA | NA |
| Slovakia | NO | NO | NO | - | - | - | - | - | NA | NA |
| Slovenia | NA,NO | NA,NO | NA,NO | - | - | - | - | - | NA | NA |
| **EU-27** | **10,406** | **14,332** | **13,881** | **100.0%** | **-451** | **-3%** | **3,475** | **33%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

$N_2O$ emissions from 2B2 Nitric acid production account for 0.36 % of total EU-27 GHG emissions in 2009. Between 1990 and 2009, $N_2O$ emissions from this source in EU-27 decreased by 67 % (Table 19.). Lithuania and Slovakia are responsible for 19 % of these emissions in the EU-27, followed by Poland (5 %).

Hungary and Romania had large reductions in absolute terms between 1990 and 2009, followed by Poland and Bulgaria, whereas the reduced emissions in Bulgaria are completely offset by increasing emissions in Lithuania (due to an increase of the nitric acid production) during that period.

Between 2008 and 2009, the $N_2O$ emissions decreased by 36 % in the EU-27. Largest emission reduction could be found for Poland due to the implementation of JI projects concerning the reduction of $N_2O$ emissions from nitric acid production. $N_2O$ emissions in Romania decreased during 2008 and 2009 due to the significant decrease of nitric acid production level in 2009. The low level of 2009 production was determined by the economic crisis.

Hungary reduced its emissions since 2005; until 2005, Hungary used obsolete technology. The implementation of a new and more advanced state-of-the-art production technology was started in 2005 and installed in September 2007, resulting in drastic emission reductions. The new factory applying the EnviNOx technology reached a reduction of emissions of about 95-99%. At the same time the old production lines were closed. During 2008 and 2009 Hungary was the only MS that increased its $N_2O$ emissions from nitric acid production. Production data from the factory confirmed an increase of production of 14 %.

Table 19.8 suggests that only one new Member State uses default methodologies but that only 37 % of EU-12 $N_2O$ emissions from 2B2 Nitric acid production are estimated with higher Tier methods.

**Table 19.10 2B2 Nitric acid production: $N_2O$ emissions of EU-27**

| Member State | $N_2O$ emissions (Gg $CO_2$ equivalents) | | | Share in EU27 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| EU-15 | 35,772 | 14,742 | 11,357 | 67.6% | -3,384 | -23% | -24,414 | -68% | | |
| Bulgaria | 1,503 | 580 | 272 | 1.6% | -308 | -53% | -1,231 | -82% | T3 | PS |
| Cyprus | NO | NO | NO | - | - | - | - | - | NO | NO |
| Czech Republic | 1,127 | 662 | 506 | 3.0% | -156 | -24% | -621 | -55% | T2 | PS |
| Estonia | NO | NO | NO | - | - | - | - | - | NA | NA |
| Hungary | 3,214 | 5 | 15 | 0.1% | 10 | 191% | -3,199 | -100% | T2 | PS |
| Latvia | NO | NO | NO | - | - | - | - | - | NA | NA |
| Lithuania | 771 | 2,408 | 2,024 | 12.0% | -384 | -16% | 1,253 | 162% | T1 | D |
| Malta | NO | NO | NO | - | - | - | - | - | NA | NA |
| Poland | 3,163 | 3,789 | 871 | 5.2% | -2,918 | -77% | -2,293 | -72% | T1 | CS |
| Romania | 3,460 | 2,530 | 517 | 3.1% | -2,013 | -80% | -2,943 | -85% | D | D,CR |
| Slovakia | 1,149 | 1,523 | 1,239 | 7.4% | -284 | -19% | 90 | 8% | T2 | PS |
| Slovenia | NO | NO | NO | - | - | - | - | - | NA | NA |
| **EU-27** | **50,159** | **26,238** | **16,801** | **100.0%** | **-9,437** | **-36%** | **-33,358** | **-67%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

$N_2O$ emissions from 2B3 Adipic Acid Production were not reported by any new MS in 2009, except for Poland and Romania in 1990. Romania stopped its adipic acid production in 2001 and thus suspended this activity from 2002 onwards and Poland stopped its adipic acid production already in 1994 (Table 19.1).

**Table 19.11 2B3 Adipic Acid Production: $N_2O$ emissions of EU-27**

| Member State | $N_2O$ emissions (Gg $CO_2$ equivalents) | | | Share in EU27 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| EU-15 | 58,927 | 8,617 | 10,804 | 100.0% | 2,187 | 25% | -48,123 | -82% | | |
| Bulgaria | NO | NO | NO | - | - | - | - | - | NO | NO |
| Cyprus | NO | NO | NO | - | - | - | - | - | NO | NO |
| Czech Republic | NO | NO | NO | - | - | - | - | - | NA | NA |
| Estonia | NO | NO | NO | - | - | - | - | - | NA | NA |
| Hungary | NO | NO | NO | - | - | - | - | - | NA | NA |
| Latvia | NO | NO | NO | - | - | - | - | - | NA | NA |
| Lithuania | NO | NO | NO | - | - | - | - | - | NA | NA |
| Malta | NO | NO | NO | - | - | - | - | - | NA | NA |
| Poland | 372 | NO | NO | - | - | - | -372 | -100% | NA | NA |
| Romania | 574 | NO | NO | - | - | - | -574 | -100% | NA | NA |
| Slovakia | NO | NO | NO | - | - | - | - | - | NA | NA |
| Slovenia | NO | NO | NO | - | - | - | - | - | NA | NA |
| **EU-27** | **59,872** | **8,617** | **10,804** | **100.0%** | **2,187** | **25%** | **-49,069** | **-82%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

$N_2O$ emissions from 2B5 Other account for 0.04% of total EU-27 GHG emissions in 2009 and are only reported by the Czech Republic and Poland. Both MS are responsible for 16 % of these emissions in the EU-27 and both consider $N_2O$ emissions from the production of caprolactam under 2B5. The MS increased their $N_2O$ emissions during 1990 and 2009, thus lowering the overall reduction of emissions achieved by EU-15 during that period by 5 %.

The increase in Czech emissions by 13 % occurred between 2005 and 2006 due to the calculation method applied. Caprolactam production data are not provided by the official Czech statistics because of confidentiality (there is only one plant in the Czech Republic). Emissions of $N_2O$ were estimated by external experts for years 1990 to 2005 by approximating the production capacity in that time period. After consultations with the producer, the $N_2O$ emission factor was revised, resulting in higher emissions since 2006. $N_2O$ emissions in Poland increased steadily from 1990 to 2005 (+54 %) and decreased afterwards until 2009 (Table 19.). This trend is driven by the caprolactam production in the country.

**Table 19.5 2B5 Other: $N_2O$ emissions of EU-27**

| Member State | $N_2O$ emissions (Gg $CO_2$ equivalents) | | | Share in EU27 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| EU-15 | 4,587 | 1,399 | 1,672 | 84.5% | 273 | 19% | -2,915 | -64% | | |
| Bulgaria | NO | NO | NO | - | - | - | - | - | NO | NO |
| Cyprus | 0.000 | 0.000 | 0.000 | 0.0% | 0.000 | - | 0.000 | - | NE | NE |
| Czech Republic | 84 | 94 | 94 | 4.8% | 0.000 | 0% | 11 | 13% | CS | CS |
| Estonia | NA | NA | NA | - | - | - | - | - | NA | NA |
| Hungary | NO | NO | NO | - | - | - | - | - | NA | NA |
| Latvia | NO | NO | NO | - | - | - | - | - | NA | NA |
| Lithuania | NO | NO | NO | - | - | - | - | - | T1 | D |
| Malta | NO | NO | NO | - | - | - | - | - | NA | NA |
| Poland | 143 | 213 | 213 | 10.8% | 0 | 0% | 70 | 49% | T1 | CS |
| Romania | NE | NE | NE,NO | - | - | - | - | - | NA | NA |
| Slovakia | NO | NO | NO | - | - | - | - | - | NA | NA |
| Slovenia | NA,NO | NA,NO | NA,NO | - | - | - | - | - | NA | NA |
| **EU-27** | **4,814** | **1,706** | **1,979** | **100.0%** | **273** | **16%** | **-2,835** | **-59%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

### 19.2.3 *Metal production (CRF Source Category 2C) (EU-27)*

$CO_2$ emissions from 2.C Metal production account for 1% of the total EU-27 GHG emissions in 2009. Poland, the Czech Republic, Romania and Slovakia are responsible for 41% of overall emissions from this sector. Poland is responsible for 12% of the overall EU27 emissions. Slovenia reported an increase of emissions on 1% compared to 1990, but is responsible for 0.1% of overall emissions from this sector.

**Table 19.6 2C1 Iron and Steel Production: $CO_2$ emissions of EU-27**

| Member State | $CO_2$ emissions in Gg | | | Share in EU27 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| EU-15 | 47,287 | 42,352 | 27,608 | 58.8% | -14,744 | -35% | -19,679 | -42% | | |
| Bulgaria | 1,973 | 683 | 73 | 0.2% | -610 | -89% | -1,900 | -96% | T2 | CS |
| Cyprus | NA | NA | NA | - | - | - | - | - | NE | NE |
| Czech Republic | 12,533 | 7,151 | 5,298 | 11.3% | -1,853 | -26% | -7,235 | -58% | T1 | D |
| Estonia | NA,NO | NA,NO | NA,NO | - | - | - | - | - | NA | NA |
| Hungary | 380 | 272 | 180 | 0.4% | -91 | -34% | -200 | -53% | CS | D |
| Latvia | 13 | 9 | 10 | 0.0% | 1 | 9% | -3 | -25% | NA | NA |
| Lithuania | 21 | 5 | 4 | 0.0% | -1 | -19% | -17 | -81% | T1 | D |
| Malta | NA,NO | NA,NO | NA,NO | - | - | - | - | - | NA | NA |
| Poland | 6,681 | 8,638 | 5,641 | 12.0% | -2,997 | -35% | -1,040 | -16% | T3,CS | CS,PS |
| Romania | 10,275 | 5,615 | 3,682 | 7.8% | -1,933 | -34% | -6,593 | -64% | T2 | D,CS |
| Slovakia | 5,381 | 5,173 | 4,447 | 9.5% | -726 | -14% | -933 | -17% | T1,T2,T3 | CS,D |
| Slovenia | 30 | 44 | 30 | 0.1% | -14 | -32% | 0 | 1% | T2 | PS |
| **EU-27** | **84,574** | **69,941** | **46,972** | **100.0%** | **-22,968** | **-33%** | **-37,602** | **-44%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

**Table 19.7 2C1 Iron and Steel Production: Information on activity data, emission factors for $CO_2$ emissions**

| Member State | 1990 Activity data: Description | 1990 Activity data: (kt) | 1990 Implied emission factor (t/t) | 1990 CO2 emissions (Gg) | 2009 Activity data: Description | 2009 Activity data: (kt) | 2009 Implied emission factor (t/t) | 2009 CO2 emissions (Gg) |
|---|---|---|---|---|---|---|---|---|
| **Bulgaria** | **Iron and steel production** | | **0.46** | **1973** | **Iron and steel production** | **0** | **0.10** | **73** |
| | steel production - kt | 2184 | 0.90 | 1973 | steel production - kt | 731 | 0.10 | 73 |
| | pig iron for production of steel - kt | C | NO | NO | pig iron for production of steel - kt | NO | NO | NO |
| | Sinter: aglomerate - kt | 2081 | NO | NO | Sinter: aglomerate - kt | NO | NO | NO |
| | Coke: at 6% wet - kt | C | NO | NO | Coke: at 6% wet - kt | NO | NO | NO |
| | Other | | | NA | Other | 0 | 0.00 | NA |
| **Cyprus** | **Iron and steel production** | | **NA** | **NA** | **Iron and steel production** | **0** | **NA** | **NA** |
| | Steel | 0 | NA | NA | Steel | 0 | NA | NA |
| | Pig Iron | 0 | NA | NA | Pig Iron | 0 | NA | NA |
| | Sinter | 0 | NA | NA | Sinter | 0 | NA | NA |
| | Coke | 0 | NA | NA | Coke | 0 | NA | NA |
| | Other | | | | Other | 0 | 0.00 | NA |
| **Czech Republic** | **Iron and steel production** | | **0.39** | **12533** | **Iron and steel production** | **0** | **0.36** | **5298** |
| | Steel | 10098 | 1.24 | 12533 | Steel | 4663 | 1.14 | 5298 |
| | Pig Iron | 6106 | IE | IE | Pig Iron | 3490 | IE | IE |
| | Sinter | 8469 | IE | IE | Sinter | 4309 | IE | IE |
| | Coke | 7285 | IE | IE | Coke | 2295 | IE | IE |
| | Other | | | NO | Other | 0 | 0.00 | NO |
| **Estonia** | **Iron and steel production** | | **NA,NO** | **NA,NO** | **Iron and steel production** | **0** | **NA,NO** | **NA,NO** |
| | (Steel) | NO | NO | NO | (Steel) | NO | NO | NO |
| | Pig Iron | NO | NO | NO | Pig Iron | NO | NO | NO |
| | Sinter | NO | NO | NO | Sinter | NO | NO | NO |
| | (Coke) | NO | NO | NO | (Coke) | NO | NO | NO |
| | Other | | | NA | Other | 0 | 0.00 | NA |

| | 1990 | | | | 2009 | | | |
|---|---|---|---|---|---|---|---|---|
| Member State | Activity data: Description | Activity data: (kt) | Implied emission factor (t/t) | CO2 emissions (Gg) | Activity data: Description | Activity data: (kt) | Implied emission factor (t/t) | CO2 emissions (Gg) |
| **Hungary** | **Iron and steel production** | | **0.08** | **380** | **Iron and steel production** | **0** | **0.07** | **180** |
| | Steel: crude steel | 2963 | 0.13 | 380 | Steel: crude steel | 1401 | 0.13 | 180 |
| | Pig Iron: 0 | 1697 | IE | IE | Pig Iron: 0 | 1050 | IE | IE |
| | Sinter: 0 | IE | IE | IE | Sinter: 0 | IE | IE | IE |
| | Coke: Consumption | IE | IE | IE | Coke: Consumption | IE | IE | IE |
| | Other | | | NA | Other | 0 | 0.00 | NA |
| **Lithuania** | **Iron and steel production** | | **0.20** | **21** | **Iron and steel production** | **0** | **0.88** | **4** |
| | Steel | NO | NO | NO | Steel | NO | NO | NO |
| | Pig Iron | 106 | 0.20 | 21 | Pig Iron | 5 | 0.88 | 4 |
| | Sinter | NO | NO | NO | Sinter | NO | NO | NO |
| | Coke | NO | NO | NO | Coke | NO | NO | NO |
| | Other | | | NO | Other | 0 | 0.00 | NO |
| **Latvia** | **Iron and steel production** | | **0.12** | **13** | **Iron and steel production** | **0** | **0.13** | **10** |
| | (crude steel produced from crude iron) | 109 | 0.12 | 13 | (crude steel produced from crude iron) | 73 | 0.13 | 10 |
| | Pig Iron | NO | NO | NO | Pig Iron | NO | NO | NO |
| | Sinter | NO | NO | NO | Sinter | NO | NO | NO |
| | Coke | NO | NO | NO | Coke | NO | NO | NO |
| | Other | | | NA | Other | 0 | 0.00 | NA |
| **Malta** | **Iron and steel production** | | **NA,NO** | **NA,NO** | **Iron and steel production** | **0** | **NA,NO** | **NA,NO** |
| | Steel | NO | NO | NO | Steel | NO | NO | NO |
| | Pig Iron | NO | NO | NO | Pig Iron | NO | NO | NO |
| | Sinter | NO | NO | NO | Sinter | NO | NO | NO |
| | Coke | NO | NO | NO | Coke | NO | NO | NO |
| | Other | | | NA | Other | 0 | 0.00 | NA |

| Member State | 1990 | | | | 2009 | | | |
|---|---|---|---|---|---|---|---|---|
| | Activity data | | Implied emission factor (t/t) | CO2 emissions (Gg) | Activity data | | Implied emission factor (t/t) | CO2 emissions (Gg) |
| | Description | (kt) | | | Description | (kt) | | |
| **Poland** | **Iron and steel production** | | **0.20** | **6681** | **Iron and steel production** | **0** | **0.39** | **5641** |
| | Steel | IE | IE | IE | Steel | IE | IE | IE |
| | Pig Iron | 8657 | 0.17 | 1430 | Pig Iron | 2984 | 0.76 | 2259 |
| | Sinter: production | 11779 | 0.07 | 834 | Sinter: production | 4363 | 0.26 | 1151 |
| | Coke: production | 13671 | 0.13 | 1821 | Coke: production | 7091 | 0.22 | 1531 |
| | Other | | | 2596 | Other | 0 | 0.00 | 699 |
| **Romania** | **Iron and steel production** | | **0.35** | **10275** | **Iron and steel production** | **0** | **0.51** | **3682** |
| | steel production | 8946 | 0.06 | 549 | steel production | 2836 | 0.06 | 169 |
| | (pig iron production) | 5916 | 1.64 | 9725 | (pig iron production) | 1569 | 2.24 | 3512 |
| | sinter used | 11357 | IE | IE | sinter used | 1807 | IE | IE |
| | (coke used) | 2885 | IE | IE | (coke used) | 1070 | IE | IE |
| | Other | | | IE | Other | 0 | 0.00 | IE |
| **Slovenia** | **Iron and steel production** | | **0.05** | **30** | **Iron and steel production** | **0** | **0.07** | **30** |
| | Steel produced | 632 | 0.05 | 30 | Steel produced | 458 | 0.07 | 30 |
| | Pig Iron | NO | NO | NO | Pig Iron | NO | NO | NO |
| | Sinter | NO | NO | NO | Sinter | NO | NO | NO |
| | Coke | NO | NO | NO | Coke | NO | NO | NO |
| | Other | | | NA | Other | 0 | 0.00 | NA |
| **Slovakia** | **Iron and steel production** | | **0.56** | **5381** | **Iron and steel production** | **0** | **0.55** | **4447** |
| | Steel | 3562 | 0.14 | 490 | Steel | 3642 | 0.12 | 435 |
| | Pig Iron | 3561 | 1.29 | 4578 | Pig Iron | 3019 | 1.25 | 3762 |
| | Sinter | 151 | IE | IE | Sinter | 35 | IE | IE |
| | Coke | 2340 | IE | IE | Coke | 1356 | IE | IE |
| | Other | | | 312 | Other | 0 | 0.00 | 250 |

According to the IPCC methodology, processes including auto-producers - power and heat production facilities located in iron and steel plants excluding heating of coke ovens (where usually coke oven gas is combusted) and fuel combustion (gaseous fuels and coke) in sinter plants (agglomeration of iron ores) should be taken into account in 1A2a; while processes including consumption of carbonaceous reducing agents, especially in blast furnaces, oxidation of carbon contained in a pig iron or scrap and the burning off carbonaceous electrodes should be taken into account in 2C1. Additionally, emissions coming from limestone and dolomite use in iron and steel plants should be included under 2A3 and Emissions coming from heating of coke ovens should be reported under 1A1c.

However, some EU-27 Member States do not keep this boundary for different reasons (local traditions used in history and in this context an attempt to keep consistency in data series). E. g. some Member States report emission from blast furnace gas and from converter gas under 1A2a instead of under 2C1, because they interpret it as emissions from energy supply.

Thus, for an overview of EU-27 total emissions it seems to be more convenient to take into account all emissions covered by the combined category 1A2a + 2C1. Resulting emissions for the EU-15 Member States in the combined category 1A2a + 2C1 are given in Table 19..

**Table 19.8 $CO_2$ Emissions of EU-27 Member States in 1A2a and 2C1 Iron and Steel**

| Member State | $CO_2$ emissions in Gg | | | Share in EU15 emissions in 2009 | Share 2C1 |
|---|---|---|---|---|---|
| | 1A2a | 2C1 | Combined | | |
| | | | | | |
| EU-15 | 68,464 | 27,608 | 96,072 | 75.4% | 29% |
| Bulgaria | 324 | 73 | 398 | 0.3% | 18% |
| Cyprus | NE,NO | NA | 0 | 0.0% | - |
| Czech Republic | 3,323 | 5,298 | 8,621 | 6.8% | 61% |
| Estonia | 1 | NA,NO | 1 | 0.0% | 0% |
| Hungary | 2,184 | 180 | 2,365 | 1.9% | 8% |
| Latvia | 260 | 10 | 270 | 0.2% | 4% |
| Lithuania | NO | 4 | 4 | 0.0% | NA |
| Malta | 67 | NA,NO | 67 | 0.1% | 0% |
| Poland | 4,210 | 5,641 | 9,850 | 7.7% | 57% |
| Romania | IE | 3,682 | 3,682 | 2.9% | 100% |
| Slovakia | 1,437 | 4,447 | 5,884 | 4.6% | 76% |
| Slovenia | 155 | 30 | 184 | 0.1% | 16% |
| **EU-27** | **80,425** | **46,972** | **127,397** | **100.0%** | **37%** |

**Table 19.9 2C1 Iron and Steel Production : Information on activity data and methods used for $CO_2$ emissions**

| **Member states** | **Description of methods** |
|---|---|
| Bulgaria | The $CO_2$ emissions from the sector are calculated using country specific data from EU ETS reports. Data from Bulgarian association of metallurgical industry (BAMI, http://www.bcm-bg.com/) as well as data from World Steel Association (WSA, http://worldsteel.org) are used for crosscheck. Country specific emission factor was developed for the EAF steel based on data from EU ETS reports for the period 2007 - 2009. In the calculation of ETS emissions the operators performed a mass balance of the Carbon content in the raw materials used and the produced end product. Thus $CO_2$ emissions were calculated similar to the the IPCC GPG Tier 2 method (equation 3.6B). |
| Cyprus | NO |
| Czech Republic | $CO_2$ emissions were determined for category 2C1 using a procedure corresponding to Tier 1 of the Good Practice Guidance for 2C1. This calculation was based on the amount of coke consumed in blast furnaces. The calculation was carried out using NCV = 28.69 MJ/kg in 2009 (NCV interval for period 1990 - 2009 is (27.9 - 28.8 MJ/kg) and using the carbon emission factor for coke, 29.5 t C / TJ, which is the IPCC default value (IPCC, 1997). As the final products in metallurgical processes are mostly steel and iron with very low carbon contents, the relevant correction for the amount of carbon remaining in the steel or iron was taken into account by using factor 0.98, |

| Member states | Description of methods |
|---|---|
| | i.e. the same factor that is standardly used for combustion of solid fuels (the oxidation factor). |
| Estonia | NO |
| Hungary | Partly for reasons related to the Hungarian traditions of energy statistics, the emissions of the sector from fuels are not included here but in sub-sector 1.A.2.A. $CO_2$ released from limestone and/or dolomite is taken into account under sub-sector 2.A.3 (Limestone and dolomite use). Iron and steel production data were obtained from the reports of the International Iron and Steel Institute and the similar European agency (EUROFER). Initially, limestone consumption data were calculated on the basis of the default value in the Revised Guidelines. In recent years data received from the factories have been used. In order to make emission calculations complete, carbon dioxide releases from raw iron and graphite electrode of the electric arc furnace (EAF) during steel production were also calculated here. For these calculations, the following default values were used: carbon content of iron: 4%; carbon content of steel: 0.5%; specific emission of electrode: 5 kg $CO_2$/t steel. |
| Latvia | $CO_2$ emission estimations from crude steel production IPCC GPG 2000 Tier2 method is based on estimation of carbon losses through the production processes when remaining carbon is emitted to air. $CO_2$ emissions were estimated only from crude iron used. Carbon emitted from consumed electrodes in electric arc furnaces has to be taken into account. These emissions are estimated by multiplying emission factor with mass of steel produced in electric arc furnaces. Default emission factor – 1.5 kg carbon per tonne of steel is used because plant reported emission factor – 6 kg carbon per tonne of steel, is considered as unreliable high. For 2008 plant reported 18 kg per tonne of steel as also was assumed as incredibly high. $CH_4$ and indirect GHG emission estimations from crude steel production. The $CH_4$, NMVOC, CO, NOx and SO2 emissions from iron and steel production are calculated at the LEGMC based on activity data from the CSB and steel production plant according to EMEP/CORNAIR methodology and emission factors. |
| Lithuania | $CO_2$ emissions from blast furnaces were calculated from coke consumption using default emission factor 3.1 tonnes $CO_2$ per tonne coke (Revised 1996 IPCC Guidelines, Table 2-12, p. 2.26). Revised 1996 IPCC Guidelines do not provide emission factor for electric arc furnaces. Therefore emission factor 0.08 tonne $CO_2$ per tonne of steel produced is provided in 2006 IPCC Guidelines was used for evaluation of $CO_2$ emissions from electric arc furnace. |
| Malta | NO |
| Poland | Iron Ore Sinter Production:<br><br>Carbon dioxide process emissions from iron ore sinter production for 2009 come from the verified reports on annual emissions of $CO_2$ from iron ore sinter installations in EU ETS. Based on verified reports of $CO_2$ emissions elaborated for the purpose of emission trading scheme, also emissions and production within this subcategory for years 2005-2008 were estimated. Emissions of $CO_2$ for the years 1988-2004 were calculated (using carbon balance method) based on data (amount of feedstock material and output from production process) from questionnaires regarding to installations included into the EU ETS collected by the National Administration of Emission Trading Scheme.<br><br>Steel Cast Production<br><br>The data on $CO_2$ process emissions from steel cast production as well as on amount of cast steel was estimated according to the methodology given in [Holtzer 2007]. $CO_2$ emission estimated in mentioned study concerns only melt process of alloy since this is main sources of process emission. $CO_2$ emission occurring at pouring into moulding sands is not included.<br><br>Iron Cast Production<br><br>The data on $CO_2$ process emissions from iron cast production as well as on amount of cast iron was estimated according to the methodology from [Holtzer 2007]. Estimation of $CO_2$ emissions concerns only melting process of alloy since this is the main source of process emission. $CO_2$ emission occurring at pouring the liquid metal into the moulding sands was not taken into consideration.<br><br>Pig Iron Production In Blast Furnaces<br><br>$CO_2$ emission for 2009 from pig iron production was taken from the verified reports prepared by installations included in EU ETS. Pig iron is produced in the integrated steel plants, so additional information was needed for application of data from the verified reports. This additional data for separation of blast furnace process and steel production in integrated steel plants were received directly from plants.<br><br>Basic Oxygen Furnace Steel Production<br><br>Amount of $CO_2$ process emission from basic oxygen furnace steel production in 2009 was taken from the verified reports from steel plants participating in EU ETS. Like in case of sintering plants and blast furnace process also in 2.C.1.f total $CO_2$ emission, without excluding emission from fuels used for energy purpose of this process, was assumed. For years 1988-2004, $CO_2$ process emission from basic oxygen furnace steel production was estimated on the basis of carbon balances (table 4.4.5) prepared by Polish Steel Association (HIPH) [HIPH 2007].<br><br>Electric Furnace Steel Production<br><br>Process emissions of $CO_2$ from steel production in electric furnaces in 2009 were taken from the verified reports prepared by installations included in EU ETS. Values of emissions for 2005-2008, were also taken from the verified reports. |

| Member states | Description of methods |
|---|---|
| | Coke Production<br>Processing emission of $CO_2$ from coking plants in the period 1990-2009 was estimated based on elementary carbon budgets in the coking plants. Data concerning input and output are based on [Eurostat] and [GUS 1991a-2010a]. |
| Romania | The method for calculating emissions of $CO_2$ from Iron and steel production is in line with the Good Practice Guidance (Tier 2 method). The recommended Tier 2 method, according to the IPCC Good Practice Guidance, is to base the calculations on the amount of reducing agent (coke oven coke) used in blast furnaces for the production of iron. Other information needed to use the Tier 2 method is the amount of pig iron produced as well as the amount used for steel production and produced steel, and the carbon content of all those parts. All these information have been collected at plant level. |
| Slovakia | Tier 2 methodology based on the plant specific information about activity data and emission factors was applied for the estimation of emissions from steel, pig iron production and Tier 1 approach for the estimation of emissions from limestone use. The technological emissions from iron (2C1.1) and steel (2C1.2) production, limestone use (2C1.5) and emissions from coke electrodes used by EAF steel production (2C1.5) are included in the category 2C1 iron and steel production. The $CO_2$ emissions originated from coke production in iron and steel industry and emissions originated from sinter production are still included in energy sector, category 1A2a in line with the IPCC2006 GL. |
| Slovenia | Data on the amount and carbon content of input and output material were obtained from three iron and steel producers. Average EF for the period 1999–2004 has been 47 kg $CO_2$/t of steel. This emission factor has been applied for calculating emissions from 1988 onwards. This EF is not appropriate for the base year because of the different type of production of steel (from ore). For the period 2005-2009 precise and verified data obtained from EU ETS was used. |

PFC emissions from 2.C.3 are listed in Table 19.10. Only 4 of the new member states report PFC emissions from Aluminum Production in 2009, however, Romania and Poland are responsible for 41% of overall PFC emissions from this sector. Poland and Slovakia reported a decrease of 93% of emissions since 2008, and Slovenia reported a decrease of 97%.

**Table 19.10 2C3 Aluminum Production: PFC emissions of EU-27**

| Member State | PFC emissions (Gg $CO_2$ equivalents) | | | Share in EU27 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| EU-15 | 13,347 | 1,051 | 677 | 56.7% | -374 | -36% | -12,670 | -95% | | |
| Bulgaria | NA,NE,NO | NA,NO | NA,NO | - | - | - | - | - | NO | NO |
| Cyprus | NO | NO | NO | - | - | - | - | - | NO | NO |
| Czech Republic | NO | NO | NO | - | - | - | - | - | NA | NA |
| Estonia | NO | NO | NO | - | - | - | - | - | NA | NA |
| Hungary | 271 | NO | NO | - | - | - | -271 | -100% | NA | NA |
| Latvia | NO | NO | NO | - | - | - | - | - | NA | NA |
| Lithuania | NO | NO | NO | - | - | - | - | - | NA | NA |
| Malta | NO | NO | NO | - | - | - | - | - | NA | NA |
| Poland | 208 | 212 | 14 | 1.2% | -197 | -93% | -194 | -93% | T1 | D |
| Romania | 2,116 | 631 | 478 | 40.0% | -153 | -24% | -1,638 | -77% | T1 | D |
| Slovakia | 271 | 36 | 18 | 1.5% | -18 | -51% | -254 | -93% | T3 | PS |
| Slovenia | 257 | 21 | 7 | 0.6% | -13 | -64% | -250 | -97% | T3 | PS |
| **EU-27** | **16,470** | **1,950** | **1,194** | **100.0%** | **-756** | **-39%** | **-15,276** | **-93%** | | |

## *19.2.4 Production of halocarbons and $SF_6$ (CRF Source Category 2E) (EU-27)*

Table 19.11 shows HFC emissions of sector 2E1. No new member state reported by-product emissions, EU15 are responsible for 100% of all HFC emissions from this sector.

**Table 19.11 2E1 By-Product Emissions: HFC emissions of EU-27**

| Member State | HFC (Gg $CO_2$ equivalents) | | | Share in EU27 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| EU-15 | 21,158 | 1,009 | 697 | 100.0% | -312 | -31% | -20,461 | -97% | | |
| Bulgaria | NO | NA,NO | NA,NO | - | - | - | - | - | NO | NO |
| Cyprus | NA,NO | NA,NO | NA,NO | - | - | - | - | - | NO | NO |
| Czech Republic | NO | NA,NO | NA,NO | - | - | - | - | - | NA | NA |
| Estonia | NO | NA,NO | NA,NO | - | - | - | - | - | NA | NA |
| Hungary | NA,NO | NA,NO | NA,NO | - | - | - | - | - | NA | NA |
| Latvia | NO | NO | NA,NO | - | - | - | - | - | NA | NA |
| Lithuania | NO | NO | NA,NO | - | - | - | - | - | NA | NA |
| Malta | NA,NO | NA,NO | NA,NO | - | - | - | - | - | NA | NA |
| Poland | NO | NA,NO | NA,NO | - | - | - | - | - | NO | NO |
| Romania | NO | NA,NO | NA,NO | - | - | - | - | - | NA | NA |
| Slovakia | NO | NA,NO | NA,NO | - | - | - | - | - | NA | NA |
| Slovenia | NA,NO | NA,NO | NA,NO | - | - | - | - | - | NA | NA |
| **EU-27** | **21,158** | **1,009** | **697** | **100.0%** | **-312** | **-31%** | **-20,461** | **-97%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

## 19.2.5 Consumption of halocarbons and $SF_6$ (CRF Source Category 2F) (EU-27)

HFC emissions from Refrigeration and Air Conditioning account for 78% of overall HFC emissions. The major share of emissions from this sector lies with the EU-15 (89.3%), Poland, the Czech Republic and Hungary are responsible for 9% of overall emissions from this sector (Table 19.12). The high increase in absolute terms of the EU 15 between 1990 and 2009 is due to the phase-out of ozone-depleting substances such as chlorofluorocarbons under the Montreal Protocol and the replacement of these substances with HFCs (mainly in refrigeration, air conditioning, foam production and as aerosol propellants). The Czech Republic, Cyprus, Hungary, and Malta are the only new member states that reported a decrease in emissions between 2008 and 2009.

**Table 19.12 2F1 Refrigeration and Air conditioning: HFC emissions of EU-27**

| Member State | HFC (Gg $CO_2$ equivalents) | | | Share in EU27 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| EU-15 | 166 | 47,717 | 50,122 | 89.3% | 2,405 | 5% | 49,956 | 30081% | | |
| Bulgaria | NO | 189 | 210 | 0.4% | 22 | 12% | 210 | - | T2 | D |
| Cyprus | 0.00 | 76 | 7 | 0.0% | -69 | -91% | 7 | - | T1 | D |
| Czech Republic | NO | 1,168 | 918 | 1.6% | -249 | -21% | 918 | - | T2 | D |
| Estonia | NO | 123 | 130 | 0.2% | 7 | 6% | 130 | - | T2 | CS |
| Hungary | NO | 862 | 784 | 1.4% | -78 | -9% | 784 | - | CS | CS |
| Latvia | IE,NA,NE,NO | 81 | 87 | 0.2% | 6 | 7% | 87 | - | T2 | D,OTH |
| Lithuania | NA | 25 | 31 | 0.1% | 6 | 24% | 31 | - | CS | CS |
| Malta | NO | 40 | 38 | 0.1% | -2 | -4% | 38 | - | M | M |
| Poland | NO | 3,154 | 3,377 | 6.0% | 224 | 7% | 3,377 | - | T1 | D |
| Romania | NO | 16 | 18 | 0.0% | 3 | 16% | 18 | - | T2 | D |
| Slovakia | NO | 258 | 294 | 0.5% | 36 | 14% | 294 | - | D | CS |
| Slovenia | NO | 116 | 121 | 0.2% | 5 | 4% | 121 | - | T2 | CS,D |
| **EU-27** | 166 | 53,824 | 56,139 | **100.0%** | **2,315** | **4%** | **55,973** | **33704%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

HFC emissions from sector 2F4, Aerosols/Metered Dose Inhalers are reported in Table 19.7. EU-15 are responsible for 96.7% of these emissions, Poland and the Czech Republic account for 2.9% of emissions. However, all new Member states reported a decrease of emissions between 2008 and 2009, except Estonia (+7%) and Bulgaria (+47%) that reported an absolute increase of emissions.

**Table 19.13 2F4 Aerosols/Metered Dose Inhalers: HFC emissions of EU-27**

| Member State | HFC (Gg $CO_2$ equivalents) | | | Share in EU27 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| EU-15 | 76 | 7,824 | 7,657 | 96.7% | -167 | -2% | 7,581 | 9975% | | |
| Bulgaria | NO | 2 | 3 | 0.0% | 1 | 47% | 3 | - | T2 | D |
| Cyprus | 0.000 | 0.000 | 0.000 | 0.0% | 0 | - | 0 | - | NA | NA |
| Czech Republic | NO | 65 | 48 | 0.6% | -17 | -26% | 48 | - | D | D |
| Estonia | NO | 3 | 3 | 0.04% | 0 | 7% | 3 | - | T2 | CS |
| Hungary | NO | 22 | 17 | 0.2% | -4 | -20% | 17 | - | D,CS | CS |
| Latvia | NE,NO | 3 | 3 | 0.03% | -0.2 | -6% | 3 | - | T2 | D |
| Lithuania | NA | 5 | 4 | 0.1% | 0 | -4% | 4 | - | NE | NE |
| Malta | NO | 5 | 2 | 0.03% | -3.2 | -62% | 2 | - | CS | CS |
| Poland | NO | 178 | 178 | 2.3% | 0 | 0% | 178 | - | T1 | D |
| Romania | NO | NO | NO | - | - | - | - | - | NA | NA |
| Slovakia | NO | NO | NO | - | - | - | - | - | NA | NA |
| Slovenia | NO | NO | NO | - | - | - | - | - | NA | NA |
| **EU-27** | **76** | **8,107** | **7,915** | **100.0%** | **-191** | **-2%** | **7,839** | **10315%** | | |

$SF_6$ emissions from sector 2F9, other are reported in Table 19.9. EU-15 are responsible for 99.3% of these emissions, only Hungary, Romania, Estonia, Malta and the Czech Republic reported emissions from this sector. Whilst the EU 15 reported an increase of emissions between 2008 and 2009, all of the new member states reported a decrease of emissions.

**Table 19.14 2F9 Other: $SF_6$ emissions of EU-27**

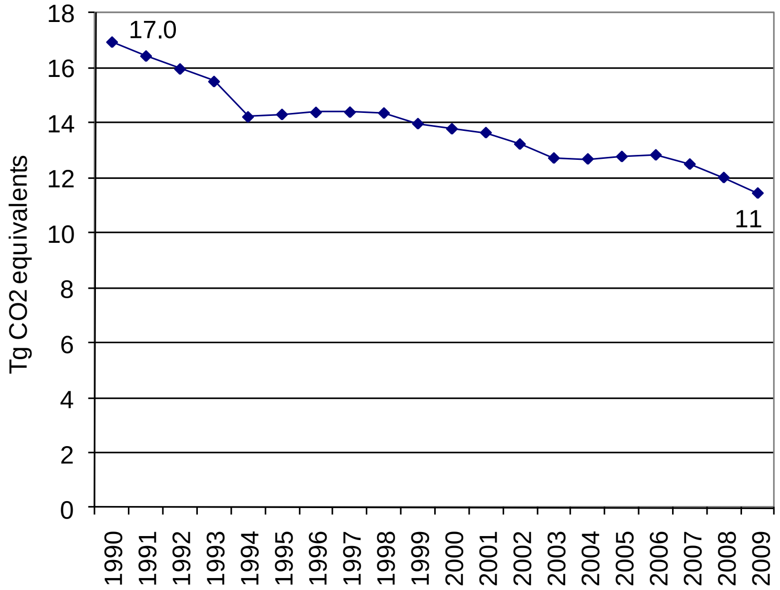
| Member State | $SF_6$ emissions (Gg $CO_2$ equivalents) | | | Share in EU27 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| EU-15 | 4,396 | 3,335 | 3,399 | 99.3% | 64 | 2% | -997 | -23% | | |
| Bulgaria | NO | NO | NO | - | - | - | - | - | NA | NA |
| Cyprus | NA | NA | NA | - | - | - | - | - | NA | NA |
| Czech Republic | NO | 6 | 5 | 0.1% | -2 | -26% | 5 | - | D | D |
| Estonia | NO | 0.05 | 0.05 | 0.0% | 0 | -10% | 0.05 | - | T2 | CS |
| Hungary | NO | 39 | 16 | 0.5% | -23 | -60% | 16 | - | T1 | D |
| Latvia | NO | NO | NO | - | - | - | - | - | NA | NA |
| Lithuania | NA | NO | NO | - | - | - | - | - | NA | NA |
| Malta | NO | 0.00 | 0.00 | 0.0% | 0 | 0% | 0 | - | CS | CS |
| Poland | NO | NO | NO | - | - | - | - | - | NA | NA |
| Romania | NO | 12 | 3 | 0.1% | -10 | - | 3 | - | T2 | D |
| Slovakia | NO | NO | NO | - | - | - | - | - | NA | NA |
| Slovenia | NO | NO | NO | - | - | - | - | - | NA | NA |
| **EU-27** | **4,396** | **3,393** | **3,422** | **100.0%** | **30** | **1%** | **-974** | **-22%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

# 20 SOLVENT AND OTHER PRODUCT USE (CRF SECTOR 3)

CRF Sector 3 Solvent and Other Product Use contribute 0.24 % to the total EU-27 GHG emissions (Table 20.5). The EU-27 Member States jointly achieved emission reductions of about 33 % from 16.96 Tg in 1990 to 11.44 Tg in 2009 (Figure 20.1 and Table 20.1).

**Figure 20.1 Sector 3 Solvent and Other Product Use: EU-27 GHG emissions for 1990–2009 in $CO_2$ equivalents (Tg)**




In 2009, the emissions decreased by 5 % compared to 2008 (Table 20.1).

**Table 20.1 Sector 3 Solvent and Other Product Use: Member States' contributions to GHG emission**

| Member State | Greenhouse gas emissions | | | Share in EU27 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | |
|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg CO2 equivalents) | (%) | (Gg CO2 equivalents) | (%) |
| EU-15 | 13,537 | 9,804 | 9,348 | 82% | -456 | -5% | -4,189 | -31% |
| Bulgaria | 898 | 51 | 48 | 0% | -3 | -6% | -850 | -95% |
| Cyprus | 2 | 3 | 3 | 0% | 0 | 1% | 1 | 33% |
| Czech Republic | 765 | 515 | 506 | 4% | -9 | -2% | -259 | -34% |
| Estonia | 21 | 22 | 17 | 0% | -491% | -22% | -347% | -17% |
| Hungary | 226 | 406 | 340 | 3% | -66 | -16% | 114 | 50% |
| Latvia | 51 | 44 | 28 | 0% | -17 | -38% | -23 | -46% |
| Lithuania | 101 | 91 | 91 | 1% | -1 | -1% | -10 | -10% |
| Malta | 2 | 2 | 2 | 0% | -1 | -24% | -1 | -36% |
| Poland | 629 | 742 | 742 | 6% | 0 | 0% | 113 | 18% |
| Romania | 541 | 135 | 122 | 1% | -13 | -9% | -418 | -77% |
| Slovakia | 147 | 167 | 164 | 1% | -2 | -1% | 17 | 12% |
| Slovenia | 43 | 28 | 31 | 0% | 3 | 12% | -12 | -29% |
| **EU-27** | **16,963** | **12,011** | **11,442** | **100%** | **-569** | **-5%** | **-5,521** | **-33%** |

In the following table the emission of $CO_2$, $N_2O$ and NMVOC as well as the Total GHG emission for the EU-12 and for all EU-12 Member States are listed as recommended in IRR 2007 (para 78) (Table 20.2).

**Table 20.2** **Sector 3 Solvent and Other Product Use: EU-12 emissions of $CO_2$, $N_2O$, NMVOC and GHG**

| | | $CO_2$ | $N_2O$ | NMVOC | Total emissions | | $CO_2$ | $N_2O$ | NMVOC | Total emissions |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Gg | Gg $CO_2$ eq | | | | Gg | Gg $CO_2$ eq |
| BG | **A. Paint Application** | 7.01 | | 3.18 | 7.01 | **B. Degreasing and Dry Cleaning** | 0.27 | NA | 0.12 | 0.27 |
| CY | | 2.43 | | 3.24 | 2.43 | | 0.61 | NE | 0.06 | 0.61 |
| CZ | | 108.85 | | 34.63 | 108.85 | | 49.18 | NA | 15.65 | 49.18 |
| EE | | 4.68 | | 2.13 | 4.68 | | 2.27 | NO | 1.03 | 2.27 |
| HU | | 47.91 | | 17.27 | 47.91 | | 0.00 | NO | 0.00 | 0.00 |
| LV | | 5.11 | | 1.74 | 5.11 | | 0.16 | NO | 0.06 | 0.16 |
| MT | | NA | | IE | NA | | NA | NA | IE | NA |
| PL | | 271.79 | | 87.21 | 271.79 | | 110.12 | NA | 35.33 | 110.12 |
| RO | | 11.05 | | 3.55 | 11.05 | | 25.43 | NE | 8.16 | 25.43 |
| SI | | NO | | 8.60 | NO | | NE | NE | 0.09 | NE |
| SK | | 59.05 | | 20.37 | 59.05 | | 9.44 | NO | 4.41 | 9.44 |
| LT | | 46.84 | | 15.03 | 46.84 | | 12.10 | NE | 3.88 | 12.10 |
| ***EU15*** | | 2,387.80 | | 955.24 | 2,387.80 | | 316.63 | 0.00 | 152.81 | 316.63 |
| EU27 | | 2,952.51 | | 1,152.18 | 2,952.51 | | 526.21 | 0.00 | 221.60 | 526.21 |
| BG | **C. Chemical Products, Manufacture and Processing** | 0.51 | | 0.23 | 0.51 | **D. Other** | 16.83 | 0.07 | 7.65 | ***40.05*** |
| CY | | NE | | NE | NE | | NE | NE | 1.03 | ***NE*** |
| CZ | | 40.60 | | 12.92 | 40.60 | | 75.02 | 0.75 | 23.87 | ***307.52*** |
| EE | | 0.64 | | 0.29 | 0.64 | | 5.28 | 0.01 | 2.40 | 0.01 |
| HU | | NO | | NO | NO | | NO | 0.94 | NO | ***292.18*** |
| LV | | 0.85 | | 0.29 | 0.85 | | 17.42 | 0.01 | 5.94 | ***21.45*** |
| MT | | NA | | IE | NA | | NA | 0.01 | 1.27 | ***1.60*** |
| PL | | 70.24 | | 22.54 | 70.24 | | 166.15 | 0.40 | 53.31 | ***290.15*** |
| RO | | NO | | 6.75 | NO | | 85.85 | NE | 27.55 | ***85.85*** |
| SI | | NE | | 3.76 | NE | | NA | 0.10 | NA | ***31.00*** |
| SK | | 18.50 | | 8.41 | 18.50 | | NO | 0.25 | 0.14 | ***77.40*** |
| LT | | NE | | NE | NE | | 31.74 | NA,NE | 10.18 | ***31.74*** |
| ***EU15*** | | 309.45 | | 299.09 | 309.45 | | 2,740.72 | 11.59 | 1,282.05 | ***6334.06*** |
| EU27 | | 440.79 | | 354.27 | 440.79 | | 3,139.01 | 14.14 | 1,415.39 | ***7522.71*** |
| BG | ***Total Solvent and Other Product Use*** | *24.62* | 0.07 | *11.19* | *47.84* | | | | | |
| CY | | *3.05* | NE | *4.33* | *3.05* | | | | | |
| CZ | | *273.65* | 0.75 | *87.07* | *506.15* | | | | | |
| EE | | *12.86* | 0.01 | *5.85* | | | | | | |
| HU | | *47.91* | 0.94 | *17.27* | *340.09* | | | | | |
| LV | | *23.54* | 0.01 | *8.03* | *27.57* | | | | | |
| MT | | *NA* | 0.01 | *1.27* | *1.60* | | | | | |
| PL | | *618.31* | 0.40 | *198.39* | *742.31* | | | | | |
| RO | | *122.33* | NE | *46.00* | *122.33* | | | | | |
| SI | | *NA,NE,NO* | 0.10 | *12.45* | *31.00* | | | | | |
| SK | | *86.99* | 0.25 | *33.33* | *164.38* | | | | | |
| LT | | *90.68* | NA,NE | *29.09* | *90.68* | | | | | |
| ***EU15*** | | *5,754.59* | 11.59 | *2,689.19* | *9,347.93* | | | | | |
| EU27 | | *7,058.52* | 14.14 | *3,143.44* | *11,442.22* | | | | | |

**Table 20.3 Sector 3 Solvent and Other Product Use: EU-27 $CO_2$ emissions as well as their share**

| | Unit | 1990 | 2009 |
|---|---|---|---|
| **CO2 emission in 'Solvent and Other Product Use'** | [Gg] | 11,664 | 7,059 |
| **Total GHG emission in 'Solvent and Other Product Use'** | [Gg $CO_2$ eq] | 13,537 | 9,348 |
| *Share of CO2 emission in Total GHG in 'Solvent and Other Product* | | *86%* | *76%* |
| **Total National CO2 Emissions and Removals (excluding net CO2 from LULUCF)** | [Gg] | 4,395,680 | 3,764,995 |
| *Share of CO2 emission from 'Solvent and Other Product Use' in Total CO2 Emissions and Removals* | | *0.27%* | *0.19%* |
| **Total National GHG Emissions and Removals (without LULUCF)** | [Gg $CO_2$ eq] | 5,588,798 | 4,614,526 |
| *Share of CO2 emission from 'Solvent and Other Product Use' in Total GHG Emissions and Removals (without LULUCF)* | | *0.21%* | *0.15%* |

**Table 20.4 Sector 3 Solvent and Other Product Use: EU-27 $N_2O$ emissions as well as their share**

| | Unit | 1990 | 2009 |
|---|---|---|---|
| **N2O emission in 'Solvent and Other Product Use'** | [Gg] | 17.1 | 14.1 |
| **Total GHG emission in 'Solvent and Other Product Use'** | [Gg $CO_2$ eq] | 13,537 | 9,348 |
| *Share of N2O emission in Total GHG* in 'Solvent and Other Product Use' | | *39%* | *47%* |
| **Total National N2O Emissions** | [Gg] | 1,718 | 1,156 |
| *Share of N2O emission from 'Solvent and Other Product Use' in Total National N2O Emissions* | | *1.00%* | *1.22%* |
| **Total National GHG Emissions and Removals (without LULUCF)** | [Gg $CO_2$ eq] | 5,588,798 | 4,614,526 |
| *Share of N2O emission from 'Solvent and Other Product Use' in Total GHG Emissions and Removals (without LULUCF)* | | *0.09%* | *0.09%* |

**Table 20.5 Sector 3 Solvent and Other Product Use: EU-27 GHG emissions as well as their share**

| | Unit | 1990 | 2009 |
|---|---|---|---|
| **GHG emission in 'Solvent and Other Product Use'** | [Gg $CO_2$ eq] | 13,537 | 9,348 |
| **Total National GHG Emissions and Removals (without LULUCF)** | [Gg $CO_2$ eq] | 5,588,798 | 4,614,526 |
| *Share of GHG emission from 'Solvent and Other Product Use' in Total GHG Emissions and Removals (without LULUCF)* | | *0.24%* | *0.20%* |

# 21 AGRICULTURE (CRF SECTOR 4)

## 21.1 Overview of sector (EU-27)

**Figure 21.1 Sector 4-Agriculture: EU-27 GHG emissions for 1990–2009 in $CO_2$ equivalents (Tg)**

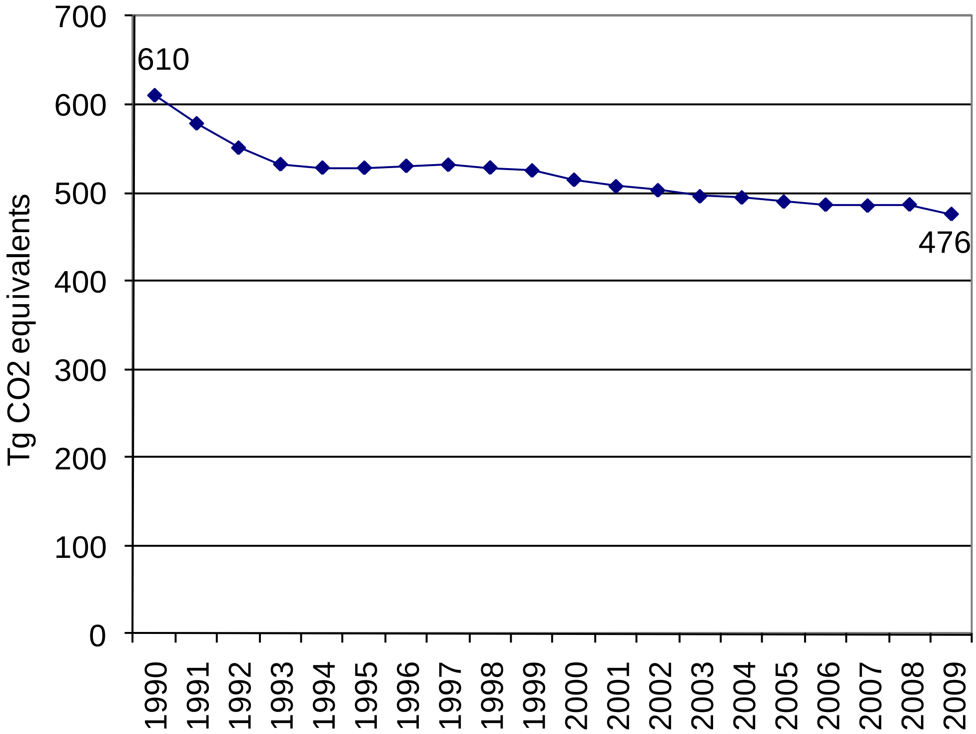
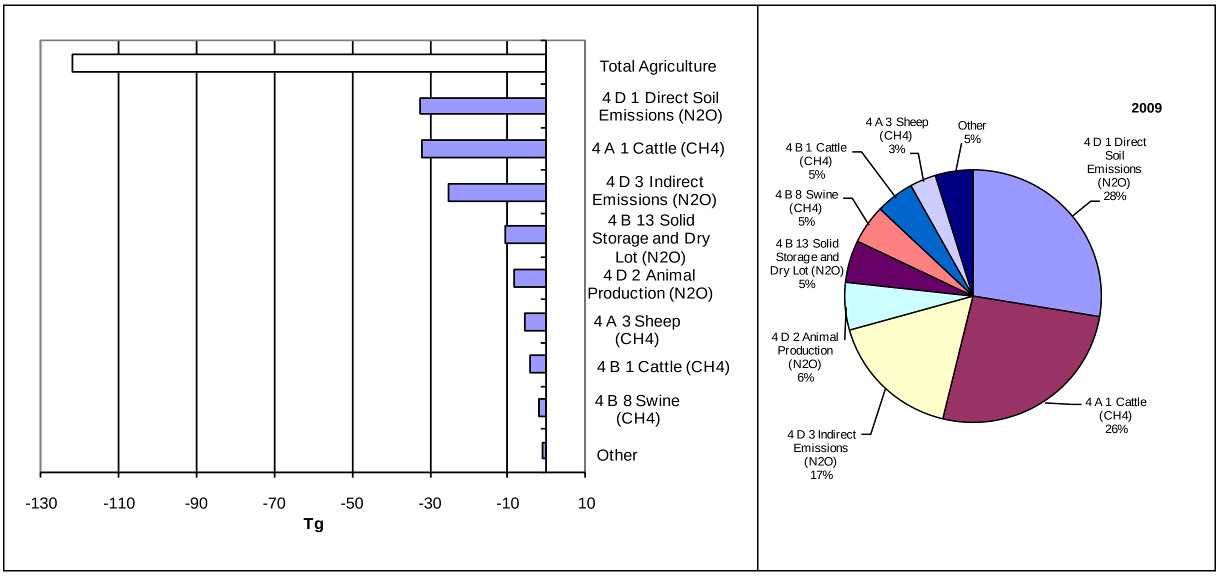



**Figure 21.2 Sector 4-Agriculture: Absolute change of GHG emissions by large key source categories 1990–2009 in $CO_2$ equivalents (Tg) and share of largest key source categories in 2009**



# 21.2 Source categories (EU-27)

## 21.2.1 Enteric fermentation (CRF Source Category 4A) (EU-27)

**Table 21.1 4A1 Cattle: $CH_4$ emissions of EU-27**

| Member State | $CH_4$ emissions (Gg $CO_2$ equivalents) | | | Share in EU27 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| EU-15 | 117,434 | 104,550 | 103,800 | 83.3% | -750 | -1% | -13,634 | -12% | | |
| Bulgaria | 2,362 | 1,036 | 973 | 0.8% | -63 | -6% | -1,389 | -59% | T2 | CS |
| Cyprus | 86 | 89 | 87 | 0.1% | -2 | -3% | 0 | 0% | T1 | D |
| Czech Republic | 4,632 | 2,292 | 2,251 | 1.8% | -41 | -2% | -2,381 | -51% | T2 | CS |
| Estonia | 1,058 | 421 | 415 | 0.3% | -6 | -1% | -643 | -61% | T1,T2 | CS,D |
| Hungary | 2,604 | 1,261 | 1,253 | 1.0% | -8 | -1% | -1,350 | -52% | T2 | CS |
| Latvia | 2,064 | 643 | 638 | 0.5% | -5 | -1% | -1,426 | -69% | T2 | CS,D |
| Lithuania | 3,017 | 1,302 | 1,226 | 1.0% | -76 | -6% | -1,791 | -59% | T2 | CS |
| Malta | 27 | 26 | 24 | 0.0% | -2 | -7% | -3 | -11% | CR | CR |
| Poland | 13,910 | 8,659 | 8,570 | 6.9% | -89 | -1% | -5,340 | -38% | T2 | CS |
| Romania | 8,016 | 4,261 | 4,005 | 3.2% | -256 | -6% | -4,012 | -50% | T1 | D |
| Slovakia | 1,802 | 801 | 758 | 0.6% | -43 | -5% | -1,044 | -58% | T2 | CS |
| Slovenia | 625 | 631 | 626 | 0.5% | -5 | -1% | 1 | 0% | T2 | CS |
| **EU-27** | **157,639** | **125,971** | **124,625** | **100.0%** | **-1,346** | **-1%** | **-33,013** | **-21%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

**Table 21.2 4A3 Sheep: $CH_4$ emissions of EU-27**

| Member State | $CH_4$ emissions (Gg $CO_2$ equivalents) | | | Share in EU27 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| EU-15 | 16,671 | 13,766 | 13,456 | 85.9% | -311 | -2% | -3,216 | -19% | | |
| Bulgaria | 1,211 | 214 | 202 | 1.3% | -12 | -6% | -1,009 | -83% | T2 | CS |
| Cyprus | 49 | 45 | 37 | 0.2% | -8 | -17% | -11 | -23% | T1 | D |
| Czech Republic | 72 | 31 | 31 | 0.2% | 0 | -1% | -41 | -57% | T1 | D |
| Estonia | 23 | 13 | 13 | 0.1% | 0 | -2% | -11 | -45% | T1 | D |
| Hungary | 329 | 213 | 212 | 1.4% | -1 | -1% | -117 | -36% | T1 | CS |
| Latvia | 28 | 11 | 12 | 0.1% | 1 | 5% | -16 | -57% | T1 | D |
| Lithuania | 9 | 9 | 9 | 0.1% | 0 | 1% | 0 | -4% | T1 | D |
| Malta | 1 | 2 | 2 | 0.0% | 0 | 0% | 1 | 179% | CR | CR |
| Poland | 700 | 55 | 49 | 0.3% | -6 | -12% | -651 | -93% | T2 | CS |
| Romania | 1,621 | 1,492 | 1,536 | 9.8% | 44 | 3% | -85 | -5% | T1 | D |
| Slovakia | 101 | 74 | 78 | 0.5% | 3 | 5% | -23 | -23% | T2 | CS |
| Slovenia | 3 | 23 | 23 | 0.1% | 0 | -1% | 20 | 581% | T1 | D |
| **EU-27** | **20,819** | **15,950** | **15,659** | **100.0%** | **-291** | **-2%** | **-5,160** | **-25%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

## 21.2.2 Manure management (CRF Source Category 4B) (EU-27)

**Table 21.3 4B1 Cattle: $CH_4$ emissions of EU-27**

| Member State | $CH_4$ emissions (Gg $CO_2$ equivalents) | | | Share in EU27 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| EU-15 | 22,346 | 20,111 | 20,011 | 86.7% | -100 | 0% | -2,335 | -10% | | |
| Bulgaria | 636 | 287 | 272 | 1.2% | -15 | -5% | -364 | -57% | T2 | CS |
| Cyprus | 34 | 35 | 34 | 0.1% | -0.91 | -3% | 0 | 1% | T1 | D |
| Czech Republic | 653 | 272 | 266 | 1.2% | -6 | -2% | -387 | -59% | T1 | D |
| Estonia | 79 | 32 | 31 | 0.1% | -0.47 | -1% | -47 | -60% | T1 | CS,D |
| Hungary | 127 | 61 | 61 | 0.3% | -0.62 | -1% | -66 | -52% | T2 | CS |
| Latvia | 138 | 48 | 54 | 0.2% | 6 | 12% | -84 | -61% | T1 | D |
| Lithuania | 417 | 258 | 243 | 1.1% | -15 | -6% | -174 | -42% | T2 | CS |
| Malta | 12 | 11 | 10 | 0.0% | -1 | -7% | -2 | -13% | CR | CR |
| Poland | 755 | 915 | 906 | 3.9% | -9 | -1% | 151 | 20% | T2 | CS |
| Romania | 1,940 | 911 | 856 | 3.7% | -55 | -6% | -1,083 | -56% | T1 | D |
| Slovakia | 127 | 40 | 39 | 0.2% | -1 | -3% | -89 | -70% | T1 | D |
| Slovenia | 212 | 288 | 296 | 1.3% | 8 | 3% | 84 | 40% | T2 | CS |
| **EU-27** | **27,474** | **23,269** | **23,078** | **100.0%** | **-191** | **-1%** | **-4,396** | **-16%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

**Table 21.4 4B8 Swine: $CH_4$ emissions of EU-27**

| Member State | $CH_4$ emissions (Gg $CO_2$ equivalents) | | | Share in EU27 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| EU-15 | 17,134 | 19,066 | 19,013 | 80.6% | -53 | 0% | 1,879 | 11% | | |
| Bulgaria | 816 | 161 | 146 | 0.6% | -15 | -9% | -670 | -82% | T2 | CS |
| Cyprus | 111 | 186 | 185 | 0.8% | -1 | 0% | 74 | 67% | T1 | D |
| Czech Republic | 302 | 153 | 124 | 0.5% | -29 | -19% | -178 | -59% | T1 | D |
| Estonia | 56 | 24 | 24 | 0.1% | 0 | 0% | -32 | -57% | T1 | CS,D |
| Hungary | 1,997 | 836 | 741 | 3.1% | -95 | -11% | -1,256 | -63% | T2 | CS |
| Latvia | 118 | 32 | 32 | 0.1% | -1 | -2% | -86 | -73% | T1 | D |
| Lithuania | 884 | 301 | 298 | 1.3% | -4 | -1% | -586 | -66% | T2 | CS |
| Malta | 13 | 14 | 14 | 0.1% | 0 | 1% | 1 | 7% | CR | CR |
| Poland | 2,208 | 2,117 | 1,960 | 8.3% | -157 | -7% | -248 | -11% | T2 | CS |
| Romania | 1,716 | 908 | 852 | 3.6% | -56 | -6% | -864 | -50% | T1 | D |
| Slovakia | 212 | 63 | 62 | 0.3% | -1 | -1% | -150 | -71% | T1 | D |
| Slovenia | 249 | 126 | 125 | 0.5% | -2 | -1% | -124 | -50% | T1 | CS |
| **EU-27** | **25,815** | **23,988** | **23,575** | **100.0%** | **-413** | **-2%** | **-2,239** | **-9%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

**Table 21.5 4B13 Solid Storage and Dry Lot: $N_2O$ emissions of EU-27**

| Member State | $N_2O$ emissions (Gg $CO_2$ equivalents) | | | Share in EU27 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| EU-15 | 20,189 | 16,921 | 16,682 | 64.9% | -239 | -1% | -3,507 | -17% | | |
| Bulgaria | 1,427 | 448 | 424 | 1.6% | -24 | -5% | -1,003 | -70% | D | D |
| Cyprus | 77 | 212 | 170 | 0.7% | -42 | -20% | 92 | 119% | T1 | D |
| Czech Republic | 522 | 245 | 222 | 0.9% | -23 | -10% | -300 | -58% | T1 | D |
| Estonia | 202 | 92 | 90 | 0.4% | -2 | -2% | -111 | -55% | T1 | D |
| Hungary | 1,726 | 947 | 931 | 3.6% | -16 | -2% | -795 | -46% | T1 | CS,D |
| Latvia | 564 | 160 | 159 | 0.6% | -2 | -1% | -406 | -72% | T1 | CS,D |
| Lithuania | 795 | 301 | 285 | 1.1% | -16 | -5% | -510 | -64% | T1 | D |
| Malta | 2 | 2 | 2 | 0.0% | -0.16 | -7% | -0.18 | -7% | CS | CS |
| Poland | 7,737 | 5,189 | 4,991 | 19.4% | -198 | -4% | -2,746 | -35% | T2 | CS,D |
| Romania | 2,112 | 1,325 | 1,256 | 4.9% | -69 | -5% | -855 | -40% | T1 | D |
| Slovakia | 1,055 | 376 | 368 | 1.4% | -8 | -2% | -686 | -65% | T2 | D |
| Slovenia | 252 | 142 | 140 | 0.5% | -2 | -2% | -111 | -44% | D | CS,D |
| **EU-27** | **36,660** | **26,363** | **25,721** | **100.0%** | **-642** | **-2%** | **-10,939** | **-30%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

**Table 21.6 4B14 Other: $N_2O$ emissions of EU-27**

| Member State | $N_2O$ emissions (Gg $CO_2$ equivalents) | | | Share in EU27 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | |
|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) |
| EU-15 | 2,044 | 2,577 | 2,506 | 87.1% | -71 | -3% | 463 | 23% |
| Bulgaria | 29 | 7 | 7 | 0.3% | 0.00 | 0% | -21 | -74% |
| Cyprus | 0.000 | 0.000 | 0.000 | 0.0% | 0.00 | - | 0.00 | - |
| Czech Republic | 78 | 49 | 47 | 1.6% | -2 | -3% | -32 | -40% |
| Estonia | 76 | 27 | 27 | 0.9% | 0.12 | 0% | -49 | -65% |
| Hungary | 0.015 | 0.032 | 0.028 | 0.0% | 0.00 | - | 0.01 | - |
| Latvia | NO | NO | NO | - | - | - | - | - |
| Lithuania | 28 | 12 | 11 | 0.4% | 0 | -3% | -17 | -60% |
| Malta | NO | NO | NO | - | - | - | - | - |
| Poland | NO | NO | NO | - | - | - | - | - |
| Romania | 581 | 283 | 277 | 9.6% | -6 | -2% | -304 | -52% |
| Slovakia | NO | NO | NO | - | - | - | - | - |
| Slovenia | 1 | 1 | 1 | 0.0% | 0.07 | 7% | -0.08 | -6% |
| **EU-27** | **2,837** | **2,955** | **2,877** | **100.0%** | **-78** | **-3%** | **40** | **1%** |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

## 21.2.3 Agricultural soils (CRF Source Category 4D) (EU-27)

**Table 21.7 4D1 Direct soil emissions: $N_2O$ emissions of EU-27**

| Member State | $N_2O$ emissions (Gg $CO_2$ equivalents) | | | Share in EU27 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| EU-15 | 117,233 | 100,279 | 96,332 | 73.3% | -3,947 | -4% | -20,901 | -18% | | |
| Bulgaria | 4,671 | 1,999 | 1,991 | 1.5% | -7 | 0% | -2,680 | -57% | T1a,T1b | D |
| Cyprus | 113 | 106 | 90 | 0.1% | -15 | -15% | -23 | -20% | T1 | D |
| Czech Republic | 4,815 | 2,895 | 2,706 | 2.1% | -190 | -7% | -2,109 | -44% | T1 | D |
| Estonia | 863 | 473 | 434 | 0.3% | -39 | -8% | -428 | -50% | T1 | D |
| Hungary | 4,051 | 3,162 | 2,891 | 2.2% | -271 | -9% | -1,160 | -29% | T1 | D |
| Latvia | 1,573 | 873 | 894 | 0.7% | 21 | 2% | -678 | -43% | T1,T1b | CS,D |
| Lithuania | 2,405 | 1,263 | 1,368 | 1.0% | 105 | 8% | -1,037 | -43% | T1 | D |
| Malta | 14 | 13 | 13 | 0.0% | 0 | -2% | -1 | -8% | T2 | D |
| Poland | 16,014 | 13,207 | 12,907 | 9.8% | -300 | -2% | -3,107 | -19% | T1,T1b,CS | CS |
| Romania | 15,932 | 10,202 | 10,181 | 7.7% | -21 | 0% | -5,751 | -36% | T1 | D |
| Slovakia | 2,414 | 1,257 | 1,209 | 0.9% | -48 | -4% | -1,205 | -50% | T2 | CS,D |
| Slovenia | 412 | 368 | 386 | 0.3% | 18 | 5% | -26 | -6% | D,T1,T1b | CS,D |
| **EU-27** | **170,510** | **136,097** | **131,404** | **100.0%** | **-4,693** | **-3.4%** | **-39,107** | **-23%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

**Table 21.8 4D2 Pasture, Range and Paddock Manure: $N_2O$ emissions of EU-27**

| Member State | $N_2O$ emissions (Gg $CO_2$ equivalents) | | | Share in EU27 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| EU-15 | 30,292 | 25,863 | 25,551 | 88.1% | -312 | -1% | -4,741 | -16% | | |
| Bulgaria | 1,045 | 291 | 282 | 1.0% | -9 | -3% | -763 | -73% | T1 | D |
| Cyprus | 114 | 47 | 29 | 0.1% | -18 | -39% | -85 | -75% | T1 | D |
| Czech Republic | 916 | 366 | 356 | 1.2% | -9 | -3% | -560 | -61% | T1 | D |
| Estonia | 82 | 35 | 34 | 0.1% | -0.25 | -1% | -47 | -58% | T1 | D |
| Hungary | 291 | 176 | 175 | 0.6% | -1 | 0% | -116 | -40% | T1 | D |
| Latvia | 358 | 103 | 102 | 0.4% | -1 | -1% | -256 | -71% | T1a | D |
| Lithuania | 400 | 217 | 204 | 0.7% | -13.01 | -6% | -196 | -49% | T1 | D |
| Malta | NO | NO | NO | - | - | - | - | - | NA | NA |
| Poland | 1,360 | 457 | 445 | 1.5% | -12 | -3% | -915 | -67% | T1 | CS,D |
| Romania | 2,871 | 1,691 | 1,693 | 5.8% | 2 | 0% | -1,178 | -41% | T1 | D |
| Slovakia | 222 | 93 | 92 | 0.3% | -0.88 | -1% | -130 | -59% | T2 | CS |
| Slovenia | 22 | 54 | 55 | 0.2% | 0.22 | 0% | 33 | 148% | D | D |
| **EU-27** | **37,973** | **29,391** | **29,018** | **100.0%** | **-374** | **-1%** | **-8,956** | **-24%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

**Table 21.9 4D3 Indirect Emissions: $N_2O$ emissions of EU-27**

| Member State | $N_2O$ emissions (Gg $CO_2$ equivalents) | | | Share in EU27 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| EU-15 | 81,939 | 67,640 | 65,135 | 81.1% | -2,505 | -4% | -16,803 | -21% | | |
| Bulgaria | 3,254 | 1,198 | 1,190 | 1.5% | -8 | -1% | -2,064 | -63% | T1b | D |
| Cyprus | NE | NE | NE | - | - | - | - | - | T1 | D |
| Czech Republic | 3,627 | 1,841 | 1,715 | 2.1% | -126 | -7% | -1,912 | -53% | T1 | D |
| Estonia | 546 | 249 | 214 | 0.3% | -35 | -14% | -332 | -61% | T1 | D |
| Hungary | 2,762 | 1,896 | 1,797 | 2.2% | -99 | -5% | -966 | -35% | T1 | D |
| Latvia | 1,034 | 339 | 356 | 0.4% | 18 | 5% | -677 | -66% | T1,T1b | D |
| Lithuania | 1,915 | 881 | 919 | 1.1% | 37 | 4% | -996 | -52% | T1 | D |
| Malta | 7 | 7 | 7 | 0.0% | 0 | -3% | -0.18 | -3% | T1 | D |
| Poland | 5,921 | 4,968 | 4,770 | 5.9% | -198 | -4% | -1,151 | -19% | T1,T1b,CS | D |
| Romania | 7,091 | 3,582 | 3,582 | 4.5% | 0 | 0% | -3,508 | -49% | T1 | D |
| Slovakia | 995 | 390 | 350 | 0.4% | -39 | -10% | -645 | -65% | T2 | CS |
| Slovenia | 313 | 287 | 301 | 0.4% | 14 | 5% | -12 | -4% | D,T1a | D |
| **EU-27** | **109,404** | **83,279** | **80,337** | **100.0%** | **-2,942** | **-4%** | **-29,067** | **-27%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

# 21.3 Methodological issues

## 21.3.1 Enteric Fermentation (CRF source category 4.A)

$CH_4$ emissions in the source category Enteric Fermentation stem for 7 EU-12 Member States to over 85% from the sub-category "Cattle" with a maximum of 96% in Lithuania and Latvia. Substantial emissions from the sub-category "Sheep" (up to 25% of emissions in category 4.A. for Romania) are reported by Bulgaria, Cyprus, Hungary, Romania). Emissions accounting for more than 5% of the emissions in this category are further reported only for the sub-category "Goats" (Cyprus, 11%).

An overview of the $CH_4$ emissions, animal population and the corresponding implied emission factors for $CH_4$ emissions from enteric fermentation for the most important categories cattle and sheep (key source at EU-12-level) and also goats and swine are given in Table 21.10. Data are given for 2009 as the last inventory year and the base year 1990. The table shows that there is a general trend of decreasing animal numbers which are partly compensated by higher emissions per head due to intensification of livestock production in Europe. Compared to the trend in EU-15 countries, the reduction of animal numbers for cattle, sheep and swine is much stronger in the EU-12 countries.

**Table 21.10** **Total $CH_4$ emissions in category 4A and implied Emission Factor at EU-12 level for the years 1990 and 200**

| 1990[1)] | Dairy Cattle | Non-dairy cattle | Sheep | Goats | Swine |
|---|---|---|---|---|---|
| | | | | | |
| $CH_4$ emissions [Gg $CH_4$] | 1061 | 853 | 197 | 10 | 79 |
| Animal population [1000 heads] | 11755 | 17917 | 31628 | 1961 | 56560 |
| Implied EF (kg $CH_4$/head/yr) | 90 | 48 | 6.2 | 5.0 | 1.4 |

| 2009 | Dairy Cattle | Non-dairy cattle | Sheep | Goats | Swine |
|---|---|---|---|---|---|
| | | | | | |
| $CH_4$ emissions [Gg $CH_4$] | 632 | 359 | 105 | 9 | 44 |
| Animal population [1000 heads] | 6211 | 6945 | 13260 | 1795 | 29403 |
| Implied EF (kg $CH_4$/head/yr) | 102 | 52 | 7.9 | 5.0 | 1.5 |

| 2009 value in percent of 1990 | Dairy Cattle | Non-dairy cattle | Sheep | Goats | Swine |
|---|---|---|---|---|---|
| | | | | | |
| CH4 emissions [Gg CH4] | 60% | 42% | 53% | 92% | 55% |
| Animal population [1000 heads] | 53% | 39% | 42% | 92% | 52% |
| Implied EF (kg CH4/head/yr) | 113% | 109% | 127% | 100% | 106% |

Information source: CRF for 1990 and 2009, submitted in 2011

### 21.3.1.1 Methodological Issues

$CH_4$ emissions from enteric fermentation is a key source category for cattle and sheep. For cattle, this is also true for all member states. Accordingly, most Member States have used Tier 2 methodology for calculating enteric $CH_4$ emissions, as shown in Table 21.11, even though the overall Tier-level for non-dairy cattle is with Tier 1.8 somewhat lower for EU-12 than for EU-15 (Tier 2.0 ). In addition to the methodology applied by the Member States for calculating $CH_4$ emissions, the table indicates also the total emissions in the category “enteric fermentation”, the contribution of the animal types considered (dairy and non-dairy cattle and sheep) to the total emissions, and whether the emissions from the animal class are belonging to the key source categories in the different Member States. On EU-12 level, 85% of the $CH_4$ emissions in category 4.A have been estimated with a Tier 2 approach compared to 97% for EU-15. For EU-27, this gives 95% of emissions estimated with a Tier 2 approach.

**Table 21.11** **Total $CH_4$ emissions in category 4A and implied Emission Factor at EU-27 level for the years 1990 and 200**

| Member State | Total | | Dairy Cattle | | Non-dairy cattle | | Cattle | Sheep | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Gg $CO_2$-eq | b | a | b | a | b | c | a | b | c |
| Bulgaria | 1,345 | Tier 1.9 | 52% | Tier 2.0 | 20% | Tier 2.0 | y | 15% | Tier 2.0 | y |
| Cyprus | 165 | Tier 1.2 | 30% | Tier 1.0 | 23% | Tier 2.0 | y | 23% | Tier 1.0 | y |
| Czech Republic | 2,356 | Tier 2.0 | 59% | Tier 2.0 | 37% | Tier 2.0 | y | 1% | Tier 1.0 | y |
| Estonia | 436 | Tier 1.6 | 63% | Tier 2.0 | 32% | Tier 1.0 | y | 3% | Tier 1.0 | y |
| Hungary | 1,615 | Tier 1.8 | 44% | Tier 2.0 | 33% | Tier 2.0 | y | 13% | Tier 1.0 | y |
| Latvia | 668 | Tier 2.0 | 61% | Tier 2.0 | 35% | Tier 2.0 | y | 2% | Tier 1.0 | y |
| Lithuania | 1,278 | Tier 2.0 | 63% | Tier 2.0 | 33% | Tier 2.0 | y | 1% | Tier 1.0 | y |
| Malta | 32 | Tier 1.0 | 46% | Tier 1.0 | 30% | Tier 1.0 | y | 7% | Tier 1.0 | y |
| Poland | 9,194 | Tier 1.9 | 60% | Tier 2.0 | 34% | Tier 2.0 | y | 1% | Tier 1.0 | y |
| Romania | 6,149 | Tier 1.4 | 45% | Tier 2.0 | 20% | Tier 1.0 | y | 25% | Tier 1.0 | y |
| Slovakia | 865 | Tier 2.0 | 52% | Tier 2.0 | 35% | Tier 2.0 | y | 9% | Tier 2.0 | y |
| Slovenia | 674 | Tier 1.9 | 36% | Tier 2.0 | 57% | Tier 2.0 | y | 3% | Tier 1.0 | y |
| EU-12 | **24,777** | **Tier 1.8** | **54%** | **Tier 2.0** | **30%** | **Tier 1.8** | | **9%** | **Tier 1.1** | |
| EU-15 | **124,325** | **Tier 1.9** | **36%** | **Tier 2.0** | **48%** | **Tier 2.0** | | **11%** | **Tier 1.7** | |
| EU-27 | **149,102** | **Tier 1.9** | **39%** | **Tier 2.0** | **45%** | **Tier 2.0** | | **11%** | **Tier 1.6** | |
| EU-12: Tier 1 | 15% | | 0% | | 19% | | | 87% | | |
| EU-12: Tier 2 | 85% | | 100% | | 81% | | | 13% | | |

a Contribution to $CH_4$ emissions from enteric fermentation
b Tier 1: default methodology; Tier 2: country-specific methodology
c Source category is key in the Member State's inventory (y/n). nr: not reported. Assessment for total cattle.

Details on the applied methodologies for the estimation of $CH_4$ emissions from enteric fermentation are given in

Table 6.15.

**Table 21.12 Methodology used by Member States for calculating $CH_4$ emissions in category 4A**

| Member State | Methodology |
|---|---|
| Bulgaria | Cattle and sheep: Tier 2. Other animal types: Tier 1 |
| Cyprus | Tier 1 |
| Czech Republic | Cattle: Tier 2 method, other animal types: Tier 1 |
| Estonia | Tier 2 method for the main cattle livestock sub-categories. A disaggregation on county level of Estonia was used. Tier 1 for other relevant animals. |
| Hungary | In the frame of the methodological development the conversion into the Tier 2 method is in progress, but a certain part of the country-specific information pertaining to the characteristics of livestock (body mass, net energy requirements, composition of feed rations, methane conversion rate, etc.) is to be confirmed as well as to be further elaborated for the entire time series. So it was decided that the simplified Tier 1 method is kept in order to maintain the consistency of time series in the current state of the methodology development. |
| Lithuania | $CH_4$ emissions from enteric fermentation by dairy cattle and non-dairy cattle were calculated using the IPCC Tier 2 methodology. For non-cattle categories, $CH_4$ emissions from enteric fermentation of sheep, goats, horses and pigs have been calculated using IPCC Tier1 methodology. The gross energy intake is calculated using the detailed characterisation of livestock herds and the methane-conversion rate from the IPCC-GPG (2000) and from national data. Feed intake for non - dairy cattle was collect from national data. |
| Latvia | $CH_4$ emissions from Enteric Fermentation have been estimated using the Tier 1 methodology. In Tier 1 method, total emissions have been calculated by multiplying the number of the animals in each category with the IPCC default emission factor of each animal category. |
| Malta | |
| Poland | Methane emissions from enteric fermentation of cattle and sheep were based on Tier 2 method. In case of goats, horses and swine the Tier 1 method and default Emission Factors for $CH_4$ was applied. |
| Romania | IPCC Tier 1 default according IPCC GPG 2000 (lack of detailed data needed for Tier 2). |
| Slovenia | Tier 2 for dairy and non-dairy cattle. Tier 1 for other animals. |
| Slovakia | Tier 2 methodology based on national data about animal number in detailed categories (for dairy, non-dairy cattle and other cattle) and more advance characteristic about feed and milk conditions for category dairy cattle. Total methane emissions from enteric fermentation of sheep were estimated from 2004 by Tier 2 methodology based on detailed classification of animal to three categories: ewes, lambs and other sheep. The country specific data are available only from 2004. Tier 1 methodology for other animals categories (Horses, Goats). |

## Activity Data

Animal population of dairy and non-dairy cattle, sheep, goat, swine, and poultry in 200 are given in Table 6.16. The characterization of the livestock population across the background tables 4.A, 4.B(a), and 4.B(b) is done in a consistent way by all Member States and will therefore be discussed only here. Estonia has chosen to use the option B for the classification of cattle. In order to allow the calculation of an EC implied emission factor for the categories listed under option A, these numbers were “converted” using the following rule: Mature Dairy Cattle → Dairy Cattle; Mature Non-dairy Cattle + Young Cattle → Non-dairy cattle.

Some information on the source of the animal numbers for the different Member States is given in

Table 21.14.

**Table 21.13 Animal population [1000 heads] in 200**

| Member State 2009 | Dairy Cattle | Non-dairy cattle | Sheep | Goats | Swine | Poultry |
|---|---|---|---|---|---|---|
| Bulgaria | 611 | 493 | 1,438 | 395 | 757 | 17,475 |
| Cyprus | 23 | 31 | 222 | 178 | 463 | 3,010 |
| Czech Republic | 560 | 803 | 183 | 17 | 1,971 | 26,491 |
| Estonia | 193 | 276 | 77 | 4 | 365 | 1,792 |
| Hungary | 258 | 444 | 1,261 | 65 | 3,248 | 44,789 |
| Latvia | 166 | 213 | 71 | 13 | 377 | 4,829 |
| Lithuania | 372 | 357 | 54 | 15 | 928 | 9,309 |
| Malta | 7 | 9 | 13 | 6 | 66 | 1,224 |
| Poland | 2,688 | 3,012 | 286 | 119 | 14,279 | 140,826 |
| Romania | 1,419 | 1,063 | 9,141 | 917 | 5,793 | 83,843 |
| Slovakia | 204 | 268 | 377 | 36 | 741 | 13,583 |
| Slovenia | 113 | 360 | 138 | 30 | 415 | 5,212 |
| **EU-12** | **6,614** | **7,330** | **13,260** | **1,795** | **29,403** | **352,383** |
| **EU-15** | **19,340** | **60,630** | **89,094** | **11,775** | **115,607** | **1,155,080** |
| **EU-27** | **25,954** | **67,959** | **102,354** | **13,570** | **145,010** | **1,507,463** |

Information source: CRF for 1990 and 2009, submitted in 2011

[1)] Finland reports non-dairy cattle under "other" in the following categories: bulls, cows, heifers, and calves. [2)] For Luxembourg and the Netherlands the numbers for cattle have been calculated using the figure given under option B.

**Table 21.14 Information on the source of animal population data**

| Member State | Methodology |
|---|---|
| Bulgaria | All domestic animals indicated in IPCC except for llamas and camels. |
| Cyprus | |
| Czech Republic | The Czech Statistical Office, see (Statistical Yearbooks, 1990 – 2006), provides detailed categorization of cattle (Calves younger than 6 months of age, Young cattle 6 – 12 months of age (young bulls, young heifers), Bulls over 1 year of age, including bullocks (1 – 2 years, over 2 years), Heifers 1 – 2 years of age, Heifers over 2 years of age, Cows. More disaggregated sub-categories given above in parenthesis are given in the study by external agricultural consultants of CHMI (Hons and Mudrik, 2003). In the calculation, it is also very important to distinguish between dairy and sucker cows (nursing cows). |
| Estonia | Activity data were used from official Estonian statistics (the Statistical Office of Estonia [ESO], Estonian Animal Recording Center (EARC). The number of livestock by sub-categories of cattle and by county of Estonia was obtained from the annual report of the ESO. |
| Hungary | Livestock population were obtained from the Department of Production Statistics, Main Department of Hungarian Central Statistical Office (HCSO). Since 2000, the HCSO has been registering the livestock three times a year (1 April, 1 August, 1 December), using a method which is equal to that of the EU. |
| Lithuania | The number of cattle, sheep, goats, horses and swine and milk production was received from the Statistical Yearbook “Agriculture in Lithuania”. |
| Latvia | The number of cattle, sheep, horses, swine and goats were obtained from the Statistical yearbooks of Latvia. The source of data on the number of livestock in state farms and statutory companies are statistical surveys while sample surveys are used to collect information from peasant farms, household plots and private subsidiary farms. The survey was first launched in 1995 and since then it is conducted twice a year. The sample for 2006 covers 15.0 thsd. farms selected by economic size and specialisation. |
| Malta | National Statistics. |
| Poland | Activity data were obtained from national statistics (GUS R2 2007). |
| Romania | Total animal number data are provided by Romanian National Institute for Statistics (NIS) being released through Statistical Yearbook (SY 2007) and other relevant correspondence. Beginning with 2004, NIS provides to Eurostat a more complete set of data, comprising also Dairy cows data. Due to impossibility of finding data from Romanian sources we used Mules and asses data from FAO databases. For 1989-2003 period the number of Dairy cows was obtained by dividing the Cow’s and buffalo cow’s milk (calfs feeding included) production by the Average production per animal (cow’s and buffalo cow’s milk). |
| Slovenia | Statistical Office of Slovenia has published revised data on livestock numbers and production for the period 1991-2002. These data have been published in Rapid Reports No. 256. The main purpose of that revision was the methodological harmonisation of data and methods of estimating data for the mentioned period. This methodology is harmonised with recommendations of the Statistical Office of the European Communities. |
| Slovakia | Basic sources of data used for evaluations of emissions were published in Census of sowing areas of field crops in the SR; Annual census of domestic livestock in the SR; Green report of the SR 1998-2006, Ministry of Agriculture of the SR; Statistical Yearbook 1990-2006, Statistic Office of the SR. Detail input data about cattle and sheep according the regions are available from 1997 and published in the Green reports of the SR (www.land.gov.sk) and verified by district offices statistical farm information (bottom-up approach). In the FAO database, livestock numbers have been grouped in 12-month periods, ending on September 30 of the year stated in the tables. Our Statistical Office collects data on animal population in December and reports them in the current year. In the FAO database, these data are applied to the next year. Considering this explanation, all data on animals in the FAO database and in our statistical database are the same. The only difference is in the number of poultry, where our entire poultry population is shown in the FAO database as chicken population. |

## Emission Factors and other parameters

Considerable variation is found in the IEF for dairy and non-dairy cattle with values between 92 kg $CH_4$ head$^{-1}$ yr$^{-1}$ (Romania) and 136 kg $CH_4$ head$^{-1}$ yr$^{-1}$ (Estonia) for dairy cattle, and 48 kg $CH_4$ head$^{-1}$ yr$^{-1}$ (Estonia)) and 58 $CH_4$ head$^{-1}$ yr$^{-1}$ (Cyprus) for non-dairy cattle. The difference can mainly be explained by the different levels of intensity for dairy production. The IEF for the EU-12 Member States and the $CH_4$ conversion factors used are given in Table 6.18. For EU-12, the implied emission factor for dairy cattle in 200 was 101.8 kg $CH_4$ head$^{-1}$ yr$^{-1}$ and lower than the value for EU-15 giving an overall IEF of 114.8 for EU-27.

More detailed information on the development of the emission factors for category 4A is given in

Table 21.16.

**Table 21.15 Implied Emission factors for $CH_4$ emissions from enteric fermentation and $CH_4$ conversion factors used in Member State's inventory**

| Member State | Implied EF (kg $CH_4$/head/yr) [1)] | | | | | $CH_4$ conversion (%) [1)] | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 2009 | Dairy Cattle | Non-dairy cattle | Sheep | Goats | Swine | Dairy Cattle | Non-dairy cattle | Sheep | Goats | Swine |
| Bulgaria | 109.8 | 51.9 | 6.7 | 5.0 | 1.5 | 6.0 | 6.0 | 0.1 | 0.1 | 0.6 |
| Cyprus | 100.0 | 58.0 | 8.0 | 5.0 | 1.5 | | | | | |
| Czech Republic | 117.5 | 51.6 | 8.0 | 5.0 | 1.5 | 6.0 | 6.0 | NA | NA | NA |
| Estonia | 136.1 | 47.8 | 8.0 | 5.0 | 0.8 | 6.0 | 6.1 | 6.0 | 5.0 | 0.6 |
| Hungary | 132.7 | 57.4 | 8.0 | 5.0 | 1.5 | 5.8 | 6.0 | 6.0 | 5.0 | 0.6 |
| Latvia | 116.5 | 52.2 | 8.0 | 5.0 | 1.5 | 6.0 | 6.0 | NA | NA | NA |
| Lithuania | 102.5 | 56.7 | 8.0 | 5.0 | 1.2 | 6.0 | 6.0 | NA | NA | NA |
| Malta | 100.0 | 48.0 | 8.0 | 5.0 | 1.5 | NE | NE | NE | NE | NE |
| Poland | 97.0 | 48.9 | 8.2 | 5.0 | 1.5 | 6.0 | 6.0 | 7.0 | NE | NE |
| Romania | 92.4 | 56.0 | 8.0 | 5.0 | 1.5 | NE | NE | NE | NE | NE |
| Slovakia | 105.6 | 54.3 | 9.8 | 5.0 | 1.5 | 6.0 | 6.0 | 7.0 | NE | NE |
| Slovenia | 102.8 | 50.5 | 8.0 | 5.0 | 1.6 | 6.0 | 6.0 | NA | NA | NA |
| **EU-12** | **101.8** | **51.8** | **7.9** | **5.0** | **1.5** | **6.0** | **6.0** | **3.7** | **0.8** | **0.6** |
| **EU-15** | **119.3** | **49.1** | **7.2** | **5.9** | **1.2** | **6.0** | **5.8** | **6.6** | **5.0** | **30.6** |
| **EU-27** | **114.8** | **49.4** | **7.3** | **5.8** | **1.3** | **6.0** | **5.8** | **6.2** | **4.4** | **24.6** |

Information source: CRF for 1990 and 2009, submitted in 2011. Abbreviations explained in the Chapter 'Units and abbreviations'.

**Table 21.16 Implied Emission factors for $CH_4$ emissions from enteric fermentation and $CH_4$ conversion factors used in Member State's inventory**

| Member State | Methodology |
|---|---|
| Bulgaria | |
| Cyprus | IPCC default. |
| Czech Republic | IPCC Tier 2. The “daily food intake” for each subcategory of cattle is not measured directly, but is calculated from national zoo-technical inputs, mainly weight (including the final weight of mature animals), weight gain (for growing animals), daily milk production including the percentage of fat (for cows) and the feeding situation (stall, pasture). The national zoo-technical inputs were updated by expert from the Czech University of Agriculture in Prague in 2006. |
| Estonia | The average enteric fermentation emission factor of dairy cattle is continuing to grow since 1995 due mostly to increasing milk production by cow and fat content of milk. IPCC default, excluding milk production per cow and milk fat content. Sheep, goats and horses: EF for developed countries. |
| Hungary | IPCC default for developed countries. Development of the country-specific emission factor for the entire time series will have been done by July 2007. |
| Lithuania | The IPCC Tier 2 EFs for Dairy and Non-Dairy Cattle were estimated based on national data. The productivity of the cows is established in accordance with the data of the Department of Statistics. Milk fat data is taken of the register of the herds in control. IPCC default emission factors were used for calculating $CH_4$ emissions from enteric fermentation for remaining animal categories (Tier 1 method). |
| Latvia | IPCC default. |
| Malta | |
| Poland | Gross Energy Intake (GE) was calculated [IPCC 2000, equation 4.11] for dairy cattle and for and non-dairy cattle disaggregated for: calves under 1 year, young cattle 1-2 years and other matured cattle (over 2 years). Country specific parameters like pregnancy [GUS R1 2008], milk production (table 6.1), percent of fat in milk [GUS R 2008] come from national statistics. Digestible energy (DE – expressed as a percent of gross energy) was estimated by[Walczak 2006] and change from 58.6% in 1988 through 60% in 1995 up to 62.8% in 2004 and after for dairy cattle what was caused by diet improving.The emission factors were estimated for each livestock category within cattle according national study (Miczko 2001) and updating data about animal breeding (Walczak 2003, 2006). The characteristics like mean mass or daily mass gain of animals come from country case study [Walczak 2006], wool production come from national statistics [GUS R 2008]. |
| Romania | The emissions factors specific to Dairy cows have been calculated through interpolation between default emissions factors values, using the Average milk production per animal (cow and buffalo cow) data series. |
| Slovenia | Dairy cattle: According to data on emission factors from period 1985-1996 an equation was developed that is based only on the data on average milk yield, where EM is methane emission in kg per animal per year, and the average annual milk yield of dairy cows. This equation has been applied for calculation of emissions for whole period 1985-2007. Other animals: default EFs. Milk recording data which is performed by the national Cattle breeding service (Verbi?, Sušin, Podgoršek 1999, p. 3). For the year 2007, more precise average daily gains for young bovine animals for fattening were obtained. |
| Slovakia | Dairy and non-dairy cattle: linear extrapolation from 1996 back to the base year 1990. The time series of EFs is based on average gross energy intake (AGEI) and detailed cattle categories analysis. The emission factor for enteric fermentation was estimated according to milk productivity for each year by interpolation when for milk productivity. |

### *21.3.2 Manure Management $CH_4$ (CRF source category 4.B(a))*

Table 21.17 shows in contrast to EU-15, where swine and catle contribute more or less equally to $CH_4$ emissions from manure management, swine are the main source of $CH_4$ emissions from manure management in EU-12 (63%). For cattle, the contributions of non-dairy cattle are slightly prevailing with percentages of total emissions in this category amounting to 20% and 17%, respectively. The highest contribution of cattle to $CH_4$ emissions from manure management are observed in Slovenia (69%) and the Czech Republic (61%); the lowest in Hungary and Cyprus, where cattle contribute with only 6% and 14%, respectively. This is compensated with the emissions from swine manure where Hungary has a share of 77%, while swine contributes only 29% in Slovenia. For EU-12 level, $CH_4$ emissions from manure management have decreased significantly for cattle and swine.

**Table 21.17** **Total $CH_4$ emissions in category 4A and implied Emission Factor at EU-12 level for the years 1990 and 200**

| | Dairy Cattle | Non-dairy cattle | Swine |
|---|---|---|---|
| | 1990 | | |
| Total Emissions of $CH_4$ [Gg $CH_4$] | 131 | 113 | 413 |
| Total Population [1000 heads] | 11755 | 17917 | 56560 |
| Implied Emission Factor [kg $CH_4$ / head / year] | 11.2 | 6.3 | 7.3 |

| | Dairy Cattle | Non-dairy cattle | Swine |
|---|---|---|---|
| | 2009 | | |
| Total Emissions of $CH_4$ [Gg $CH_4$] | 93 | 53 | 217 |
| Total Population [1000 heads] | 6211 | 6945 | 29403 |
| Implied Emission Factor [kg $CH_4$ / head / year] | 15.0 | 7.6 | 7.4 |

| | Dairy Cattle | Non-dairy cattle | Swine |
|---|---|---|---|
| | 2009 value in percent of 1990 | | |
| Total Emissions of $CH_4$ [Gg $CH_4$] | 71% | 47% | 53% |
| Total Population [1000 heads] | 53% | 39% | 52% |
| Implied Emission Factor [kg $CH_4$ / head / year] | 134% | 121% | 101% |

Source of information: CRF Table4s1 and 4.B(a) for 1990 and 2009, submitted in 2011

Dairy cattle includes Mature Dairy cattle, Non-dairy cattle includes Mature Non-Dairy Cattle and Young Cattle

### 21.3.2.1 Methodological Issues

$CH_4$ emissions from manure management are a key source category for cattle and swine at EU-12 level. This is true also for many Member States. Table 6.27 shows the total emissions in category 4.B(a), how this is composed and the methodology used for calculating the emissions for cattle and swine by Member States. Also, it is reports whether the source category is a key source category for the Member States.

The method for calculation of $CH_4$ emissions from manure management has been done as described in Chapter 6.3.2.2. and 6.4.1. Overall, the quality of the emission estimates in category 4B(a) range between Tier 1.0 and Tier 1.9 with a Tier level for EU-12 of Tier 1.3 (corresponding to 40% of the emissions being calculated with country-specific data). Some additional information on the methodological approaches for some Member States is given in Table 21.19.

**Table 21.18** **Total emissions and contribution of the main sub-categories to $CH_4$ emissions in category 4B(a), methodology applied and key source assessment by Member States for the sub-categories dairy cattle, non-dairy cattle and swine.**

| | Total | | Dairy Cattle | | Non-dairy cattle | | Cattle | Swine | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Gg $CO_2$-eq | b | a | b | a | b | c | a | b | c |
| Bulgaria | 758 | Tier 1.9 | 26% | Tier 1.9 | 10% | Tier 1.9 | y | 19% | Tier 1.9 | y |
| Cyprus | 238 | Tier 1.0 | 9% | Tier 1.0 | 6% | Tier 1.0 | y | 78% | Tier 1.0 | y |
| Czech Republic | 435 | Tier 1.0 | 38% | Tier 1.0 | 23% | Tier 1.0 | y | 29% | Tier 1.0 | y |
| Estonia | 59 | Tier 1.7 | 36% | Tier 1.9 | 16% | Tier 1.9 | y | 41% | Tier 1.9 | y |
| Hungary | 963 | Tier 1.6 | 4% | Tier 1.9 | 2% | Tier 1.9 | y | 77% | Tier 1.2 | y |
| Latvia | 94 | Tier 1.6 | 38% | Tier 1.9 | 19% | Tier 2.0 | y | 34% | Tier 1.2 | y |
| Lithuania | 557 | Tier 1.5 | 29% | Tier 1.9 | 14% | Tier 1.9 | y | 53% | Tier 1.9 | y |
| Malta | 27 | Tier 1.0 | 23% | Tier 1.0 | 14% | Tier 1.0 | y | 51% | Tier 1.0 | y |
| Poland | 3,107 | Tier 1.5 | 19% | Tier 2.0 | 10% | Tier 2.0 | y | 63% | Tier 1.3 | y |
| Romania | 2,011 | Tier 1.0 | 28% | Tier 1.0 | 14% | Tier 1.0 | y | 42% | Tier 1.0 | y |
| Slovakia | 125 | Tier 1.0 | 14% | Tier 1.0 | 17% | Tier 1.0 | y | 50% | Tier 1.0 | y |
| Slovenia | 430 | Tier 1.8 | 31% | Tier 1.9 | 38% | Tier 1.8 | y | 29% | Tier 1.9 | y |
| **EU-12** | **8,804** | **Tier 1.3** | **22%** | **Tier 1.6** | **13%** | **Tier 1.6** | | **52%** | **Tier 1.3** | |
| **EU-15** | **41,753** | **Tier 1.6** | **21%** | **Tier 1.8** | **27%** | **Tier 1.5** | | **46%** | **Tier 1.7** | |
| **EU-27** | **50,557** | **Tier 1.6** | **21%** | **Tier 1.7** | **25%** | **Tier 1.5** | | **47%** | **Tier 1.6** | |
| EU-12: Tier 1 | 60% | | 42% | | | 43% | | 72% | | |
| EU-12: Tier 2 | 40% | | 58% | | | 57% | | 28% | | |

a Contribution to $CH_4$ emissions from manure management

b Tier 1: default methodology; Tier 2: country-specific methodology

c Source category is key in the Member State's inventory (y/n)

**Table 21.19 Methodology used by Member States for calculating $CH_4$ emissions in category 4A**

| Member State | Methodology |
|---|---|
| Bulgaria | Cattle (dairy and non-dairy) and swine: Tier 2 method with country-specific parameters for the systems for management and storage of manure. Other animals: Tier 1 |
| Cyprus | Tier 1 |
| Czech Republic | Tier 1 |
| Estonia | Tier 1. Swine manure management emissions for Hiiu and Lääne-Viru counties is not presented due to the absence of population data for the counties. |
| Hungary | Tier 1, except for the Dairy Cattle and the Non-Dairy Cattle categories, where country-specific emission factors were calculated on the basis of Tier 2 method. In the Dairy Cattle category gross energy intake was determined on the basis of the data of the Hungarian Nutrition Codex, 2004. |
| Lithuania | Methane emissions from horses, goats, sheep and poultry were calculated according to the Tier1 method. |
| Latvia | Dairy cattle: Tier 2. Other animal types: Tier 1 |
| Malta | |
| Poland | |
| Romania | Cattle, sheep and swine: Tier 2. Goats, horses and poultry: Tier 1. |
| Slovenia | For dairy cows IPCC Tier 2, on the basis of national publication (Tomši? et al., 2000), which enables a direct estimation of the amount of excreted decomposable organic matter on the basis of annual milk yield. Other categories of bovine animals: Tier 1. |
| Slovakia | Tier 1 |

## Activity Data

Table 21.20 summarizes the allocation of the produced manure over the animal wastes management systems 'liquid systems', 'solid storage and dry lot' and 'pasture, range and paddock' for the animal categories dairy and non-dairy cattle and swine in 200. While in EU-15 the liquid systems dominate for swind with 65%, only 34% of swine manure is treated in liquid management systems in EU-12, however, with very large shares of 75% in Hungary and the Czech Republic. Still the share of liquid system for swine is higher than that for cattle, but differently from the situation in EU-15, more manure from non-dairy cattle (24%) are managed in liquid systems than from dairy cattle (19%). Daily spread occurs for dairy cattle in the Czech Republic (20%), Lithuania (14%) and Romania (1%). Pasture, range and paddock ranges up to 41% and 47% (Latvia) for dairy and non-dairy cattle, respectively.

Only few countries in EU-12 report dynamic shares of manure management systems. Substantial changes are reported for cattle in Slovenia, where liquid systems increased in importance between 1990 and 200. In the Czech Republic, the share of manure in pasture, range and paddock increased signficantly for dairy cattle from 12% in 1990 to 19%, while the contribution for non-dairy cattle remained constant.

For some countries, background information on in addition to what is reported in Table 21.20 on the activity data used for the estimation of $CH_4$ emissions from manure management is given in the respective National Inventory Reports and is listed in

Table 6.37.

**Table 21.20 Animal population [1000 heads] in 200**

| Member State 2009 | Dairy Cattle - Allocation of AWMS (%) | | | | Non-Dairy Cattle - Allocation of AWMS (%) | | | | Swine - Allocation of AWMS (%) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Liquid system[1)] | Daily Spread | Solid storage and dry lot | Pasture range paddock | Liquid system[1)] | Daily Spread | Solid storage and dry lot | Pasture range paddock | Liquid system[1)] | Daily Spread | Solid storage and dry lot | Pasture range paddock |
| Bulgaria | 18% | 1% | 67% | 13% | 28% | NO | 49% | 22% | 8% | NO | 53% | NO |
| Cyprus | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO |
| Czech Republic | 40% | 20% | 20% | 19% | 50% | NO | 4% | 38% | 76% | NO | 23% | NO |
| Estonia | 19% | 1% | 67% | 13% | 38% | NO | 27% | 12% | 8% | NO | 53% | NO |
| Hungary | 4% | | 88% | 8% | 2% | | 83% | 15% | 75% | | 25% | |
| Latvia | 5% | NO | 51% | 41% | 2% | NO | 49% | 47% | 47% | NO | 50% | NO |
| Lithuania | 29% | 14% | 29% | 14% | 29% | 14% | 29% | 14% | 29% | 14% | 29% | 14% |
| Malta | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO |
| Poland | 8% | | 81% | 12% | 12% | | 79% | 9% | 29% | | 71% | |
| Romania | 18% | 1% | 68% | 13% | 28% | NO | NO | 26% | 8% | NO | 53% | NO |
| Slovakia | 5% | NO | 75% | 20% | 5% | NO | 85% | 10% | 86% | NO | 14% | NO |
| Slovenia | 54% | NO | 34% | 12% | 54% | NO | 34% | 12% | 63% | NO | 33% | NO |
| **EU-12** | 19% | 6% | 57% | 14% | 24% | 4% | 44% | 17% | 34% | 2% | 51% | 2% |
| **EU-15** | 42% | 3% | 28% | 26% | 30% | 3% | 25% | 39% | 65% | 0% | 8% | 0% |
| **EU-27** | 34% | 4% | 37% | 22% | 29% | 3% | 28% | 36% | 58% | 1% | 18% | 1% |

Source of information: CRF 4.B(a) for 2009, submitted in 2011. Abbreviations explained in the Chapter 'Units and abbreviations'.
[1)] Anaerobic lagoon + Liquid system. Missing fraction belong to the category 'Other'

**Table 21.21 Member State's background information on the emission factors and other parameters used for the calculation of $CH_4$ emissions in category 4.B(a)**

| Member State | Methodology |
|---|---|
| Bulgaria | |
| Cyprus | Default distribution to AWMS |
| Czech Republic | As agricultural farming in the Czech Republic has not yet been classified according stable types. Collection of the relevant country specific AWMS parameters is under way. Default parameters from IPCC1997 and IPCC2000 are used. |
| Estonia | Default distribution to AWMS (changed from eastern to western europe numbers) |
| Hungary | As regards manure management, Hungarian conditions were analysed on the basis of expertconsultations (Mészáros, 2000) and a paper by Ráki (2003). This paper includes theprocessing of three databases:· General Agricultural Census 2000 (HCSO),· data from the legally required registration of agricultural producers in 2000 (thisincludes data for agricultural enterprises),· a survey of animal production holdings performed in October and November 2001,which covered the capacity, capacity exploitation and the conditions of buildings andequipment. This survey allows conclusions to be drawn in connection with the entireanimal keeping sector because it covers 70% to 100% of the livestock populationsdepending on the given category. |
| Lithuania | The information about manure management systems is given from the institute of Water of the University of Agriculture of the Republic of Lithuania. |
| Latvia | The distribution of different manure management systems received from research made by Latvian State Institute of Agrarian Economics (2005). Manure management systems reported in the inventory are liquid system, daily spread, solid storage and dry lot, pasture range and paddock and other. |
| Malta | |
| Poland | Country specific data on the fraction of manure managed per AWMS and animal type (Myczko 2001; Walczak 2003, 2006). |
| Romania | Default distribution to AWMS. |
| Slovenia | The fraction of individual manure management systems has been estimated on the basis of the results of a farm census done in 2000. Data published by the Statistical Office of the Republic of Slovenia allow a breakdown of the entire herd into commercial farms and family farms for the period 1985-2002. For the years 2003 and 2004 the herd was allocated to both segments on the basis of ratio in 2002. For poultry, floor system on bedding was assumed for broilers, and combined floor system (1/4) and battery-cage systems (3/4) were assumed for layers. |
| Slovakia | Knowledge on animal housing, pasture and production of manures and slurries was found on the base of questionnaires in the national paper. Some additional information was based on expert judgement. The fraction of individual manure management systems has been estimated on the basis of the results of a farm census done in 2000. |

### Emission Factors and other parameters

The implied emission factors for $CH_4$ emissions from manure management vary substantially among the EU-12 Member States, as shown in Table 6.32. The range of the implied emission factors for dairy cattle, non-dairy cattle and swine covers about one order of magnitude, as has already been observed for EU-15. The ratio of the highest and the smallest IEF used by the Member States is 14 for dairy cattle, and 11 for non-dairy cattle and 2, 2, and 6 for sheep, goats and swine, respectively. The highest IEF for dairy cattle is used by Slovenia with 56 kg $CH_4$/head/year (higher than the highest value found in EU-15) and the smallest by Slovakia with 4.0 kg $CH_4$/head/year.

The two most important factors influencing the amount of $CH_4$ emitted from manure management systems are the climate region and if solid or liquid systems are dominating. We have already discussed the large range of systems used in the EU-12 Member States. The other two factors, the excretion rate of volatile solids and the methane producing potential, are not significantly influencing the order of magnitude.

More detailed information on the development of the emission factors for category 4A is given in

Table 21.23.

**Table 21.22 Implied Emission factors for $CH_4$ emissions from manure management used in Member State's inventory 200**

| Member State | Implied EF (kg $CH_4$/head/yr) | | | | | |
|---|---|---|---|---|---|---|
| 2009 | Dairy Cattle | Non-dairy cattle | Sheep | Goats | Sw ine | Poultry |
| Bulgaria | 30.2 | 15.0 | 0.14 | 0.14 | 9.2 | 0.9 |
| Cyprus | 42.0 | 21.0 | 0.37 | 0.26 | 19.0 | 0.3 |
| Czech Republic | 14.0 | 6.0 | 0.19 | 0.12 | 3.0 | 0.1 |
| Estonia | 10.6 | 3.3 | 0.19 | 0.12 | 3.2 | 0.1 |
| Hungary | 7.7 | 2.1 | 0.25 | 0.12 | 10.9 | 0.2 |
| Latvia | 10.3 | 4.0 | 0.19 | 0.12 | 4.0 | 0.1 |
| Lithuania | 20.9 | 10.6 | 0.19 | 0.12 | 15.3 | 0.1 |
| Malta | 44.0 | 20.0 | 0.28 | 0.18 | 10.0 | 0.1 |
| Poland | 10.5 | 4.9 | 0.17 | 0.12 | 6.5 | 0.1 |
| Romania | 19.0 | 13.0 | 0.28 | 0.18 | 7.0 | 0.1 |
| Slovakia | 4.0 | 3.8 | 0.19 | 0.12 | 4.0 | 0.1 |
| Slovenia | 55.9 | 21.6 | 0.19 | 0.12 | 14.3 | 0.1 |
| **EU-12** | **15.0** | **7.6** | **0.25** | **0.17** | **7.4** | **0.1** |
| **EU-15** | **23.0** | **9.5** | **0.24** | **0.24** | **7.9** | **0.1** |
| **EU-27** | **21.0** | **9.3** | **0.24** | **0.23** | **7.8** | **0.1** |

*Source of information: CRF 4.B(a) for 2009, submitted in 2011 Abbreviations explained in the Chapter 'Units and abbreviations'.*

**Table 21.23 Implied Emission factors for $CH_4$ emissions from enteric fermentation and $CH_4$ conversion factors used in Member State's inventory**

| Member State | Methodology |
|---|---|
| Bulgaria | Cattle (dairy and non-dairy) and swine: country-specific parameters for the systems for management and storage of manure. |
| Cyprus | |
| Czech Republic | Default EFs for Western Europe |
| Estonia | Dairy cattle, non-dairy cattle: country-specific data and default factors. Other animals - default parameters. |
| Hungary | Available parameters of animal production systems were compared to the criteria listed for the Tier 1 factors in the IPCC Guidelines. National conditions on the basis of expert consultations (Mészáros 2000) and a paper by Ráki (2003). In the case of Non-Dairy Cattle category the default values of Rev. 1996 IPCC Guidelines were used for the Tier 2 calculations. In the case of Buffalo, Sheep, Goats, Horses, Asses & Mules, Swine, Poultry and Rabbits catego- |

| | |
|---|---|
| | ries GPG Tier 1 and IPCC default emission factors were used. |
| Lithuania | default |
| Latvia | For animals other than dairy cattle, default values for the cool climate region were chosen because annual temperature in Latvia is 6.0 ºC (reference period 1971-2000). |
| Malta | |
| Poland | country specific data for dairy and non-dairy cattle, sheep and swine |
| Romania | default for developing countries. |
| Slovenia | default |
| Slovakia | default |

### 21.3.3 Manure Management $N_2O$ (CRF source category 4.B(b))

Generally, GHG emissions (in $CO_{2\text{-eq}}$) from manure management are predominantly as $CH_4$ rather than as $N_2O$. For four countries in EU-12 (Slovakia, Estonia, Latvia, Poland), emissions from manure management are higher for $N_2O$ than for $CH_4$. In Poland, the $CH_4/N_2O$ ratio is 0.9. As Poland accounts for 53% of $N_2O$ emissions and 35% of $CH_4$ emissions from manure management, the average ratio for EU-12 countries is 1.4 compared to the values of EU-15 (2.9) and EU-27 (2.4). In the EU-12 countries, only Slovenia and Malta are above the EU-15 average with ratios of 4.3 and 8.9, respectively.

The differences of the ratio across the countries can partly be explained by the implied emission factor used for $CH_4$ emissions in the manure management category (see discussion above), and partly by the nitrogen excretion factors. Total nitrogen excretion by Member State and manure management system are given in Table 6.42.

Table 6.42 shows that the implied emission factors used for $N_2O$ emission from manure management are IPCC default for all countries are close to the default value and that only small changes in the IEF occurred in the time between 1990 and 200 with a 1% increase of the IEF for solid systems and a 0% increase for liquid systems.

**Table 21.24 Total $N_2O$ emissions in category 4B(b) and implied Emission Factor at EU-12 level for the years 1990 and 200**

| | Anaerobic lagoon | Liquid systems | Solid storage and dry lots |
|---|---|---|---|
| | 1990 | | |
| Total Emissions of $N_2O$ [Gg $N_2O$-N] | 0 | 1 | 53 |
| Total Nitrogen excreted [Gg N] | 30 | 601 | 1690 |
| Implied Emission Factor [kg $N_2O$-N / kg N] | 0.10% | 0.10% | 2.00% |

| | Anaerobic lagoon | Liquid systems | Solid storage and dry lots |
|---|---|---|---|
| | 2009 | | |
| Total Emissions of $N_2O$ [Gg $N_2O$-N] | 0 | 1 | 29 |
| Total Nitrogen excreted [Gg N] | 11 | 338 | 928 |
| Implied Emission Factor [kg $N_2O$-N / kg N] | 0.22% | 0.10% | 2.00% |

| | Anaerobic lagoon | Liquid systems | Solid storage and dry lots |
|---|---|---|---|
| | 2009 value in percent of 1990 | | |
| Total Emissions of N2O [Gg N2O-N] | 82% | 57% | 55% |
| Total Nitrogen excreted [Gg N] | 37% | 56% | 55% |
| Implied Emission Factor [kg N2O-N / kg N] | 223% | 101% | 100% |

#### 21.3.3.1 Methodological Issues

Emissions of nitrous oxide are much higher from solid storage systems than from liquid systems, this is even more true for EU-12 countries (94%) than for EU-15 countries (78%); however, the range is large in EU-12 with lowest share of 50% in Malte, followed by 76% in Estonia and highest share of 99% in Poland.

Table 6.43 shows the total emissions in category 4B(b), how this is composed and the methodology used for calculating the emissions for cattle and swine by Member States. The table shows also that ‘solid storage’ is a key category for all Member States. Activity Data are the excretion of nitrogen per animal and the distribution over the manure management systems. The emission factor of $N_2O$ per nitrogen managed in a certain manure management system is usually IPCC default.

The quality of the emission estimates are calculated from the Nex factor and the emission factor as described in Section 6.3.3.2 and 6.4.1.3.

Most countries use default factors for both nitrogen excretion rates for most animals and emission factors with the exception of Slovakia for the IEFs, and several countries for N-excretion rates; for all EU-12 countries, a level of Tier 1.6 is obtained for N excretion and Tier 1.0 for the emission factors. Thus, the overall quality level is Tier 1.5 for $N_2O$ emissions from manure management in EU-12 countries. Nitrogen excretion is reported by animal type and not by manure management system in the CRF tables. To assign nevertheless a Tier level for the nitrogen excretion by manure management system, the allocation of animal waste to manure management systems from the calculation of $CH_4$ emissions from manure management is used.

Additional background information on the methodology, if available, is summarised in

Table 6.44.

**Table 21.25** **Total emissions and contribution of the main sub-categories to $N_2O$ emissions in category 4B(b), methodology applied (EF) and key source assessment by Member States for the sub-categories solid storage and liquid systems**

| | Total | | Solid Storage | | | Liquid Systems | |
|---|---|---|---|---|---|---|---|
| | Gg $CO_2$-eq | b | a | b | c | a | b |
| Bulgaria | 437 | Tier 0.0 | 97% | Tier 1.0 | y | 1% | NO |
| Cyprus | 177 | Tier 1.3 | 96% | Tier 1.6 | y | 1% | Tier 1.3 |
| Czech Republic | 309 | Tier 1.0 | 72% | Tier 1.0 | y | 13% | Tier 1.0 |
| Estonia | 119 | Tier 0.4 | 76% | Tier 1.7 | y | 1% | NO |
| Hungary | 945 | Tier 1.4 | 99% | Tier 1.5 | y | 1% | Tier 1.4 |
| Latvia | 161 | Tier 1.1 | 99% | Tier 1.3 | y | 1% | Tier 1.1 |
| Lithuania | 307 | Tier 1.7 | 93% | Tier 1.7 | y | 3% | Tier 1.7 |
| Malta | 5 | NO | 50% | NO | y | 50% | NO |
| Poland | 5,042 | Tier 1.7 | 99% | Tier 1.7 | y | 1% | Tier 1.7 |
| Romania | 1,561 | Tier 1.1 | 80% | Tier 1.0 | y | 1% | Tier 1.0 |
| Slovakia | 377 | Tier 1.7 | 98% | Tier 1.7 | y | 2% | Tier 1.7 |
| Slovenia | 151 | Tier 1.5 | 93% | Tier 1.7 | y | 6% | Tier 1.5 |
| **EU-12** | **9,589** | **Tier 1.5** | **94%** | **Tier 1.4** | | **2%** | **Tier 1.5** |
| **EU-15** | **21,439** | **Tier 1.6** | **78%** | **Tier 1.1** | | **10%** | **Tier 1.7** |
| **EU-27** | **31,028** | **Tier 1.6** | **83%** | **Tier 1.2** | | **8%** | **Tier 1.7** |
| EU-12: Tier 1 | 45% | | 45% | | | 63% | |
| EU-12: Tier 2 | 55% | | 55% | | | 37% | |

a Contribution to $N_2O$ emissions from manure management
b Quality level (betw een Tier 1 and Tier 2)
c Source category is key in the Member State's inventory (y/n); nr: not reported

**Table 21.26** **Member State's background information on the methodology for estimating $N_2O$ emissions in category 4.B(b)**

| Member State | Methodology |
|---|---|
| Latvia | Tier 1 and local expert assumptions. |
| Malta | Tier 2 for cattle, swine and poultry. Tier 1 for other animal types |
| Romania | Tier 1. $N_2O$ emissions from Daily spread and Pasture range and paddock AWMS are reported under 4D – Agricultural soils. |
| Slovenia | Tier 1 with national specifications. |
| Slovakia | Tier 1 with national specifications regarding pasture. |

## Activity Data

In EU-12, a total of 1,839 Gg N was managed in manure management systems or excreted on pasture range and paddock in 200. Together with the 7,876 Gg N from EU-15 countries, this gives a total of 9,716 Gg N for EU-27. The largest share of this manure-nitrogen was managed in solid storage systems (928 Gg N in EU-12), followed by liquid systems (338 Gg N) and manure excreted by grazing animals (356 Gg N). Compared with 1990, this was a decrease of manure-nitrogen by 49%. The decreases were similar for the different manure management systems. The decrease of nitrogen was particularly pronounced in Latvia and Bulgaria, where in 200 only about 30% of manure was excreted as compared to 1990.

The nitrogen managed in the various manure management systems in 200 is given in Table 6.45. Nitrogen excretion data per head will be discussed below. Some information on the source of the animal numbers for the different Member States is given in

Table 21.14.

**Table 21.27 Member State's nitrogen managed in the manure managed systems anaerobic lagoon, liquid systems, daily spread, and other systems, manure excreted on pasture range and paddock, and total nitrogen excreted in 200**

| Member State 2009 | Anaerobic lagoon | Liquid systems | Daily Spread | Solid storage and dry lot | Other | Pasture range paddock | Total |
|---|---|---|---|---|---|---|---|
| Bulgaria | 1 | 10 | 0 | 44 | 14 | 29 | 98 |
| Cyprus | | 2 | | 17 | | 3 | 22 |
| Czech Republi | | 83 | 11 | 23 | 19 | 37 | 172 |
| Estonia | 0 | 3 | 0 | 9 | 5 | 4 | 22 |
| Hungary | | 29 | | 96 | 0 | 18 | 142 |
| Latvia | | 4 | | 16 | | 10 | 31 |
| Lithuania | | 21 | | 29 | 6 | 21 | 77 |
| Malta | | | | | | | |
| Poland | | 104 | | 512 | | 46 | 662 |
| Romania | 9 | 47 | 1 | 129 | 149 | 174 | 509 |
| Slovakia | | 18 | | 38 | | 9 | 65 |
| Slovenia | 0 | 19 | | 14 | 1 | 6 | 40 |
| **EU-12** | **11** | **338** | **13** | **928** | **194** | **356** | **1,839** |
| **EU-15** | **24** | **2,585** | **130** | **1,945** | **567** | **2,626** | **7,876** |
| **EU-27** | **35** | **2,923** | **142** | **2,872** | **762** | **2,982** | **9,716** |

Information source: CRF Table 4.B(b) for 2009, submitted in 2011. Abbreviations explained in the Chapter 'Units and abbreviations'.

## Emission Factors and other parameters

As all countries are using IPCC default values for the IEF or values that are close to it (with the exception of the IEFs used by Slovakia (both liquid and solid systems) and Hungary for liquid systems. Poland is the largest source of excreted manure in EU-12 accounting for 28% of nitrogen in manure for EU-12. An overview of the implied emission factors is given in Table 6.46.

**Table 21.28 Implied Emission factors for $N_2O$ emissions from manure management used in Member State's inventory 200**

| Member State | Implied EF (kg $N_2O$-N / kg N) | | | |
|---|---|---|---|---|
| 2009 | Anaerobic lagoon | Liquid system | Solid storage and dry lot | Other |
| Bulgaria | 0.100% | 0.106% | 2.0% | 0.1% |
| Cyprus | NA | 0.100% | 2.0% | NA |
| Czech Republic | NO | 0.100% | 2.0% | 0.5% |
| Estonia | 0.100% | 0.100% | 2.0% | 1.1% |
| Hungary | NO | 0.100% | 2.0% | 0.5% |
| Latvia | NA | 0.100% | 2.0% | NO |
| Lithuania | NA | 0.100% | 2.0% | 0.4% |
| Malta | NO | NE,NO | NE,NO | NO |
| Poland | NO | 0.100% | 2.0% | NO |
| Romania | 0.100% | 0.100% | 2.0% | 0.4% |
| Slovakia | NO | 0.100% | 2.0% | NO |
| Slovenia | 0.100% | 0.100% | 2.0% | 0.2% |
| **EU-12** | **0.223%** | **0.102%** | **2.0%** | **0.4%** |
| **EU-15** | **0.100%** | **0.178%** | **1.8%** | **0.9%** |
| **EU-27** | **0.139%** | **0.169%** | **1.8%** | **0.8%** |

Information source: CRF Table 4.B(b) for 2009, submitted in 2011
Abbreviations explained in the Chapter 'Units and abbreviations'.

An important parameter in the calculation of $N_2O$ emissions from manure management is nitrogen excretion rate per head and year, which is given in Table 6.47 for EU12-countries and the main animal types. The table shows a range by a factor of up to 3.0 between the highest and the lowest value used is found. For example, for dairy cattle, we have a range of about 60 kg N head$^{-1}$ y$^{-1}$ from 70 kg N head$^{-1}$ y$^{-1}$ used in many countries to 132 kg N head$^{-1}$ y$^{-1}$ for Hungary. Very large ranges are found for non-dairy cattle with values between 32 (Estonia) and 70 kg N head$^{-1}$ y$^{-1}$ (Czech Republic) and sheep with values between 6.8 kg N head$^{-1}$ y$^{-1}$ (Poland) and 20.0 kg N head$^{-1}$ y$^{-1}$ (Czech Republic).

Additional information on the development of the emission factor is available for some Member States and is summarized in

Table 6.48. Additional background information on the calculation of nitrogen excretion rates are summarised in

Table 6.49.

**Table 21.29** **Total Nitrogen excretion by AWMS [Gg N] for dairy and non-dairy cattle, sheep, swine, and poultry in 200**

| Member State 2009 | Dairy | Non-Dairy | Sheep | Swine | Poultry | Buffalo | Goats | Horses | Mules and Asses |
|---|---|---|---|---|---|---|---|---|---|
| Bulgaria | 70.0 | 50.0 | 14.7 | 20.0 | 0.6 | 50.0 | 17.0 | 25.0 | 42.5 |
| Cyprus | 70.0 | 50.0 | 12.0 | 16.0 | 0.6 | | 40.0 | | |
| Czech Republic | 100.0 | 70.0 | 20.0 | 20.0 | 0.6 | NO | 25.0 | 25.0 | NO |
| Estonia | 102.1 | 31.6 | 16.0 | 12.9 | 0.6 | NA | 25.0 | 25.0 | NA |
| Hungary | 131.8 | 48.3 | 20.0 | 8.1 | 0.6 | 70.0 | 18.0 | 60.0 | 25.0 |
| Latvia | 70.0 | 50.0 | 13.0 | 10.0 | 0.6 | NA | 13.0 | 48.0 | NA |
| Lithuania | 99.2 | 57.6 | 16.0 | 12.3 | 0.6 | NO | 16.0 | 25.0 | NO |
| Malta | NE | NE | NE | NE | NE | NO | NE | NE | NE |
| Poland | 86.7 | 58.1 | 6.8 | 13.6 | 0.3 | NO | 6.7 | 28.0 | NO |
| Romania | 70.0 | 50.0 | 16.0 | 20.0 | 0.6 | 50.0 | 25.0 | 25.0 | 25.0 |
| Slovakia | 100.0 | 60.0 | 16.0 | 15.8 | 0.7 | NO | 16.0 | 25.0 | NO |
| Slovenia | 110.6 | 42.3 | 20.0 | 11.9 | 0.6 | NO | 25.0 | 25.0 | NO |
| **EU-12** | **86.4** | **55.7** | **16.0** | **14.8** | **0.5** | **50.7** | **22.8** | **27.3** | **39.2** |
| **EU-15** | **112.5** | **49.2** | **7.8** | **10.6** | **0.6** | **92.9** | **13.4** | **47.9** | **37.9** |
| **EU-27** | **105.8** | **49.9** | **8.9** | **11.5** | **0.5** | **88.5** | **14.6** | **41.4** | **38.3** |

*Information source: CRF Table 4.B(b) for 2009, submitted in 2011. Abbreviations explained in the Chapter 'Units and abbreviations'.*

**Table 21.30 Member State's background information on the emission factor for calculation of $N_2O$ emissions in category 4.B(b)**

| Member State | Methodology |
|---|---|
| Bulgaria | Default IPCC for Eastern Europe |
| Czech Republic | Default EFs for Western Europe. |
| Hungary | The factors were selected on the basis of expert consultations (Gundel 2004, Várhegyi 2004) and the relevant literature (Walther et al. 1994; Várhegyiné et al. 1999; Babinszky et al. 2002; Borka 2003). |

**Table 21.31 Member State's background information for the development of nitrogen excretion rates used in the calculation of $N_2O$ emissions in category 4.B(b)**

| Member State | Methodology |
|---|---|
| Hungary | National data from source: HCSO (2000), Mészáros (2000), Ráki (2003). On the basis of expert consultations (Gundel 2004, Várhegyi 2004, Fébel 2007) and literature data (Várhegyiné et al. 1999, Babinszky et al. 2002, Fébel and Gundel 2007) it was asserted that production level and feeding technology of animal breeding in Hungary are close to the Western European standards, therefore the default IPCC factors for Western Europe were used. |
| Latvia | Annual N excretion per animal until 2004 obtained from national studies. Since 2005, annual N excretion per anima is corrected according to results of newest studies on development of manure normative and livestock units carried out by the State Ltd." Agrochemical Research Centre". N excretion by farm livestock was estimated with the mass balance approach (N intake- N products).National studies showed that average Nex for sheep and goats in Latvia is very low as compared to IPCC default value. The reason is (i) sheep and goats nutrition is as they receive usually no feed additions; (ii) mainly local breeds are used which are not very productive. Commercial pig production in Latvia mainly includes four or five phases, to take account of changes in nutrient requirements with increasing age of the pig: piglets with live weight 7-30 kg, fattening pigs 30-100 kg or 7-100 kg, young breeding sows and breeding sows. There are no data on N excretion by young pigs with live weight 20-50 kg. N excretion for breeding sows is calculated taken into account N excretion by sucking piglets. |
| Malta | Country-specific values for cattle, swine and poultry |
| Slovenia | Dairy cows: nitrogen excretion has been linked to productivity, i.e. milk production. The nitrogen excretion rates for cattle and pigs were harmonized with the methodology for ammonia emissions (Verbi?, 2004). |
| Slovakia | Default nitrogen excretion factors. Direct measurements of nitrogen produced by domestic livestock showed that real amounts could be much higher. Based on data about management in 222 agriculture farms will be perform the total analysis of manure production in the SR. |

### *21.3.4 Agricultural Soils - $N_2O$ (Source category 4.D)*

For EU-12, emissions from all sub-categories in the category 4.D have decreased since 1990 (see Table 6.59). This was most significant for emission related to manure application or manure excretion on pasture, range and paddock and is a direct consequence of decreasing animal numbers. The implied emission factor remains constant for all sub-categories and decreases only slightly for direct emissions from mineral fertilizer and manure application.

The decrease in the input of nitrogen to agricultural soils was significant for all sub-categories and was 37% for synthetic fertilizer application, 47% for application of manure, 7% of the area of histosols cultivated and 55% of nitrogen excreted by grazing animals. This translated to a reduction of volatilized and re-deposited nitrogen by 48% and of the amount of nitrogen leached by 44%.

**Table 21.32** **Total $N_2O$ emissions, Total Nitrogen input into agricultural soils and implied Emission Factor for category 4D at EU-12 level in 200 and 1990 and relative changes**

| 1990 | Synthetic Fertilizer | Animal Wastes appl. | Cultiv. of Histosols[1)] | Animal Production | Atmospheric Deposition | Nitrogen Leaching and run-off |
|---|---|---|---|---|---|---|
| | Direct | | | | Indirect | |
| Total Emissions of $N_2O$ [Gg $N_2O$] | 67 | 43 | 13 | 25 | 14 | 74 |
| Total Nitrogen input [Gg N] | 3465 | 2240 | 10228 | 788 | 919 | 1888 |
| Implied Emission Factor [kg $N_2O$-N / kg N] | 1.24% | 1.23% | 8.0 | 2.00% | 1.00% | 2.50% |

| 2009 | Synthetic Fertilizer | Animal Wastes appl. | Cultiv. of Histosols[1)] | Animal Production | Atmospheric Deposition | Nitrogen Leaching and run-off |
|---|---|---|---|---|---|---|
| | Direct | | | | Indirect | |
| Total Emissions of $N_2O$ [Gg $N_2O$] | 42 | 23 | 12 | 11 | 8 | 41 |
| Total Nitrogen input [Gg N] | 2169 | 1192 | 9493 | 356 | 481 | 1055 |
| Implied Emission Factor [kg $N_2O$-N / kg N] | 1.24% | 1.23% | 8.0 | 2.00% | 1.00% | 2.50% |

| 2005 value in percent of 1990 | Synthetic Fertilizer | Animal Wastes appl. | Cultiv. of Histosols | Animal Production | Atmospheric Deposition | Nitrogen Leaching and run-off |
|---|---|---|---|---|---|---|
| | Direct | | | | Indirect | |
| Total Emissions of $N_2O$ | 63% | 53% | 93% | 45% | 52% | 56% |
| Total Nitrogen input | 63% | 53% | 93% | 45% | 52% | 56% |
| Implied Emission Factor | 100% | 100% | 100% | 100% | 100% | 100% |

Source of information: Tables 4.D for 1990 and 2009, submitted in 2011

[1)] Histosols unit AD: $km^2$; Unit for IEF: kg $N_2O$-N/ha

### 21.3.4.1 Methodological Issues

**Methods**

Due to the large uncertainty associated with the emission factors in this category and the lack of well-established alternatives, most Member States rely on the IPCC default emission factors (see below). In contrast to EU-15 countries, default factors are used also to estimate the emissions from indirect emissions. Table 6.60 gives an overview of the total $N_2O$ emissions in category 4D and the contribution of the main sub-categories. Thus, the vast majority of the emissions are calculated with the Tier 1 approach with the important exception of the emission factor from synthetic fertilizer in Poland. Direct $N_2O$ fluxes from synthetic fertilizer in Poland are the single largest emission flux in this category for EU-12 (12% of total emissions).

For each single sub-category we calculated a ‘Tier-level’ scoring between 1 and 2 according to the methodology described in Section 6.4.1.5. and 6.3.5.2. As a result, we estimate that a minimum of 21% of the emissions reported in category 4D are estimated with country-specific information. Highest share of country-specific calculations is obtained for direct $N_2O$ emissions (22%). All countries in EU-12 use IPCC default methodology.

**Table 21.33 Total emissions and contribution of the main sub-categories to $N_2O$ emissions in category 4D, methodology and key source assessment by Member States for the sub-categories direct emissions, animal production and indirect emissions for the year 200.**

| | Total | | Direct | | | Animal Production | | | Indirect | | | Volatilization | | Leaching | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Member State | Gg $CO_2$-eq | b | a | b | c | a | b | c | a | b | c | a | b | a | b |
| Bulgaria | 3,464 | Tier 1.1 | 57% | Tier 1.1 | y | 8% | Tier 1.0 | y | 34% | Tier 1.2 | y | 5% | Tier 1.0 | 29% | Tier 1.2 |
| Cyprus | 119 | Tier 1.6 | 76% | Tier 1.8 | y | 24% | Tier 1.1 | y | | NE | y | | NE | | NE |
| Czech Republic | 4,777 | Tier 1.0 | 57% | Tier 1.0 | y | 7% | Tier 1.0 | y | 36% | Tier 1.0 | y | 6% | Tier 1.0 | 30% | Tier 1.0 |
| Estonia | 683 | Tier 1.4 | 64% | Tier 1.6 | y | 5% | Tier 1.0 | y | 31% | Tier 1.1 | y | 5% | Tier 1.0 | 26% | Tier 1.1 |
| Hungary | 4,863 | Tier 1.1 | 59% | Tier 1.0 | y | 4% | Tier 1.2 | y | 37% | Tier 1.1 | y | 6% | Tier 1.0 | 31% | Tier 1.1 |
| Latvia | 1,353 | Tier 1.2 | 66% | Tier 1.3 | y | 8% | Tier 1.0 | y | 26% | Tier 1.0 | y | 4% | Tier 1.0 | 22% | Tier 1.0 |
| Lithuania | 2,490 | Tier 1.5 | 55% | Tier 1.7 | y | 8% | Tier 1.4 | y | 37% | Tier 1.1 | y | 6% | Tier 1.0 | 31% | Tier 1.1 |
| Malta | 19 | NE | 66% | NE | y | | NE | y | 34% | NE | y | 26% | NE | 8% | NE |
| Poland | 18,122 | Tier 1.3 | 71% | Tier 1.2 | y | 2% | Tier 1.4 | y | 26% | Tier 1.5 | y | 3% | Tier 1.0 | 23% | Tier 1.6 |
| Romania | 15,456 | Tier 1.2 | 66% | Tier 1.2 | y | 11% | Tier 1.0 | y | 23% | Tier 1.0 | y | 4% | Tier 1.0 | 19% | Tier 1.0 |
| Slovakia | 1,652 | Tier 1.4 | 73% | Tier 1.3 | y | 6% | Tier 1.4 | y | 21% | Tier 1.5 | y | 6% | Tier 1.2 | 15% | Tier 1.6 |
| Slovenia | 742 | Tier 1.2 | 52% | Tier 1.2 | y | 7% | Tier 1.2 | y | 41% | Tier 1.1 | y | 7% | Tier 1.0 | 33% | Tier 1.1 |
| **EU-12** | **53,740** | **Tier 1.2** | **65%** | **Tier 1.2** | **y** | **6%** | **Tier 1.1** | **y** | **28%** | **Tier 1.2** | **y** | **4%** | **Tier 1.0** | **24%** | **Tier 1.2** |
| **EU-15** | **188,378** | **Tier 1.4** | **51%** | **Tier 1.3** | nr | 14% | **Tier 1.5** | nr | 35% | **Tier 1.3** | nr | 6% | **Tier 1.3** | 28% | **Tier 1.3** |
| **EU-27** | **242,118** | **Tier 1.3** | **54%** | **Tier 1.3** | y | 12% | **Tier 1.5** | y | 33% | **Tier 1.3** | y | 6% | **Tier 1.3** | 27% | **Tier 1.3** |
| EU-12: Tier 1 | 79% | | 78% | | | 90% | | | 79% | | | 99% | | 75% | |
| EU-12: Tier 2 | 21% | | 22% | | | 10% | | | 21% | | | 1% | | 25% | |

a Contribution to N2O emissions from agricultural soils
b Tier 1: default methodology; Tier 2: country-specific methodology
c Source category is key in the Member State's inventory (y/n)

## Activity Data

For the estimation of $N_2O$ emissions from N-fixing crops and crop residues, most Member States use the amount of N input (in Gg N) as activity data in the CRF table; but some countries give the emission factor in kilogram of nitrogen emitted per kg of dry crop production (N-fixing crop or other crops, respectively). Therefore, the data given in Table 6.62 in the respective columns are not comparable.

Additional background information on the source of the data used in the Member States's inventories is given in Table 6.63.

**Table 21.34 Member State's activity data to calculate direct and indirect $N_2O$ emissions in category 4D**

| Member States | Synthetic Fertilizer (Gg N) | Animal Wastes appl. (Gg N) | N-fixing crops (Gg N) | Crop residue (Gg N) | Cultiv. of Histosols ($km^2$) | Animal Production (Gg N) | Atmosph. Deposition (Gg N) | Nitrogen Leaching and run-off (Gg N) |
|---|---|---|---|---|---|---|---|---|
| 2009 | Direct | | | | | | Indirect | |
| Bulgaria | 160 | 55 | 0 | 111 | NO | 29 | 37 | 83 |
| Cyprus | 4 | 16 | 1 | 11 | NE | 3 | NE | NE |
| Czech Republic | 200 | 109 | 5 | 132 | NO | 37 | 57 | 118 |
| Estonia | 27 | 14 | 0.2 | 4 | 431 | 4 | 7 | 15 |
| Hungary | 248 | 99 | 18 | 110 | NO | 18 | 56 | 125 |
| Latvia | 47 | 14 | 0 | 6 | 1,245 | 10 | 11 | 25 |
| Lithuania | 136 | 56 | 5 | 45 | 116 | 21 | 29 | 64 |
| Malta | 1 | 1 | NE | NE | NO | NO | 1 | 0 |
| Poland | 986 | 493 | 20 | 163 | 7,067 | 46 | 120 | 342 |
| Romania | 266 | 268 | 490 | 611 | 565 | 174 | 131 | 242 |
| Slovakia | 69 | 39 | 20 | 70 | NO | 9 | 21 | 20 |
| Slovenia | 25 | 27 | 2 | 4 | 69 | 6 | 11 | 20 |
| **EU-12** | **2,169** | **1,192** | **561** | **1,257** | **9,493** | **356** | **481** | **1,055** |
| **EU-15** | **7,078** | **3,857** | **881** | **2,789** | **20,960** | **2,619** | **2,407** | **4,425** |
| **EU-27** | **9,246** | **5,049** | **1,442** | **4,046** | **30,453** | **2,975** | **2,887** | **5,479** |

Source of information: Tables 4.D for 2009, submitted in 2011. Abbreviations explained in the Chapter 'Units and abbreviations'.

**Table 21.35 Member State's background information on the activity data used for the calculation of $N_2O$ emissions in category 4.D**

| Member State | Methodology |
|---|---|

| | |
|---|---|
| Bulgaria | The synthetic fertilizers quantities are provided by the National Service for Plant Protection at the Ministry of Agriculture and Food Supplies. |
| Cyprus | The officially published statistical data for the annually used quantities were used, and the amount of nitrogen per type. |
| Czech Republic | All data were taken from the Statistical Yearbooks of the Czech Republic (Statistical Yearbooks, 1990 – 2005). |
| Estonia | Activity data for fertilisers and the production of N-fixing crops were used from official Estonian statistics (the Statistical Office of Estonia [ESO]). |
| Hungary | Activity data for the sector (total harvested production of plants, N-fertilizer) were obtained from the Agricultural Statistics Yearbook of HCSO. |
| Lithuania | Activity data is received from the Statistical Yearbooks “Agriculture in Lithuania” (crop and pulses yields) and “Production of commodities” (annual amount of N fertilisers sold). |
| Latvia | Activity data obtained from the CSB (animal numbers), use of N synthetic fertilizers and productions of crops. Other data sources are Latvian State Institute of Agrarian Economics (distribution of different manure management systems and researches made by local experts (area of cultivated organic soils). |
| Malta | Data for 1990 to 1994: FAOSTAT – Nitrogenous Fertiliser Consumption; for 1995 to 2001: SOER 2002 – Fertiliser Import Statistics for nitrogen based fertilisers; for 2002 to 2006: Nitrogen fertiliser import figures, National Statistics Office. |
| Poland | Activity data concerning crop production was taken from an experimental study (Gus, 2006). Based on national methodology (Mercik 2001) about sown area of N-fixing crops. |
| Romania | The amount of synthetic fertilizer applied to soils data are provided by Romanian National Institute for Statistics (NIS) being released through Statistical Yearbook 1989-2007. |
| Slovenia | The consumption of nitrogen from mineral fertilizers on agricultural soil in Slovenia has been obtained from the Statistical Yearbook. SORS collect data on fertilisers used in enterprises, companies and co-operatives involved in crop production. Likewise, they are taking into account the data on import, export, and production. The difference between all fertilizers sold in this country and the amount that is used by enterprises, is the consumption of mineral fertilizers on family farms. Fertilizers that are not appropriate for agricultural production (mineral fertilizers for balcony flowers, lawns and similar) are not included. |
| Slovakia | According to Statistical Yearbook and Green Report of Slovak Republic it is not possible to split fodder crops and grasslands into year subcategories. During 1986-1997 the crop and root residuals were observed from 29 crop species on three to seven different soil-climate sites in the Slovak Republic (partly on the small parcels production and partly an the large scale production. The sampling was provided according the plant specification (numbers of plants per hectare). |

**Emission Factors and other parameters**

Table 6.64 and Table 6.65 give an overview of the emission factors and other parameters used for the calculation of $N_2O$ emissions from agricultural soil in 200 in EU-12 countries. As discussed already above, emission factors are largely IPCC default, while other parameters are more frequently country-specific. Most Member States use the IPCC default emission factors for the calculation of $N_2O$ emissions from the application of mineral and organic fertiliser. Poland, Malte, Lithuana, and Cyprus use a different emission factor for synthetic fertilizer nitrogen and applied manure than IPCC default, Estonia only for synthetic fertilizer. Indirect emissions are estimated with default values for both volatilization/leaching fractions and emission factors, with the exception of $Frac_{GASM}$ in Slovakia.

**Table 21.36 Implied Emission Factors for the category 4D - $N_2O$ emissions from agricultural soils in 200**

| Member States | Synthetic Fertilizer | Animal Wastes appl. | N-fixing crops | Crop residue | Cultiv. of Histosols | Animal Production | Atmosph. Deposition | Nitrogen Leaching and run-off |
|---|---|---|---|---|---|---|---|---|
| 2009 | Direct | | | | | | Indirect | |
| Bulgaria | 1.25% | 1.25% | 1.25% | 1.25% | NO | 2.0% | 1.00% | 2.50% |
| Cyprus | 1.12% | 0.80% | 0.10% | 0.10% | NE | 2.0% | NE | NE |
| Czech Republic | 1.25% | 1.25% | 1.25% | 1.25% | NO | 2.0% | 1.00% | 2.50% |
| Estonia | 1.12% | 1.25% | 1.25% | 1.25% | 8.0 | 2.0% | 1.00% | 2.50% |
| Hungary | 1.25% | 1.25% | 1.25% | 1.25% | NO | 2.0% | 1.00% | 2.50% |
| Latvia | 1.25% | 1.25% | 1.25% | 1.25% | 8.0 | 2.0% | 1.00% | 2.50% |
| Lithuania | 1.12% | 1.00% | 1.25% | 1.25% | 8.0 | 2.0% | 1.00% | 2.50% |
| Malta | 0.62% | 2.00% | NE | NE | NO | NO | 1.25% | 0.75% |
| Poland | 1.25% | 1.25% | 1.25% | 1.25% | 8.0 | 2.0% | 1.00% | 2.51% |
| Romania | 1.25% | 1.25% | 1.25% | 1.25% | 8.0 | 2.0% | 1.00% | 2.50% |
| Slovakia | 1.25% | 1.25% | 1.25% | 1.25% | NO | 2.0% | 1.00% | 2.50% |
| Slovenia | 1.25% | 1.25% | 1.25% | 1.25% | 8.0 | 2.0% | 1.00% | 2.50% |
| **EU-12** | **1.24%** | **1.23%** | **1.25%** | **1.25%** | **8.0** | **2.0%** | **1.00%** | **2.50%** |
| **EU-15** | **1.2%** | **1.22%** | **1.25%** | **1.25%** | **7.7** | **2.0%** | **1.00%** | **2.48%** |
| **EU-27** | **1.23%** | **1.22%** | **1.25%** | **1.25%** | **7.8** | **2.0%** | **1.00%** | **2.48%** |

Source of information: Tables 4.D for 2009, submitted in 2011. Abbreviations explained in the Chapter 'Units and abbreviations'.

**Table 21.37 Relevant parameters for the calculation of $N_2O$ emissions from agricultural soils in 200**

| Member States | FracBURN | FracFUEL | FracGASF | FracGASM | FracGRAZ | FracLEACH | FracNCRBF | FracNCRO | FracR |
|---|---|---|---|---|---|---|---|---|---|
| Bulgaria | 10% | | 10.0% | 20% | 28% | 30% | 3.0% | 1.5% | 45% |
| Cyprus | | | | | | | | | |
| Czech Republic | NO | NO | 10.0% | 20% | 21% | 30% | 3.0% | 1.5% | 45% |
| Estonia | 10% | NO | 10.0% | 20% | 16% | 30% | 3.0% | 1.5% | 45% |
| Hungary | NO | NO | 10.0% | 20% | 13% | 30% | 1.7% | 1.0% | NO |
| Latvia | NO | NO | 10.0% | 20% | 34% | 30% | 2.0% | 3.0% | 45% |
| Lithuania | NO | NO | 10.0% | 20% | 27% | 30% | 3.0% | 1.5% | 45% |
| Malta | NE | NE | NE | NE | NE | NE | NE | NE | NE |
| Poland | 3% | NO | 10.0% | 20% | 7% | 30% | 2.6% | 1.4% | 44% |
| Romania | NA | NA | 10.0% | 20% | 34% | 30% | 3.0% | 1.5% | 50% |
| Slovakia | NO | NO | 10.0% | 24% | 15% | 14% | 7.1% | 14.5% | NE |
| Slovenia | NO | NO | 10.0% | 20% | 14% | 30% | 1.9% | 0.7% | 47% |
| **EU-12** | NA | NA | 10.0% | 20% | 21% | 28% | 3.0% | 1.6% | 46% |
| **EU-15** | NA | NA | 5.9% | 22% | 35% | 27% | 3.0% | 1.2% | 54% |
| **EU-27** | NA | NA | 8.0% | 21% | 28% | 27% | 3.0% | 1.4% | 50% |

Source of information: Tables 4.D for 2009, submitted in 2011. Abbreviations explained in the Chapter 'Units and abbreviations'.

[1)] Arithmetic average over the MS that reported.

# 22 LULUCF (CRF SECTOR 5)

EU-12 new EU MS have in place national estimating systems. Ability of reporting GHG inventories of the new MS is high for forestland and lower for all other land use categories, what explains generally low completeness when looking to entire LULUCF sector. The lack of an EU-27 fully harmonized system is mostly caused by historical differences in data type availability and different principles of resources management under different economical and political orientation, and also because of different economical progress over last two decades. Nevertheless, the new EU 12 MS benefit on experience gained in EU-15 MS by various common programmes and projects (e.g. COST, JRC workshops, European Commissions financing).

Activity data datasets are available especially in forms of statistics and the data is often not of direct use in the GHG estimation (i.e. net data is only available, without land conversion information). For other pools, especially on soils, data is generally limited to maps and C stocks, with very poor information of C stock changes. Dead organic matter pool is particularly poorly reported. Effort of developing of integrated systems for resources assessment, like the statistic national forest inventories, is slow with several countries having already finished or performing currently the first NFI cycle, is ongoing in several new Member States (e.g. Czech Republic, Latvia, Romania and Slovenia).

The contribution of LULUCF to total emission of each of EU-12 MS varies according the sink size and country's total emissions (Table 22.1). EU-12 aggregated offset of LULUCF is 18, with range among countries from only 5% to over 200 % of other national sectors emissions. These estimates have to be considered under the current completeness (see Table 22.3).

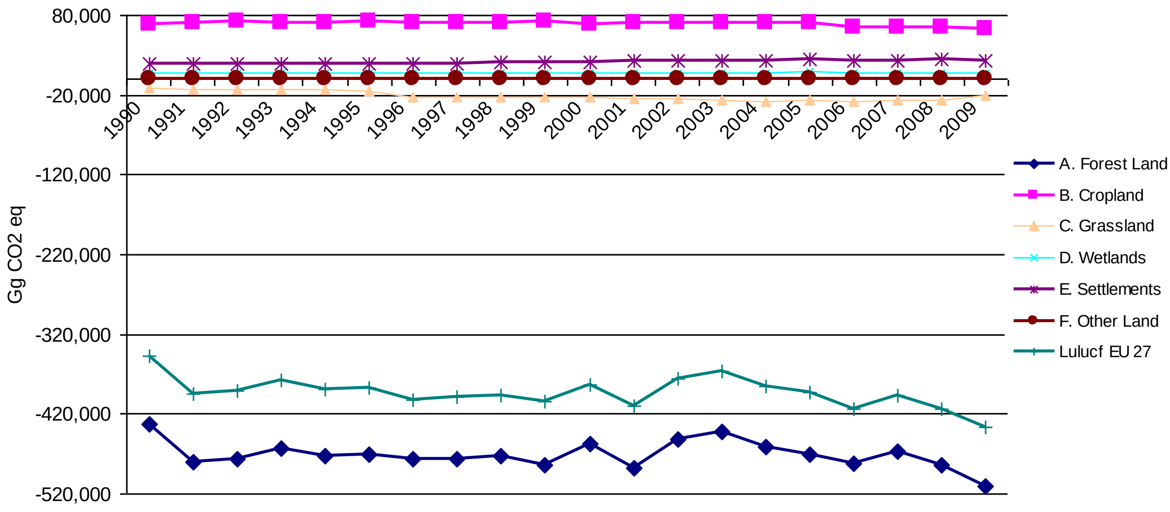
**Table 22.1 Sector 5 LULUCF contributions to total national emissions of EU-12 ($GgCO_2eq$)**

| MS | LULUCF removal | National emissions (without LULUCF) | National emissions (with LULUCF) | Share of emissions offset by LULUCF sector |
|---|---|---|---|---|
| Bulgaria | -11,566 | 69,029 | 57,463 | -20% |
| Czech Republic | -6,863 | 132,925 | 126,062 | -5% |
| Estonia | -7,035 | 16,837 | 9,802 | -72% |
| Hungary | -3,042 | 66,727 | 63,685 | -5% |
| Lithuania | -3,750 | 21,609 | 17,859 | -21% |
| Latvia | -20,484 | 10,723 | -9,761 | 210% |
| Malta | -61 | 2,866 | 2,806 | -2% |
| Poland | -37,175 | 376,659 | 339,484 | -11% |
| Romania | -36,533 | 130,828 | 94,295 | -39% |
| Slovakia | -3,449 | 43,404 | 39,955 | -9% |
| Slovenia | -8,458 | 19,339 | 10,881 | -78% |
| Total EU-12 | -138,416 | 890,946 | 752,530 | -18% |

## 22.1 Overview of the sector (EU-27)

At the EU-27 level, the LULUCF sector is a net sink with values ranging around 436,000 Gg $CO_2$ eq in 2009 (Figure 22.1), with a similar structure of removals and emissions across categories as EU-15. Overall for EU-27, only Forestland (5A) and Grassland (5C) are sinks. Compared to 1990 the annual removal increased 18 % on Forestland and 92 % for Grassland. Emissions form Cropland (5B) decreased by 10%. Emissions from Wetland (5D) increased by 9%, from Settlements (5E) by 25 % and Otherland (5F) by 26%.

**Figure 22.1** **Sector 5 LULUCF: EU-27 net $CO_2$ emissions for 1990–2009 from CRF tables in $CO_2$ (Gg)**




Most of the methodological considerations expressed for EU-15 are also valid for the new 12 MS (Table 22.2, Table 22.3). It should be considered in this regard that National Forest Inventories are harmonized to a lesser degree in new 12 EU MS), which often utilize other national statistics or forest planning & management data.

**Table 22.2** **Sector 5 LULUCF: Coverage of $CO_2$ emissions and removals of the new MS in the various subcategories for the year 2009, as derived from Table 5 of CRF tables**

| Member State | Reporting category | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Forest land | | Cropland | | Grassland | | Wetland | | Settlements | | Other land | |
| | 5A1 F-F | 5A2 L-F | 5B1 C-C | 5B2 L-C | 5C1 G-G | 5C2 L-G | 5D1 W-W | 5D2 L-W | 5E1 S-S | 5E2 L-S | 5F1 O-O | 5F2 L-O |
| Bulgaria | R | R | E | E | NE,NO | R | E | E | E | E | | NO |
| Cyprus | na | na | na | na | na | na | na | na | na | na | | na |
| Czech R. | R | R | E | E | E | R | NO | E | | E | | NO |
| Estonia | R | NE,NO | E | NE | E | R | R | NE | NE | NE | | R |
| Hungary | R | R | E | E | R | R | NE,NO | IE,NE,NO | NE | IE,NE | | R |
| Latvia | R | R | E | NE | R | NE | R | NE | R | NE | | NE |
| Lithuania | R | R | NA,NE | NA,NE | NA,NE | NA,NE | E | E | NE | E | | E |
| Malta | R | NA,NO | R | NO | NO | NO | NO | NO | R | NO | | NO |
| Poland | R | R | E | NA,NE,NO | E | NE | E | E | R | NA,NO | | NA |
| Romania | R | NA,NE | NA,NE | NA,NE | NA,NE | NA,NE | NA,NE | NA,NE | NE | NA,NE | | NA,NE |
| Slovakia | R | R | E | NE,NO | NE,NO | R | IE,NO | IE,NO | IE | IE | | E |
| Slovenia | R | R | E | E | E | E | NE,NO | NO | NE | NE,NO | | NO |

*Legend: R: net Removal; E: net Emission; IE: included elsewhere; NE: not estimated; NO: not occurring; NA: not applicable.*

Furthermore, most new MS reported less sub-categories and pools than most of the EU-15 MS because of lack of national data, but more often because of lack of both national capacity of processing existing data (e.g. rich data related to forest management) and adapt and develop it according reporting needs. Actions that the new MS have taken include: improving the coverage of activity data for more land use and land use change categories; adjusting and improve the NFI to reporting needs; improving the methodology of converting activity data to emissions and removals by the appropriate factors (e.g., adjustments of biomass expansion factors by Poland); changing the estimation methods (e.g. the approach to consider the standing volume as activity data by Hungary); frequent recalculations due to improved data reporting (e.g. Lithuania, Latvia); efforts for estimating uncertainties and improving the transparency of the reporting and the active participation in European projects and actions aimed at improving the reporting. Several new MS indicate that additional changes and improvements are under way and will be implemented in their supplementary report under the Kyoto Protocol.

Forestland is a key category in all EU 12.

**Table 22.3 Sector 5 LULUCF: Reporting of carbon pools by the new MS for the most important categories for the year 2009, as derived from Table 5A, 5B and 5C of the CRF tables 2011 (Information on data sources and methodological approaches for EU-15 is available in Chapter 7, Table 7.6)**

| MS | Forest land | | | | | | | | Cropland | | | | | | | | Grassland | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | FL-FL | | | | L-FL | | | | CL-CL | | | | L-CL | | | | GL-GL | | | | L-GL | | | |
| | Biomass | DOM-1 | SOM Min | SOM Org-2 | Biomass | DOM | SOM Min | SOM Org-2 | Biomass-3 | DOM | SOM Min-4 | SOM Org-2 | Biomass-5 | DOM | SOM Min | SOM Org-2 | Biomass | DOM | SOM Min-4 | SOM Org-2 | Biomass | DOM | SOM Min | SOM Org-2 |
| BG | CS | D | D | NO | CS | D | CS | NO | CS | CS | CS | NO | CS,D | NE | CS | NO | D | D | NE | NO | CS | NE | CS | NO |
| CY | CS | D | D | NE | NE | D | NE | NO | NE | D | NE | NO | NE | NE | NE | NO | D | D | NE | NO | NE | NE | NE | NO |
| CZ | CS | D | D | NO | CS | D | CS | NO | CS | D | CS,D | NO | CS, D | CS | CS | NO | D | D | CS,D | NO | CS | CS | CS | NO |
| EE | CS | CS,D | D | CS,D | CS | CS | NE | CS,D | NE | D | NE | CS,D | NO,NO | NO | NO | CS,D | CS,D | CS | NE | CS,D | CS | NE | NE | CS,D |
| HU | CS | D | D | NO | CS | D | D | NO | CS | D | D,D | NO | CS,D | CS | D | NO | D | D | D,D | NO | CS | CS | D | NO |
| LV | CS | D | D | CS | CS | D | NE | CS | D | D | NE | CS | CS,NO | CS | NE | CS | D | D | NE | CS | NE | NE | NE | CS |
| LT | CS | CS | CS | CS | CS | D | NE | NE | NE | D | NE | NE | NE,NE | NE | NE | NE | D | D | NE | NE | NE | NE | NE | NE |
| MT | CS | D | D | NE | NO | NO | NO | NO | CS | D | NE | NO | NE | NE | NE | NO | D | D | NE | NO | NO | NE | NE | NO |
| PL | CS | D | CS | NE | CS | CS | CS | NE | CS | CS | CS | CS | NE,NO | NE | NE | NE | D | CS | NE | CS | NE | CS | NE | NE |
| RO | CS | D | D | NE | NE | D | NE | NE | NE | D | NE | NE | NE,NE | NE | NE | NE | D | D | NE | NE | NE | NE | NE | NE |
| SK | CS | D | D | NO | CS | D | CS | NO | CS | D | NE | NO | CS,D | CS | CS | NO | D | D | NE | NO | CS | CS | CS | NO |
| SI | CS | CS | D | NO | CS | CS | CS | NO | CS | D | CS | CS | CS,D | NE | CS | NO | D | D | NE | CS | CS | NE | CS | NO |

*Legend*

*"CS" country specific data, associated either with IPCC method (tier 2) or country-specific method (tier 3, if data are highly disaggregated). Note that sometimes not all parameters involved in the estimation are truly "CS" (e.g. root/shoot ratio and BEF are often taken by IPCC). However it is expected that if "CS" is reported, the most important parameters are truly "CS".*

*"D" means that the default IPCC emission factors are used in the estimation. D is typically associated with IPCC default method (tier 1). If the heading is in grey, D means that NO change in C stock is assumed (following IPCC tier 1).*

*"NE" means either country assumes the emission/removal is negligible or not enough data is available for estimation.*

*"NO" means emissions or removals "not occurring" in a country (it includes also "NA" - not applicable)*

*(1) for DOM under "FL r FL" the 2 notations separated by a comma mean: first one refers to DW (dead wood), second to LT (litter)*

*(2) for ORGANIC SOIL any notation key reported for a country showing some activity data of org soil for any land (sub)category is assumed as NE. D refers to the use of IPCC default emissions factors*

*(3) BIOMASS C stock change in CL-CL is assumed only for perennial woody crops. Biomass of annual crops is always assumed zero C stock change by definition.*

*(4) for SOM MIN on CL and GL the 2 notation keys separated by comma mean that the country uses IPCC default method (which is tier 1 if associated with D data or tier 2 if associated with CS data); in this case, the first notation key refers to "reference C stock", and second to "C stock change factor" (see IPCC-GPG for details). A cell with a single "CS" indicate a country-specific method and data (i.e. tier 3 if data are highly disaggregated)*

*(5) for BIOMASS under L - CL, "conversion to cropland", the 2 notation keys used mean: first one refers to FL-CL and second to GL-CL.*

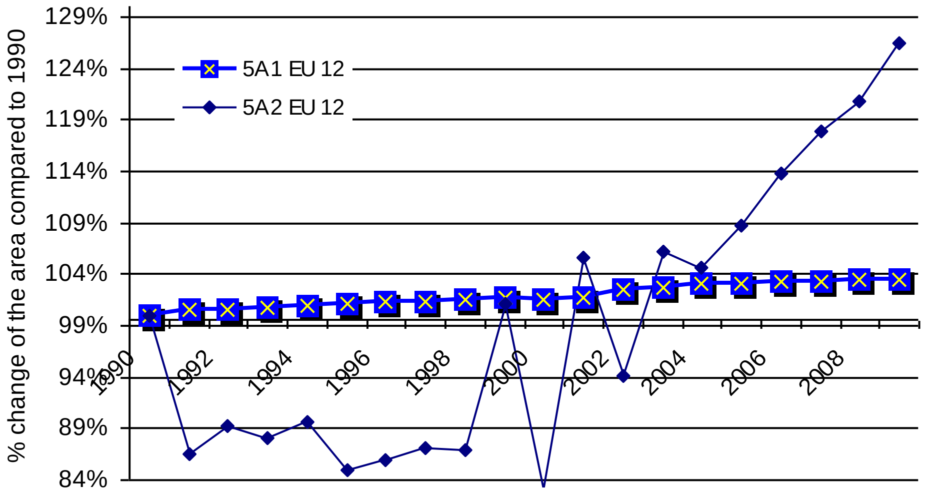
*Grey heading means that for these pools IPCC TIER 1 allows to assume no change in the C stock of that pool (note that if the category is a key category, in theory higher tiers should be used)*

## 22.2 Source and sink categories (EU-27)

### *22.2.1 Forest land (5A; EU-27)*

According to the latest submissions, EU-27 has a forest area of about 155,000 kha, out of which 34,200 is in EU-12 (22 % of total EU-27 forestland). Since 1990, the new 12 MS have reported on the whole an increase of 4 % of forest area as compared to 1990, due especially to Bulgaria, Lithuania, Poland, Romania and Slovakia, wit insignificant decreases in Latvia and Estonia (Figure 22.2).

**Figure 22.2** **The percentage increase of the forest land area between 1990 and 2009 in the EU-12 (% compared to 1990)**




In absolute terms Poland reports an increase of 33 000 kha and Romania and Slovakia around 17000 kha. As in EU-15, the category 5A contributes the most to the LULUCF sector GHG balance in the new MS. As the spikes in 5A1, the general pattern of 5A2 area is driven by Romania (which reports large areas of land conversion to forestland with only one year transition period).

Subcategory 5A1 represents a net sink since 2009 of 467,000 Gg$CO_2$ eq, with 13 % more than in 1990 and 6 % more than in the previous reported year 2008 (Table 22.4). The new EU MS report a sink of some 140,000 Gg$CO_2$ in 2009. Notable increases of the annual removal by 5A1 are reported by Latvia and Poland. A significant increase compared to previous year is reported by Czech Republic. The rate of removals has almost doubled in the lands under conversion to forest land category ( New MS report increase of removal from 5A2, with only Slovakia reporting decreasing annual removal under less area converted to forestland over last decade. Under current improving of national system, Romania reports NE for this land category (Table 22.5).

Concerning the methods applied, Tier 2 and country specific methods dominate in both subcategories, and however, default data and Tier 1 are also applied. Default data is extensively used for root to shoot ratio and biomass expansion factors (BEFs).

**Table 22.4 5A1 Forest Land remaining Forest Land: Net $CO_2$ emissions of EU-27**

| Member State | Net $CO_2$ emissions (Gg) | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$) | (%) | (Gg $CO_2$) | (%) | | |
| EU-15 | -277,318 | -302,460 | -320,048 | 68.5% | -17,587 | 6% | -42,730 | 15% | | |
| Bulgaria | -13,729 | -12,047 | -12,143 | 2.6% | -96 | 1% | 1,586 | -12% | T1,T2 | CS,D |
| Cyprus | -156 | -176 | -178 | 0.0% | -2 | 1% | -22 | 14% | T1 | CS |
| Czech Republic | -4,777 | -4,558 | -6,575 | 1.4% | -2,017 | 44% | -1,798 | 38% | T1,T2, | CS,D |
| Estonia | -10,289 | 1,057 | -5,476 | 1.2% | -6,532 | -618% | 4,813 | -47% | T1,T2 | D |
| Hungary | -2,604 | -4,039 | -3,039 | 0.7% | 1,000 | -25% | -434 | 17% | T1,T2 | CS,D |
| Latvia | -16,925 | -23,501 | -21,051 | 4.5% | 2,450 | -10% | -4,126 | 24% | T1,T2 | CS |
| Lithuania | -5,068 | -4,439 | -4,411 | 0.9% | 28 | -1% | 657 | -13% | T2 | D |
| Malta | -49 | -49 | -49 | 0.0% | 0 | 0% | 0 | 0% | CS | D |
| Poland | -36,837 | -42,604 | -44,605 | 9.5% | -2,001 | 5% | -7,768 | 21% | T2,T1 | CS,D |
| Romania | -35,584 | -36,417 | -36,536 | 7.8% | -119 | 0% | -951 | 3% | T1,T2 | CS,D |
| Slovakia | -1,085 | -2,033 | -2,516 | 0.5% | -483 | 24% | -1,431 | 132% | T2 | CS |
| Slovenia | -9,111 | -10,769 | -10,759 | 2.3% | 10 | 0% | -1,648 | 18% | D,CS,T1,T3 | CS,D,PS |
| **EU-27** | **-413,534** | **-442,035** | **-467,385** | **100.0%** | **-25,350** | **6%** | **-53,851** | **13%** | | |

New MS report increase of the removal from 5A2, with only Slovakia reporting decreasing annual removal under less area converted to forestland over last decade. Under current improving of national system, Romania reports NE for this land category.

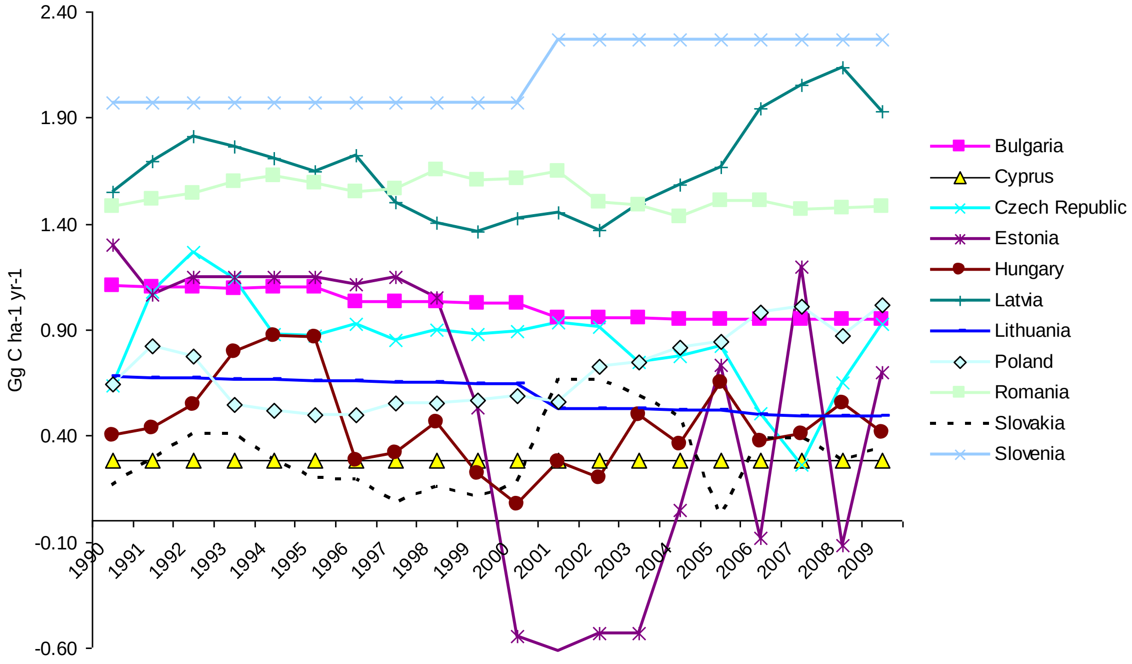
**Table 22.5 5A2 Land converted to Forest Land: Net $CO_2$ emissions of EU-27**

| Member State | Net $CO_2$ emissions (Gg) | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$) | (%) | (Gg $CO_2$) | (%) | | |
| EU-15 | -16,474 | -34,868 | -31,502 | 73.7% | 3,367 | -10% | -15,028 | 91% | | |
| Bulgaria | -1,039 | -1,551 | -1,673 | 3.9% | -122 | 8% | -634 | 61% | T1 | CS |
| Cyprus | 0.00 | 0.00 | 0.0 | 0.0% | 0.00 | - | 0.00 | - | T1 | CS |
| Czech Republic | -280 | -283 | -295 | 0.7% | -12 | 4% | -15 | 5% | T1,T2 | CS,D |
| Estonia | -47 | -659 | -694 | 1.6% | -35 | 5% | -647 | 1369% | T1,T2 | D |
| Hungary | 24 | -106 | -139 | 0.3% | -33 | 31% | -163 | -678% | T1,T2 | CS,D |
| Latvia | 1 | -441 | -506 | 1.2% | -66 | 15% | -507 | -80438% | T1,T2 | CS |
| Lithuania | 0.22 | 0.12 | -0.01 | 0.0% | -0.13 | -106% | -0.23 | -104% | T2 | D |
| Malta | NA,NO | NA,NO | NA,NO | - | - | - | - | - | NA | NA |
| Poland | -224 | -6,800 | -7,339 | 17.2% | -539 | 8% | -7,116 | 3182% | T2,T1 | CS,D |
| Romania | NA,NE | NA,NE | NA,NE | - | - | - | - | - | NA | NA |
| Slovakia | -1,950 | -421 | -318 | 0.7% | 103 | -24% | 1,632 | - | T2 | CS |
| Slovenia | -269 | -269 | -269 | 0.6% | 0.00 | 0% | 0.00 | 0% | D,T1,T2 | CS,D |
| **EU-27** | **-20,258** | **-45,398** | **-42,734** | **100.0%** | **2,664** | **-6%** | **-22,476** | **111%** | | |

For the new EU-12 MS, the average C stock change factor in net biomass is 15 % higher then in EU-15, within similar range. The highest net change in biomass is reported by Slovenia, under close to nature extensive forest management practiced there. Swift change in Slovenia's estimate is given by different data obtained by successive inventory.  The smallest values are shown by Cyprus, Hungary and Slovakia (Figure 22.4). IEF is negative, suggesting a source, only in case of Estonia, under high harvesting volume about twice higher than usual between 1999 and 2004 and wildfires in 2006 and 2008.

DOM is practically reported by only three MS with an average value across EU-12 of 0.07 to 0.011 MgCha-1yr-1. C stok change in the soil is poorly reported by only 2 countries, with an average value of 0.012 MgCha-1yr-1. Average IEF for organic soils is -0.3 MgCha-1yr-1.

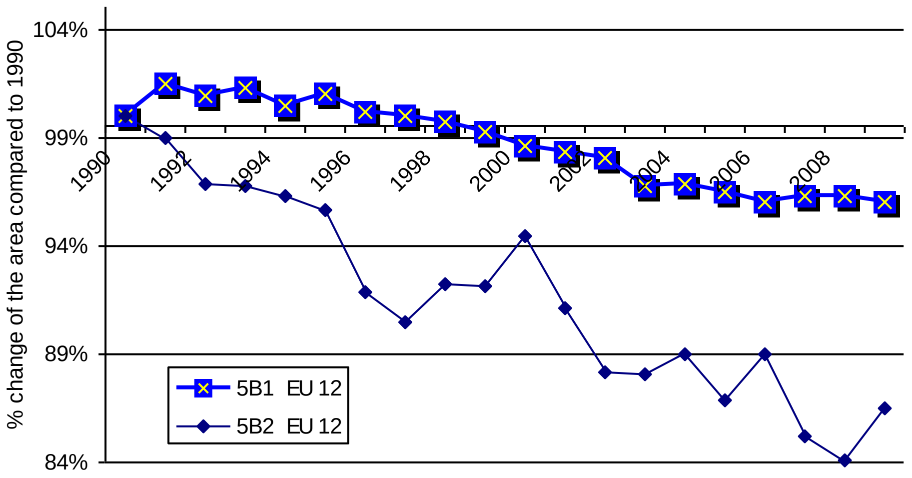
**Figure 22.3** **Implied net C stock change factor for the net biomass C pool in the EU-12**




## *22.2.2 Cropland (5B; EU-27)*

In the new 12 EU MS, cropland area (5B) decreased by 4% since 1990, respectively 1,732 kha. All MS report decreases of cropland area, with the exception of Lithuania and Estonia that report significant increase compared to 1990. In absolute terms, the highest reductions of cropland areas are in Latvia (some 700 kha) and Poland (1,200 kha), and increase by Lithuania (600 kha). Area of land under conversion to cropland decreased sharply since 1990 (Figure 22.4).

**Figure 22.4** **The percentage increase of the cropland area between 1990 and 2009 in the EU-12 (% compared to 1990)**



Subcategory 5B1, cropland remaining cropland is a source of GHGs of about 28,500 $GgCO_2eq$ (Table 22.6), somehow constant in time since 1990. Bulgaria and Slovenia report increase of emissions compared to 1990. The methodologies are still largely based on Tier 1 in subcategory 5B1 and most new MS are still weak in reporting the emissions from subcategory 5B2.

**Table 22.6 5B1 Cropland remaining Cropland: Net $CO_2$ emissions of EU-27**

| Member State | Net $CO_2$ emissions (Gg) | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$) | (%) | (Gg $CO_2$) | (%) | | |
| EU-15 | 14,888 | 18,693 | 18,960 | 66.1% | 267 | 1% | 4,072 | 27% | | |
| Bulgaria | 487 | 955 | 1,053 | 3.7% | 98 | 10% | 566 | 116% | T1,T2 | CS,D |
| Cyprus | 0.00 | 0.00 | 0.00 | 0.0% | 0.00 | - | 0.00 | - | NE | NE |
| Czech Republic | 1,089 | 69 | 40 | 0.1% | -30 | -43% | -1,050 | -96% | T1 | D |
| Estonia | 170 | 101 | 100 | 0.3% | -1 | -1% | -70 | -41% | T1 | D |
| Hungary | 382 | -467 | -494 | -1.7% | -27 | 6% | -876 | -229% | T1 | D |
| Latvia | 338 | 226 | 221 | 0.8% | -5 | -2% | -117 | -35% | T2 | D |
| Lithuania | 93 | NA,NE | NA,NE | - | - | - | - | - | NA | NA |
| Malta | -8 | -10 | -10 | 0.0% | 0.01 | 0% | -2 | 29% | CS | D |
| Poland | 11,758 | 9,034 | 9,254 | 32.3% | 219 | 2% | -2,504 | -21% | T2 | D,CS |
| Romania | NA,NE | NA,NE | NA,NE | - | - | - | - | - | NA | NA |
| Slovakia | -937 | -859 | -859 | -3.0% | -0.23 | 0% | 78 | -8% | T1,T2 | CS,D |
| Slovenia | 174 | 400 | 412 | 1.4% | 12 | 3% | 238 | 136% | D,T1,T2 | CS,D |
| **EU-27** | **28,435** | **28,142** | **28,676** | **100.0%** | **533** | **2%** | **241** | **1%** | | |

Lands under conversion to cropland are reported as source with 15% less than in 1990 and 8 % less than in previous reported year 2007 (Table 22.7).

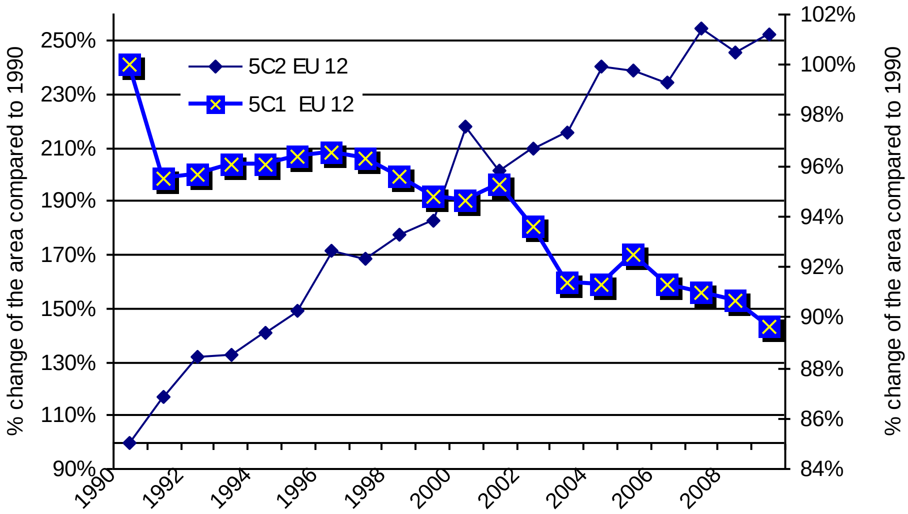
**Table 22.7 5B2 Land converted to Cropland: Net $CO_2$ emissions of EU-27**

| Member State | Net $CO_2$ emissions (Gg) | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$) | (%) | (Gg $CO_2$) | (%) | | |
| EU-15 | 37,762 | 35,571 | 32,551 | 91.9% | -3,020 | -8% | -5,211 | -14% | | |
| Bulgaria | 1,012 | 1,012 | 1,012 | 2.9% | 0.00 | 0% | 0.00 | 0% | T1 | CS |
| Cyprus | 0.00 | 0.00 | 0.00 | 0.0% | 0.00 | - | 0.00 | - | NE | NE |
| Czech Republic | 226 | 96 | 74 | 0.2% | -21 | -22% | -152 | -67% | T1,T2 | CS,D |
| Estonia | NO | NE,NO | 4 | 0.0% | - | - | - | - | T1 | D |
| Hungary | 74 | 244 | 226 | 0.6% | -17 | -7% | 152 | 206% | T1 | D |
| Latvia | 835 | 302 | 175 | 0.5% | -127 | -42% | -660 | -79% | T2 | D |
| Lithuania | NA,NE | NA,NE | NA,NE | - | - | - | - | - | NA | NA |
| Malta | NO | NO | NO | - | - | - | - | - | NA | NA |
| Poland | NA,NE,NO | NA,NE,NO | NA,NE,NO | - | - | - | - | - | NA | NA |
| Romania | NA,NE | NA,NE | NA,NE | - | - | - | - | - | NA | NA |
| Slovakia | 789 | 162 | 164 | 0.5% | 2 | 1% | -625 | -79% | T2 | CS |
| Slovenia | 1,150 | 1,201 | 1,201 | 3.4% | 0.00 | 0% | 51 | 4% | D,T1,T2 | CS,D |
| **EU-27** | **41,847** | **38,586** | **35,406** | **100.0%** | **-3,179** | **-8%** | **-6,441** | **-15%** | | |

## *22.2.3 Grassland (5C; EU-27)*

Grassland area decreased by 11 % compared to 1990 in the new EU MS level, but in general there is a general trend of stabilizing land use in this category. The highest decrease is shown by Poland (735 kha) and Lithuania (636 kha) (Figure 22.5).

**Figure 22.5** **The percentage increase of the grassland area between 1990 and 2009 in the EU-12 (% compared to 1990)**




Subcategory 5C1, grassland remaining grassland, is reported as a source of GHGs by the EU-12 countries, with a total emission of 10,437 $GgCO_2$ in 2009, 11 % less than in 1990 and 27% compared to previous year (Table 22.8). The methodologies are largely based on Tier 1 with default data; country specific values are available only in few new MS.

**Table 22.8** **5C1 Grassland remaining Grassland: Net $CO_2$ emissions of EU-27**

| Member State | Net $CO_2$ emissions (Gg) | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$) | (%) | (Gg $CO_2$) | (%) | | |
| EU-15 | 11,753 | 8,321 | 10,427 | 99.9% | 2,107 | 25% | -1,325 | -11% | | |
| Bulgaria | NO | NO | NO | - | - | - | - | - | T1 | D |
| Cyprus | 0 | 0 | 0 | 0.0% | 0.00 | - | 0.00 | - | NE | NE |
| Czech Republic | 59 | 5 | 3 | 0.0% | -2 | -37% | -56 | -95% | T1 | D |
| Estonia | -236 | -737 | -640 | -6.1% | 97 | -13% | -404 | 171% | T1,T2 | D |
| Hungary | 18 | 445 | 444 | 4.3% | -1 | 0% | 425 | 2325% | T1 | D |
| Latvia | 40 | 61 | 68 | 0.7% | 7 | 11% | 28 | 69% | T1 | D |
| Lithuania | NA,NE | NA,NE | NA,NE | - | - | - | - | - | NA | NA |
| Malta | NO | NO | NO | - | - | - | - | - | NA | NA |
| Poland | 153 | 137 | 136 | 1.3% | -1 | -1% | -17 | -11% | T1,T2 | D,CS |
| Romania | NA,NE | NA,NE | NA,NE | - | - | - | - | - | NA | NA |
| Slovakia | NO | NO | NO | - | - | - | - | - | NA | NA |
| Slovenia | IE,NA,NO | IE,NA,NO | IE,NA,NO | - | - | - | - | - | NA | NA |
| **EU-27** | **11,787** | **8,231** | **10,437** | **100.0%** | **2,207** | **27%** | **-1,349** | **-11%** | | |

However, land conversion to grassland is reported as emissions of $CO_2$, which decreased by 8 % compared to last reported year and increased 39 % compared to 1990 (Table 22.9).

**Table 22.9** **5C2 Land converted to Grassland: Net $CO_2$ emissions of EU-27**

| Member State | Net $CO_2$ emissions (Gg) | | | Share in EU15 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$) | (%) | (Gg $CO_2$) | (%) | | |
| EU-15 | -21,810 | -32,869 | -30,164 | 94.4% | 2,705 | -8% | -8,354 | 38% | | |
| Bulgaria | -787 | -787 | -787 | 2.5% | 0.00 | 0% | 0.00 | 0% | T1 | CS |
| Cyprus | 0 | 0 | 0 | 0.0% | 0.00 | - | 0.00 | - | NE | NE |
| Czech Republic | -187 | -389 | -374 | 1.2% | 15 | -4% | -187 | 100% | T1,T2 | CS,D |
| Estonia | -12 | -328 | -328 | 1.0% | 0.00 | 0% | -316 | - | T1,T2 | D |
| Hungary | -21 | -196 | -214 | 0.7% | -18 | 9% | -193 | 913% | T1 | D |
| Latvia | IE,NE,NO | IE,NE,NO | IE,NE,NO | - | - | - | - | - | NA | NA |
| Lithuania | NA,NE | NA,NE | NA,NE | - | - | - | - | - | NA | NA |
| Malta | NO | NO | NO | - | - | - | - | - | NA | NA |
| Poland | -71 | NA,NE,NO | NA,NE,NO | - | - | - | - | - | NA | NA |
| Romania | NA,NE | NA,NE | NA,NE | - | - | - | - | - | NA | NA |
| Slovakia | -347 | -376 | -426 | 1.3% | -50 | 13% | -79 | - | T2 | CS |
| Slovenia | 222 | 343 | 343 | -1.1% | 0.00 | 0% | 121 | 54% | D,T1,T2 | CS,D |
| **EU-27** | **-23,012** | **-34,602** | **-31,949** | **100.0%** | **2,652** | **-8%** | **-8,938** | **39%** | | |

### 22.2.4 Wetlands, Settlements and Other land

Activity data is reported for all land use as derived from national scale land matrices for each of EU-12 MS. Wetland area is large in Poland (900 kha), Estonia (some 500 kha), Romania (435 kha), with area of conversion to wetland is quite small. Flooded area is only reported by Poland (880 kha) for computation of $CH_4$ emissions. Area of conversion to settlements (to total settlements area) is relatively smaller comparative to homologue share in the EU-15. Large areas of Other land is reported by Bulgaria (600 kha), and Poland (2,900kha), Romania (400 kha), while other MS reports very small areas under this land category.

Emissions of any GHG are mainly computed based on IPCC default factors, especially for conversions, with best estimated land subcategory being 5E2. Meanwhile for other land uses they are mainly reported as NE (planned to be estimated) or NO. In case of forestland conversions the emissions from biomass and DOM pools are estimated, but not always from the soil.

### 22.2.5 Non-$CO_2$ GHG emissions from land use

**Direct $N_2O$ emissions from N fertilization of Forest Land and Other** are mainly reported and justified as NO, as activities of fertilization on forestland do not occur in the new 12 EU MS.

**Non-$CO_2$ emissions from drainage of soils and wetlands** are reported as NO (i.e. Bulgaria) or are estimated in case of drainage of peatlands (i.e. Estonia, Latvia and Lithuania). The largest area is reported by Latvia, with almost half of it occurring on organic soils. Nevertheless, Estonia reports NE for drainage in other land uses which means there is more drainage that is not yet reported. All reporting MS use IPCC default emission factor for the emission estimation.

**$N_2O$ emissions from disturbance associated with land-use conversion to cropland** are reported by Bulgaria as occurring on significant area (300 kha) under conversion of grassland to cropland. Some inconsistencies regarding the areas reported under conversion from forestland or grassland to cropland were identified (i.e. Estonia). Other MS report this source as NE (i.e. Lithuania). They all use IPCC default emission factor for the emission estimation.

**$CO_2$ emissions from agricultural lime application** are mainly reported as NO. Czech Republic, Estonia, Hungary, Latvia, Poland and Slovenia provide estimates. They all use IPCC default emission factor for the emission estimation.

**Biomass Burning is reported** by Bulgaria as occurring on 2,300 ha, Poland on 4,400 ha in 2009 or Czech Republic that reports emission based on biomass burnt. Estonia, Latvia and Hungary provide detailed estimates on all relevant land use sub-categories (despite areas are vey small). Few countries report it as NE because data is not available (i.e. Lithuania).

## 22.3 Recalculations

Changes in activity data occurred for several new EU MS. In 5A1 Bulgaria, Slovakia, Lithuania and Hungary rectified entire time series, with highest change by Hungary. Same MS have rectified 5A2, as well Latvia. In 5B1 only Hungary, Latvia and Slovakia rectified time series for this land sub-category, while for 5B2 there was no recalculations. Grassland remaining grassland (5C1) and wetlands remaining wetlands (5D1) underwent major recalculations by several countries (e.g. Bulgaria, Estonia, Hungary, Slovakia), while practically there were no changes in 5C2 and 5D2. Same countries change significantly the lands reported under 5F1.

Estonia recalculated the time series for 5A which generated the increase of total LULUCF removal by some 20% compared to previous figure estimated for the inventory year 2008. Hungary also revised downward by 20 % the estimate for 2008, while Cropland is re-estimated as a sink while previously it was a source. Lithuania revised downward the removal estimate for the ear 2008 by 70 % in the current submission compared to previous submission. Latvia also revised downward the estimates for 2008 by 30%.

# 23 WASTE (CRF SECTOR 6)

## 23.1 Overview of sector (EU-27)

CRF Sector 6 Waste is the fourth largest sector in the EU-27, contributing 2.97 % to total EU-27 GHG emissions. Total emissions from Waste have been decreasing by 36 % from 214 Tg in 1990 to 137 Tg in 2009 (Figure 22.1).

**Figure 23.1 Sector 6 Waste: EU-27 GHG emissions 1990–2009 from CRF in $CO_2$ equivalents (Tg)**

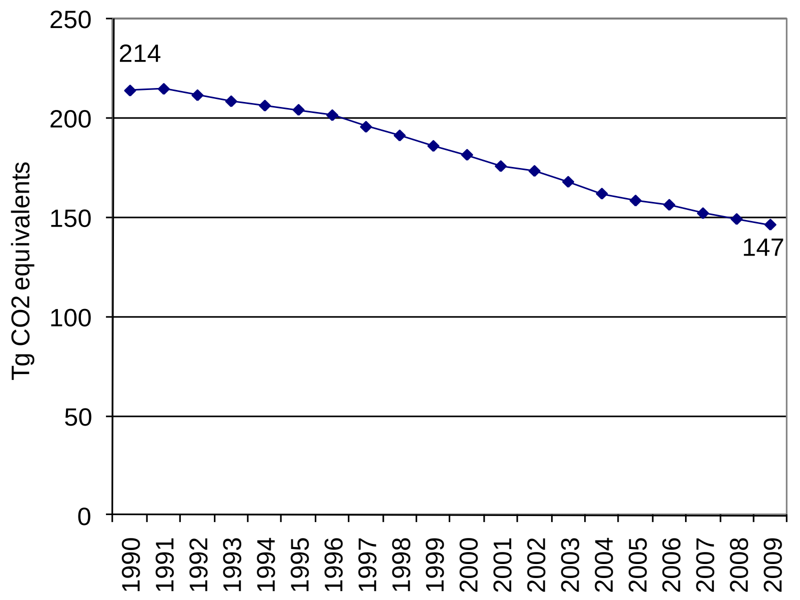
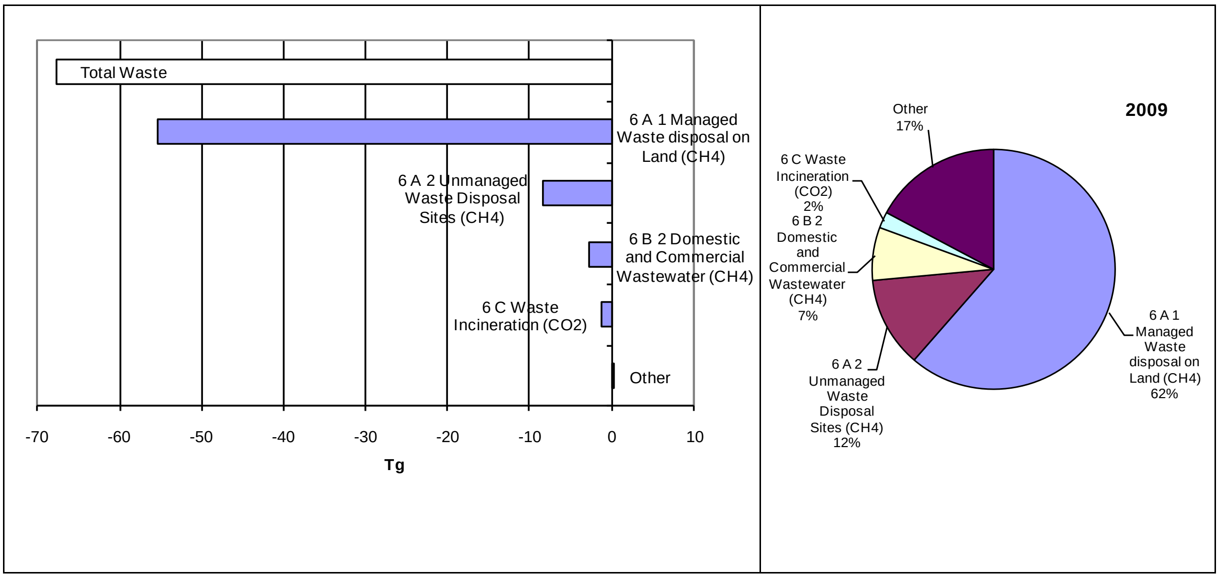



Figure 23.2 shows that $CH_4$ emissions from 6A1 Managed Waste Disposal on Land had the greatest decrease of all waste-related emissions, but still accounts for 62 % of waste-related GHG emissions in the EU-27.

**Figure 23.2 Sector 6 Waste: Absolute change of GHG emissions by large key source categories 1990–2009 in $CO_2$ equivalents (Tg) and share of largest key source categories in 2009**



## 23.2 Source categories (EU-27)

### *23.2.1 Solid waste disposal on land (CRF Source Category 6A) (EU-27)*

Source category 6A Solid waste disposal on land includes two key sources: $CH_4$ from 6A1 Managed waste disposal on land and $CH_4$ from 6A2 Unmanaged waste disposal on land. The twenty largest EU key categories cover 72 % of total GHG emissions of which emissions from managed waste disposal on land are included. More information on the 20 largest key categories of total GHG emissions of EU 27 and thus for 6A1 in EU-27 are provided in the following subchapters.

Table 22.2 provides information on emission trends of the key source $CH_4$ from 6A1 Managed Waste Disposal on Land by Member State. $CH_4$ emissions from this source account for 1.73 % of total EU-27 GHG emissions. Between 1990 and 2009, $CH_4$ emissions from managed landfills declined by 38 % in the EU-27.

During 1990 and 2009, eleven out of the 27 Member States reduced their emissions from this source, France, Greece, Italy, Portugal, Spain, Bulgaria, Cyprus, the Czech Republic, Hungary, Latvia, Lithuania, Malta, Poland, Romania, Slovakia and Slovenia did not. In 2009, $CH_4$ emissions from landfills decreased by 2 % compared to 2008. A main driving force for $CH_4$ emissions from managed waste disposal on land is the amount of biodegradable waste going to landfills. Total municipal waste disposal on land declined by 28% between 1990 and 2009. $CH_4$ emissions from landfills are also influenced by the amount of $CH_4$ recovered and utilized or flared. Compared to last year's inventory, the share of $CH_4$ recovery increased in all EU-12 Member States, except for the Czech Republic and Slovakia, see also Figure 23.7.

Member States contributing most to $CH_4$ emissions from this source were Hungary, Romania and the Czech Republic, accounting for 9 % of EU-27 emissions. Thus the new Member States only have a minor contribution to total EU-27 GHG emissions in 2009. A reduction of emissions during 1990 and 2009 could only be found for Estonia; whereas Romania increased significantly its $CH_4$ emissions during 1995 and 2008, especially during 1998-1999, 2000-2001, 2004-2006, due to number of managed sites increasing along this period: from 1 site in 1995, 2 in 1999, 6 in 2001, to 20 at the end of 2006. The Czech Republic increased steadily its $CH_4$ emissions due to a rather constant generation of municipal waste on waste disposal sites. Nevertheless, emissions stopped increasing during 1996 and 1997, because new facilities recovering landfill gas started operation in that time. In following years this increase in recovery was offset by a growing trend of methane generation. Today the increase of methane emissions is almost balanced by the growing recovery of landfill gas.

Hungary, responsible for 3.3 % of total EU-27 emissions from solid waste disposal on land steadily increased its emissions until 2005 and managed to reduce its emissions until now. This might also be due to a change in waste treatment: the rate of landfilled waste decreased from 83 % in 2001 (recycling 1 %, composting 0 %) to 74 % in 2009, in favor of recycling (13 %) and composting (2 %), see Figure 23.4.

Almost all new MS used higher tier methodologies for estimating $CH_4$ emissions; the table suggests that 75 % of $CH_4$ emissions from managed waste disposal on land are calculated with higher tier methodologies.

**Table 23.1** **6A1 Managed Waste Disposal on Land: $CH_4$ emissions of EU-27**

| Member State | $CH_4$ emissions (Gg $CO_2$ equivalents) | | | Share in EU27 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| EU-15 | 138,429 | 78,930 | 76,701 | 85.3% | -2,229 | -3% | -61,728 | -45% | | |
| Bulgaria | NO | 360 | 344 | 0.4% | -17 | -5% | 344 | - | T2 | CS,D |
| Cyprus | 305 | 498 | 481 | 0.5% | -18 | -4% | 176 | 58% | T1 | D |
| Czech Republic | 1,663 | 2,446 | 2,529 | 2.8% | 83 | 3% | 866 | 52% | T2 | D |
| Estonia | 600 | 514 | 468 | 0.5% | -46 | -9% | -132 | -22% | 2 (the fod) | D |
| Hungary | 2,264 | 3,021 | 2,990 | 3.3% | -31 | -1% | 726 | 32% | T2 | D |
| Latvia | 396 | 593 | 593 | 0.7% | 0 | 0% | 197 | 50% | T2 | D |
| Lithuania | 525 | 586 | 609 | 0.7% | 23 | 4% | 84 | 16% | T2 | D |
| Malta | NA | 73 | 91 | 0.1% | 18 | 25% | 91 | - | M | M |
| Poland | 840 | 853 | 845 | 0.9% | -8 | -1% | 6 | 1% | M | D |
| Romania | NO | 2,577 | 2,853 | 3.2% | 276 | 11% | 2,853 | - | T1 | D |
| Slovakia | IE | 1,007 | 1,027 | 1.1% | 20 | 2% | 1,027 | - | T2 | CS |
| Slovenia | 345 | 400 | 361 | 0.4% | -38 | -10% | 16 | 5% | T2 | D |
| **EU-27** | **145,366** | **91,859** | **89,891** | **100.0%** | **-1,968** | **-2%** | **-55,474** | **-38%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

$CH_4$ emissions from managed solid waste disposal are key sources in all new Member States, except for Poland. Although it is good practice to calculate the emissions for key sources using the First Order Decay (FOD) method (Tier 2), some MS use lower methodologies. Besides Cyprus this is the case for Romania, too, as there are no sufficient historical data series available to estimate the amount of the collected waste. Table 23.2 summarizes the characteristics of the national methodologies for estimating $CH_4$ emissions from managed solid waste disposal sites.

**Table 23.2** **6A1 Managed Waste Disposal: Description of national methods used for estimating $CH_4$ emissions in the new MS**

| **Managed Waste Disposal on Land** | |
|---|---|
| **Member State** | **Description of methods** |
| **Bulgaria** | Emissions from solid waste disposal on land have been calculated using the First Order Decay (FOD) method, which is the IPCC Tier 2 method given in the IPCC Good Practice Guidance (GPG 2000). Activity data for the whole period (1950-2009), according to IPCC GPG comes from NSI. [NIR 2011] |
| **Cyprus** | The emissions arising from solid waste disposal on land are estimated on the basis of waste production and type of management, based on the methodology proposed by IPCC guidelines 1996. According to the particular methodology, the uncontrolled disposal sites are distinguished into two categories: depth smaller and larger than 5 meters, where the first have smaller methane emission coefficient since the conditions do not allow intensive fermentation to take place. The uncontrolled sites in Cyprus have been classified as of the first type. For the estimation of methane emissions from solid wastes, the IPCC 1996 default methodology was applied. [NIR 2011] |
| **Czech Republic** | Key activity data for methane quantification from 6.A is amount of waste disposed in to landfills.The method we are using for estimation of methane emissions from this source category is tier 2 FOD approach (First order decay model). In new methodology it is actually basic tier for this category. First order decay (FOD) model assumes gradual decomposition of waste disposed to landfill. For calculation of GHG emissions from we used IPCC Spreadsheet for Estimating Methane emissions from Solid Waste Disposal Sites which is part of new methodology guidelines IPCC, 2007. [NIR 2011] |
| **Estonia** | Waste key categories in 2009 calculated with the Tier 2 method. The First Order Decay (the FOD) approach were employed (IPCC 2000).Calculating emissions from solid waste disposal sites the total amount generated and the quantity of municipal waste generated in 2009 (collected from Estonian Environment Information Centre (EEIC) and amount of recovered methane (obtained from the EEIC Air bureau) are used as activity data. Due to obtainable waste disposal activity data for the current inventory year and available waste disposal activity data for previous years, however country-specific key parameters are not available, the FOD method with default parameters and country-specific activity data was used. Emission factors (EFs) used in calculations of emissions from solid waste disposal sites are default emission factors from IPCC 2000. [NIR 2011] |

| | |
|---|---|
| **Hungary** | Emissions were calculated using a first order decay methodology, as response to the recommendations of the ERT in 2007. For the calculations, the IPCC Waste Model from the 2006 IPCC Guidelines was used. The FOD method produces a time-dependent emission profile which may better reflect the true pattern of the degradation process as it is claimed by the IPCC GPG. Activity data is obtained from the Waste Management Information System maintained by the Ministry of Environment and Water. This database is a new development and contains very detailed information on waste management practices in Hungary. [NIR 2011] |
| **Latvia** | IPCC GPG 2000 (Tier 2) method is used for $CH_4$ emissions calculation. All emissions factors are default factors from IPCC GPG 2000, because Latvia hasn't national emission factors.To estimate $CH_4$ emissions with First Order Decay (Tier2) method from landfills, time series for disposed waste amounts till 1970 was developed. Disposed amounts for years 1970 – 1989 were estimated taking into account population and Grand domestic product (GDP). Landfills from 1970 – 1979 are estimated as uncategorised, from 1980 – 1989 landfills estimated as 50% - uncategorised and 50% - managed. Since year 1990 all waste disposal sites are estimated as managed sites, because waste levelling taking place in Latvia's landfills. [NIR 2011] |
| **Lithuania** | Methane emissions from solid waste disposal sites were estimated using IPCC waste model based on the first order decay method provided in the 2006 IPCC Guidelines. Data on waste generation and disposal were collected in Lithuania only from 1991, data on disposal before 1991 are not available. The data provided by the Lithuanian Environmental Protection Agency (EPA) responsible for environmental statistics in Lithuania show that waste generation and disposal in 1991-1994 were fluctuating very substantially and were almost twice as high as in 1999-2008. [NIR 2011] |
| **Malta** | The IPCC 2006 Tier 2 First Order Decay (FOD) spreadsheet model has been used to work out methane emissions from the solid waste category. This Tier 2 method uses IPCC default parameters as well as country specific activity data. Prior to 1997 no weighing bridges were available at the Maltese landfills. Hence, the available solid waste statistics prior to 1997 may at best be considered as indicative. In the IPCC 2006 [8] waste model, 1977 was chosen as the starting year for waste deposition into landfills. The year 1977 was chosen since at that time waste started being deposited into Maghtab and Wied Fulija in Malta. [NIR 2011] |
| **Poland** | The methane emissions from solid waste disposals were calculated using the IPCC Waste Model (Tier 2) published in [IPCC 2006]. The model establish multiyear series when methane is generated from organic matter decomposition in anaerobic conditions. The emission of $CH_4$ is diminished by recapturing of this gas. IPCC default values have been applied. [NIR 2011] |
| **Romania** | Tier 1 method has been applied due to the fact that there are no sufficient historical data series to estimate the amount of the collected waste. Methane emissions from SWDS were calculated according to the equation 5.3 from page 5.7 of IPCC GPG 2000. The fraction of degradable organic carbon (DOC) in MSW was calculated according to the equation 5.4 from page 5.9 of IPCC GPG 2000 and using the percentage composition of domestic waste. The percentage composition of domestic waste data for 2003-2009 period were provided by the Waste Directorate of NEPA. [NIR 2011] |
| **Slovakia** | The estimation of methane emissions from SWDSs by FOD method were calculated using a spreadsheet model. The methane emissions for MSW are included into category Managed waste disposal on land (6A1) from 2001, before this year the waste disposal sites were uncategorized and emissions were included in category Other municipal waste uncategorized (6A3). [NIR 2011] |
| **Slovenia** | The First Order Decay (FOD) method is used to calculate emissions. Methane generation rate k has been taken from GPG, 2000 and is 0.05. There are no data on the amount of waste prior to 1995. An estimate for the period 1964 - 1994 arrived on presumption that in 1964 50% of population was included in municipal waste collection system and that this percentage have slightly increased end reach 60% in 1977 and 76% in 1995. For 1995 on we have used actual data on amount of waste. [NIR 2011] |

*Source: NIR 2011*

The Tier 2 FOD method requires data on current as well as historic waste quantities, composition and disposal practices for several decades. In the following section a detailed overview of the most important parameters and methodological aspects of the FOD method applied by the Member States are presented. The main factors influencing the quantity of $CH_4$ produced are the amount of waste disposed of on land and the concentration of biodegradable C in that waste.

Amount of waste disposed on SWDS: The FOD method requires historic data on waste generation over decades but it is difficult to achieve consistent time series for the activity data over such long periods. The data sources used for generating time series of activity data by the new Member States are summarized in

Table 23.3.

**Table 23.3** **6A1 Managed Solid Waste Disposal: Data sources used for generating time series of activity data in new MS**

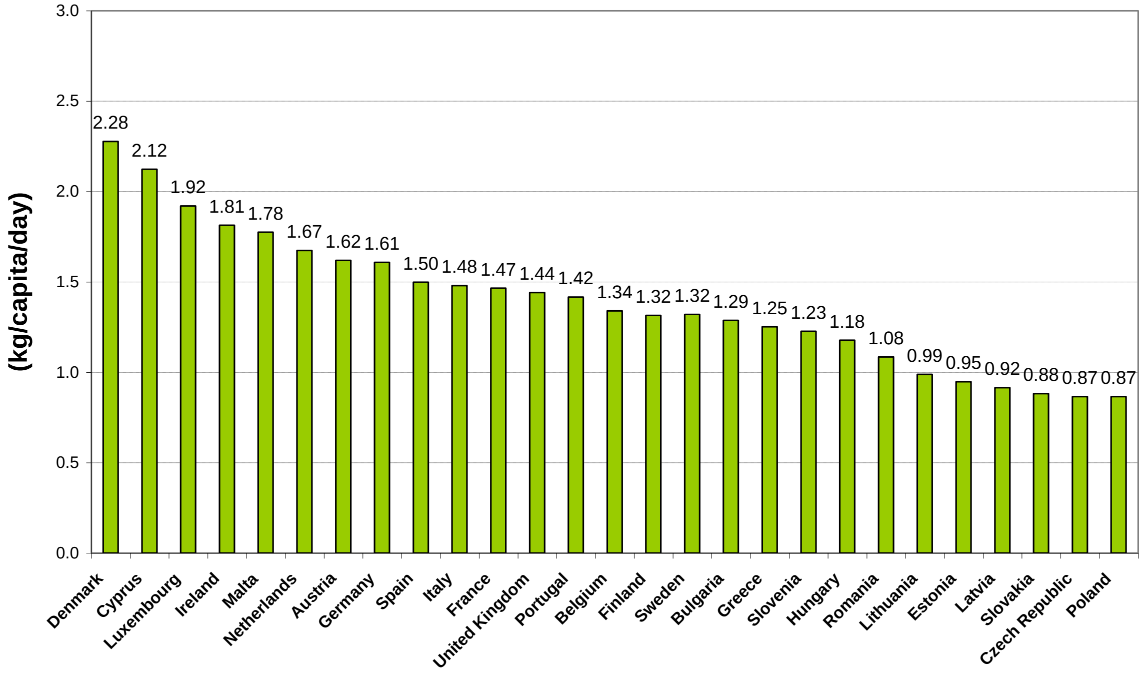
| Managed Waste Disposal on Land | |
|---|---|
| **Member State** | **Description of methods** |
| **Bulgaria** | The main source of activity data is NSI. Data on Municipal Solid Waste generation rate and on the quantity of MSW disposed to SWDSs and etc. are available and country specific data. Activity data for the whole period (1950-2009), according to IPCC GPG comes from NSI. NSI has data on waste after 1979 year;<br>a. From 1979 to 1993 data on waste generated are received by the waste collectors serving serviced settlements;<br>b. From 1994 to 1998 data on waste generation are obtained by linear interpolation between available data for 1993 and 1999.<br>c. From 1999 to 2009 waste generation data are reported by municipalities and supplemented with additional data for evaluation of non-performing locations derived from NSI. [NIR 2011] |
| **Cyprus** | No detailed descriation of activity data in NIR 2011. |
| **Czech Republic** | Data for annual disposal are from mixed sources because for correct application of FOD model one needs data from 1950 to present days. These data are not available in the country therefore assumptions about past must be used. Activity data coming from national agencies and ministries. [NIR 2011] |
| **Estonia** | The main providers of activity data used in the estimates are Estonian Environment Information Centre (EEIC) and the Statistics Estonia (SE). Since 1992 the EEIC has started to collect data of inert and degradable waste in accordance with the Estonian waste classification, however in 1999 the adapted classification system was changed and the European Waste Catalogue was employed. The data for 1990-1991 were interpolated basing on the data of 1992-1998. [NIR 2011] |
| **Hungary** | Formerly, as basic activity data the amount of removed municipal solid waste, which was published by the Hungarian Central Statistical Office in the Statistical Yearbook of Hungary and Environmental Statistical Yearbook of Hungary, were used. However, these publications do not contain this basic information any more, but make a reference to the Waste Management Information System maintained by the Ministry of Environment and Water. This database is a new development and contains very detailed information on waste management practices in Hungary. As the eldest data which can be found in statistical publications are for 1975 extrapolation had to be made. [NIR 2011] |
| **Latvia** | Amount of disposed wastes are estimated in different ways for time period since 1970. There are no other possibilities for Latvia, because waste statistics are available only from 2001. For some years primary data from National statistics is available. All other years are estimated. Disposed amount are estimated according to GDP and population changes. Population amounts for year 1971 -1978, 1982 – 1985, 1987 – 1988, 1991 – 1994 are calculated according to available amounts in nearest years. [NIR 2011] |
| **Lithuania** | Data on waste generation and disposal were collected in Lithuania only from 1991, data on disposal before 1991 are not available. The data is provided by the Lithuanian Environmental Protection Agency (EPA), which is responsible for environmental statistics in Lithuania. The amount of waste disposed of in landfills in 1950-1989 was evaluated on the basis of the several considerations. [NIR 2011] |
| **Malta** | Prior to 1997 no weighing bridges were available at the Maltese landfills. Hence, the available solid waste statistics prior to 1997 may at best be considered as indicative. Waste started being deposited into Maghtab and Wied Fulija in 1977. The opening of Qortin in Gozo came later in the 1980s. The waste generation figures for the years 1977 to 1989 have been estimated, using a backward extrapolation of waste generation statistics and population figures from 1990 to 1996. [NIR 2011] |
| **Poland** | Activities used for estimation of $CH_4$ emissions from solid waste disposals contain:<br>• Population – number of population was taken from [GUS 2010]<br>• Municipal Solid Wastes (MSW) – for years 1971-1973 data were interpolated on a basis of data from 1970 and 1974. The same method was used for 1976. In domestic statistics data were given in dam3.<br>The percentage of waste generated, which goes to solid waste disposal sites – according to the GUS Statistical Yearbook, Environment 1990, in 1981-1990 there was no combustion of waste and the composting was on level of 0.1%. Because of the lack of data, for other years this value was assumed on level of 0.1%. Distribution of solid waste disposal sites for managed and unmanaged ones was made in accordance to elaboration [Gworek 2003]. [NIR 2011] |

| | |
|---|---|
| **Romania** | For 1989–1997 where no information was available, the amount of MSW was estimated based on: waste generation rates, population whose waste goes to SWDSs and to the Fraction of MSW Disposed to SWDSs (parameters provided by the National Institute for Statistics). The National Research and Development Institute for Environmental Protection (ICIM Bucharest) was responsible for statistical inquires on waste for 1998–2002 period while the Waste Directorate of National Environmental Protection Agency is responsible for statistical inquires on waste for 2003–2009 period. The Amounts of MSW disposed to managed sites became available starting with 1995 and used for $CH_4$ emissions estimate. [NIR 2011] |
| **Slovakia** | The Statistical office of the Slovak Republic publishes data on MSW generation and disposal since 1992. Although this creates a timeline of 15 years, this is not sufficient for the use of FOD method. A longer timeline of data is needed, thus it was decided to generate a MSW data from 1960, i.e. for 48 years. Latest indication on MSW generation in the Slovak Republic was found for 1960 and 1970. Since 1992, data from annual monitoring are available. Annual MSW generation was interpolated. [NIR 2011] |
| **Slovenia** | There are no data on the amount of waste prior to 1995. The first regulated municipal solid waste disposal site, the Ljubljana Barje SWDS, started its operation in 1964. An estimate for the period 1964 - 1994 arrived on presumption that in 1964 50% of population was included in municipal waste collection system and that this percentage have slightly increased end reach 60% in 1977 and 76% in 1995. The amount of waste in the period 1995 – 2000 is provided by the SURS (data submitted to EUROSTAT) The total annual amount of municipal waste and the fraction of landfilled municipal waste during 2001 and 2009, data of the Environmental Agency of the Republic of Slovenia, which on a regular basis collects data on the formation and handling all types of waste in Slovenia was used. [NIR 2011] |

*Source: NIR 2011*

In the additional information box of the CRF tables, the waste generation rate is not very well defined. No clear definition is available on which waste fractions should be included for comparability; neither the UNFCCC reporting guidelines, nor the CRF, nor the IPCC Guidelines provide an exact definition which waste types and waste streams should be included in the estimation of the waste generation rate. Therefore Figure 23.3 provides an overview for EU-27 based on data derived from EUROSTAT. To conform to the Regulation on waste statistics (EC) No. 2150/2002, amended by Commission Regulation (EU) No. 849/2010, data on the generation and treatment of waste is collected from the Member States and prepared in a homogenous way.

**Figure 23.3 6A1 Managed Waste Disposal: Waste Generation Rate for EU-27**

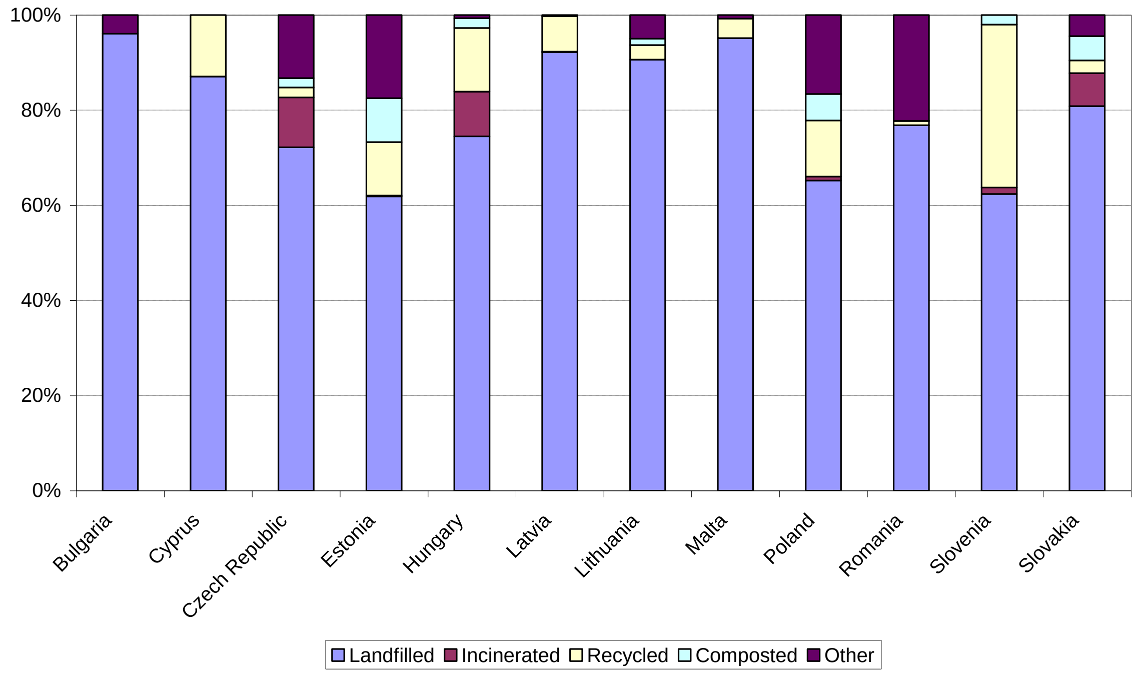



*Source: EUROSTAT 2011*

The waste generation rate per capita varies only slightly among the new Member States (0.87 kg/capita/year for Poland to 2.12 kg/capita/year for Cyprus).

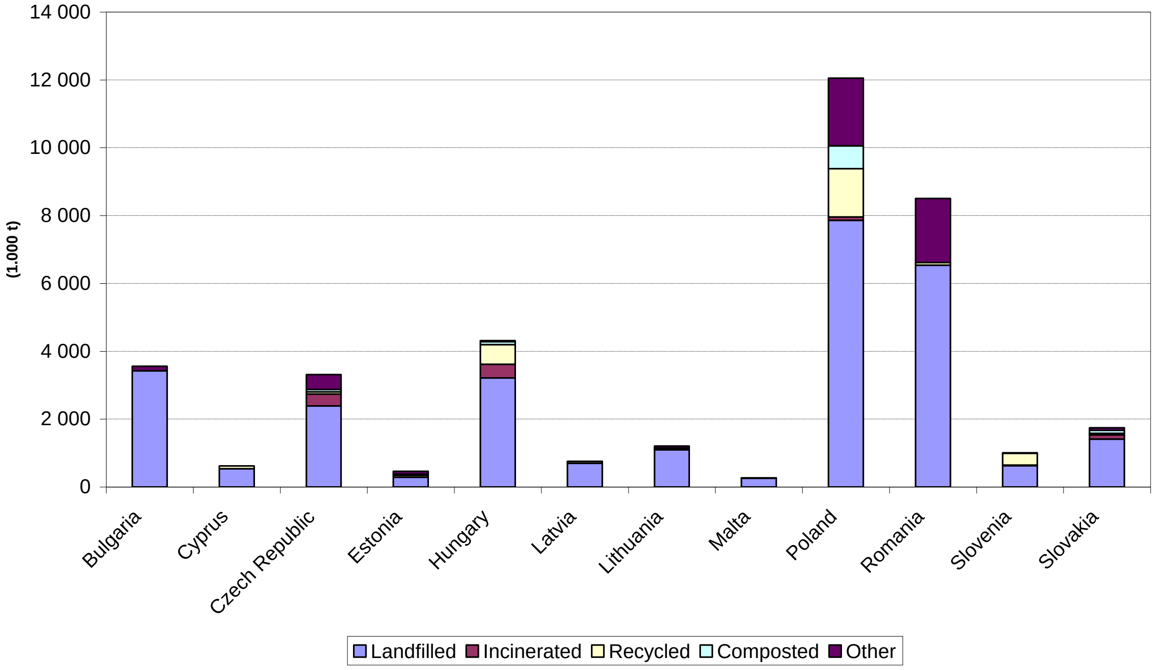
The amount of waste generated on SWDS is strongly influenced by the waste management practices or rather the share of waste incinerated, recycled and composted (Figure 23.4). Compared to the management practices in EU-15, recycling and composting is still of minor importance in the new MS, only 10 % of municipal waste was recycled or composted in EU-12 MS, compared to 46 % for the EU-15. The recycling rate of waste is highest in Slovenia (34 % of treated waste) and thus higher than the average rate for EU-27 (23 %). Figure 23.5 shows absolute values for waste management practices.

**Figure 23.4 6A1 Managed Waste Disposal: Waste management practices for the new EU-12 MS (shares) in 2009**




*Source: EUROSTAT 2011*

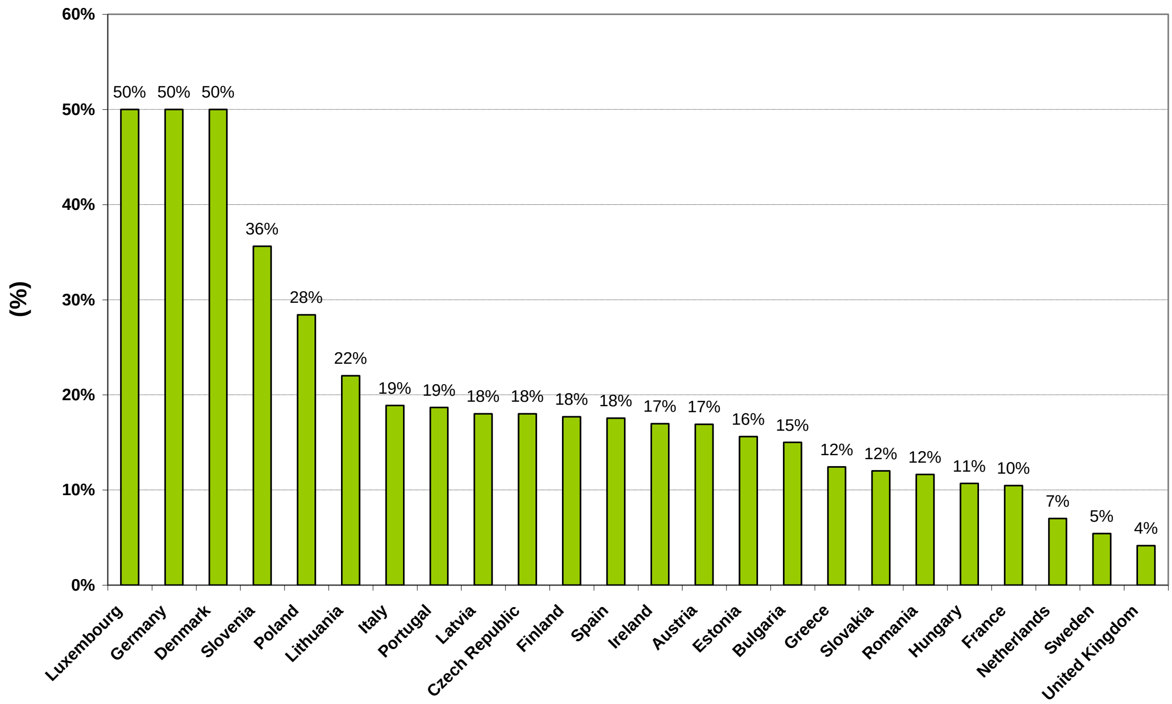
**Figure 23.5** **6A1 Managed Waste Disposal: Waste management practices for the new EU-12 MS (absolute values) in 2009**




*Source: EUROSTAT 2011*

The amount of methane generated on SWDS depends on the Methane Correction Factor, the fraction of dissolved organic carbon (DOC) dissimilated, the fraction by volume of $CH_4$ in landfill gas and the waste composition, more precisely the fraction of DOC in waste. Last mentioned is likely to vary due to the strong influence of waste management practices and policies, whereas the first three parameters do not vary strongly among the Member States. The DOC content of landfill waste is based on the composition of waste and can be calculated from a weighted average of the carbon content of various components of the waste stream; different countries are known to have MSW with widely differing waste compositions. Figure 23.6 illustrates the average DOC value in MSW for EU-27.

**Figure 23.6** **6A1 Managed Solid Waste Disposal: Fraction of DOC in MSW for EU-27**



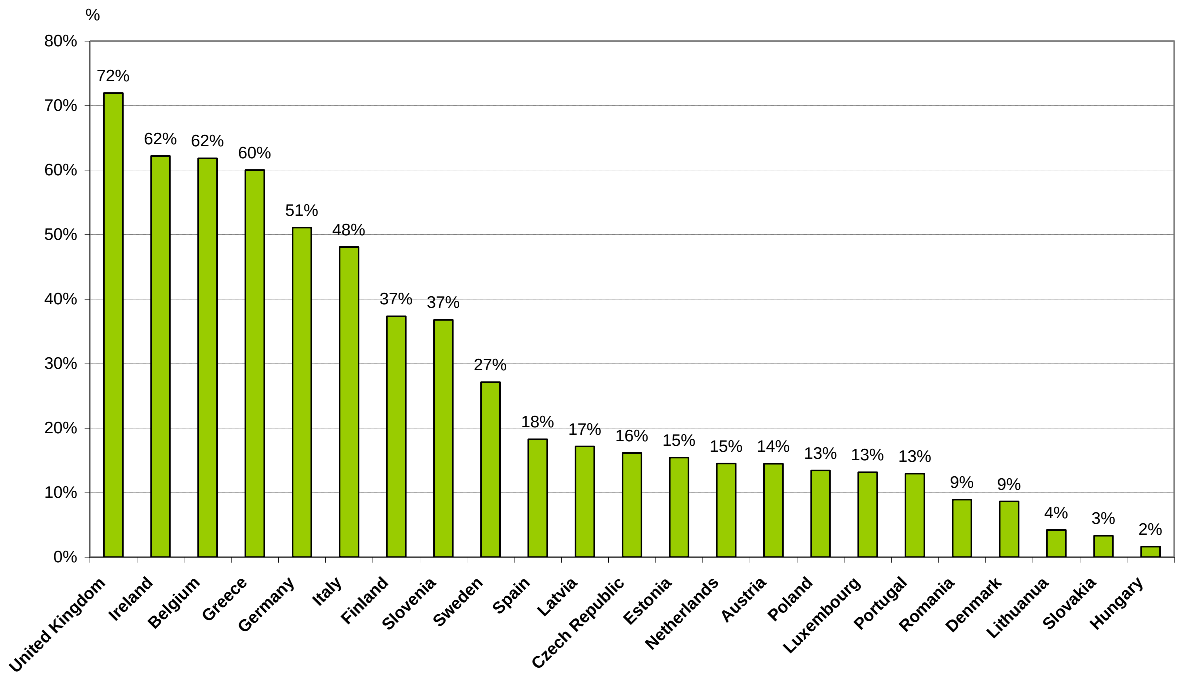

*Source: CRF 2011 Table 6A,C Additional information.*

Besides lower quantities of organic carbon deposited into landfills, the major determining factor for the decrease in net $CH_4$ emissions are increasing methane recovery rates from landfills. The recovered $CH_4$ is the amount of $CH_4$ that is captured for flaring or energy use and is a country-specific value which has significant influence on the emission level. The percentage of $CH_4$ recovered varies among the Member States, tending to be low in the new MS, except for Slovenia. Compared to last year's inventory, all new MS (except for Slovakia and the Czech Republic) managed to increase its recovery (Slovenia: +6.8, Estonia: +4.4 %, Lithuania: +3.6 %, Latvia: +1.7 %, Poland: +0.5 %, Hungary: +0.4 %). Starting with the current submission, Romania collected data on methane recovered from landfill facilities from the operators. Only three managed sites recovered methane to be burned: The first landfill began recovering in 2001, the second began recovering in 2004 and the third began in 2007.

Due changes in the activity data on methane recovery in years 2007 and 2008, the Czech Republic, recalculated these years, which resulted in a reduction of the methane recovery of 1 % compared to last year's inventory.

Following Slovenian legislation the recovery has become obligatory on all SWDS in 2008. In the period 2005-2008 the process of adaptation of SWDS to the new legislation has been in place, resulting in a significant increase in methane recovery. Recovery in Estonia started in 1995. During 1995 and 2006 only one solid waste disposal site in Estonia collected and recovered methane (Pääsküla landfill in Tallinn). The amount of reused $CH_4$ changed due to the changes in the quantity of waste generation and the share of organic waste in the total amount of waste generated. In 2007 Jõelähtme solid waste disposal site started to collect methane, causing a significant increase of the amount of reused $CH_4$. Methane recovery was highest in 2009 because in 2009 Väätsa solid waste disposal site started to collect methane (Figure 23.7).

**Figure 23.7** **6A1 Managed Solid Waste Disposal: Methane recovery for EU-27**




*$CH_4$ recovery in% = $CH_4$recovery in Gg/ ($CH_4$ recovery in Gg + $CH_4$ emissions in Gg)*100*
*Source: CRF 2011 Table 6A,C*

$CH_4$ emissions from 6A2 Unmanaged Waste Disposal on Land account for 0.39 % of total EU-27 GHG emissions in 2009. Between 1990 and 2009, $CH_4$ emissions from this source in the EU-15 decreased, but increased in the new MS, except for Bulgaria and Lithuania. In response to a recommendation by the ERT, Bulgaria estimated emissions from managed and unmanaged sites separately for the first time in its 2011 submission. Before 2000 year all sites are categorized as unmanaged and since 2000 the quantity of waste going to managed and unmanaged sites is calculated separately, leading to a reduced amount of waste treated in unmanaged waste disposal sites. In Lithuania, new landfills corresponding to EU requirements have been constructed and the share of waste treated in deep managed landfills increased.

Thus the overall reduction of $CH_4$ emissions from 6A2 Unmanaged Waste Disposal on Land for the EU-27 was lower than for EU-15 (-56 %), amounting to 32 % during 1990 and 2009 (Table 23.4). Emission reductions were highest in Bulgaria due to the decrease in population and the increasing quantity of waste deposited on managed sites.

The share in EU-27 emissions 2009 was highest for Poland (29 %) and Bulgaria (20 %). Romania had the largest increase in absolute terms during 1990 and 2009. Table 23.4 suggests that 76 % of $CH_4$ emissions from 6A2 Unmanaged Waste Disposal on Land are calculated with higher tier methodologies.

**Table 23.4 6A2 Unmanaged Waste Disposal on Land: $CH_4$ emissions of EU-27**

| Member State | $CH_4$ emissions (Gg $CO_2$ equivalents) | | | Share in EU27 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| EU-15 | 13,578 | 6,333 | 5,997 | 33.6% | -336 | -5% | -7,580 | -56% | | |
| Bulgaria | 4,718 | 3,652 | 3,527 | 19.8% | -126 | -3% | -1,191 | -25% | T2 | CS,D |
| Cyprus | 70 | 94 | 91 | 0.5% | -3 | -4% | 21 | 30% | T1 | D |
| Czech Republic | NO | NO | NO | - | - | - | - | - | NA | NA |
| Estonia | NO | NO | NO | - | - | - | - | - | NE | NE |
| Hungary | NA,NO | NO | NO | - | - | - | - | - | NA | NA |
| Latvia | NO | NO | NO | - | - | - | - | - | NA | NA |
| Lithuania | 228 | 240 | 221 | 1.2% | -19 | -8% | -7 | -3% | T2 | D |
| Malta | 82 | 109 | 100 | 0.6% | -9 | -8% | 18 | 22% | M | M |
| Poland | 5,157 | 5,243 | 5,191 | 29.1% | -52 | -1% | 34 | 1% | M | D |
| Romania | 2,393 | 2,781 | 2,702 | 15.2% | -78 | -3% | 309 | 13% | T1 | D |
| Slovakia | NO | NO | NO | - | - | - | - | - | NA | NA |
| Slovenia | NO | NO | NO | - | - | - | - | - | NA | NA |
| **EU-27** | **26,226** | **18,452** | **17,829** | **100.0%** | **-623** | **-3%** | **-8,396** | **-32%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

## 23.2.2 Wastewater handling (CRF Source Category 6B) (EU-27)

$CH_4$ from 6B2 Domestic and Commercial Wastewater accounts for 0.23 % of total EU-27 GHG emissions. Between 1990 and 2009 EU-27 emissions decreased by 21 %. Large decreases in absolute terms are reported from Hungary, Lithuania and Poland, only three out of twelve new MS reported an increase of emissions of which Romania had the highest emission increase (

Table 23.3).

Poland, Romania and Hungary are responsible for 21 % of the EU-27 emissions from this source in 2009. The emissions reductions in Poland and Hungary during 1990 and 2008 have been offset by the increase of emissions in Romania. Romanian $CH_4$ emissions from domestic and commercial wastewater increased especially from 2000 onwards due to expert judgment on the three periods considered for the calculation of emissions from wastewater handling (1990 – 1994, 1995 – 1999 and 2000 – 2005). For the first period, population connected to sewerage was assumed to be 45 % in urban areas and 10 % in rural areas; the share in population whose wastewater is treated was assumed to be 50 % in urban and 0 % in rural areas. In the second period, the share of population connected to sewerage changed to 40 % urban and 8 % rural; the share of population whose wastewater is treated changed to 35 % urban and 0 % rural. For the third period all shares were set at higher levels: population connected to sewerage was 60 % for urban population and 20 % for rural, share of population whose wastewater is treated was 60 % urban population 15 % for rural.

Emissions reductions in Poland are due to the availability of activity data only; a huge drop in emissions of 63 % between 1990 and 2000 could be found. Before and after 1999 and 2000, $CH_4$ emissions increased slightly. The inconsistency is a result of the application of various national data sets (based on case studies) for the following time periods 1988-1994, 1995-1999 and 2000-2008.

Between 2008 and 2009, $CH_4$ from 6B2 Domestic and Commercial Wastewater decreased only very slightly for the EU-27.

Table 23.5 also suggests that only one MS used higher tier methodologies to calculate $CH_4$ from 6B2 Domestic and Commercial Wastewater which correspond to 2 % of total EU-12 emissions (Latvia: Tier 2).

**Table 23.5 6B2 Domestic and commercial wastewater: $CH_4$ emissions of EU-27**

| Member State | $CH_4$ emissions (Gg $CO_2$ equivalents) | | | Share in EU27 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| EU-15 | 8,999 | 6,578 | 6,609 | 63.1% | 30 | 0% | -2,391 | -27% | | |
| Bulgaria | 498 | 437 | 435 | 4.2% | -2 | -1% | -64 | -13% | D | D |
| Cyprus | 18 | 24 | 24 | 0.2% | 0 | 0% | 6 | 36% | T1 | D |
| Czech Republic | 214 | 191 | 192 | 1.8% | 1 | 0% | -22 | -10% | D | CS |
| Estonia | 8 | 1 | 1 | 0.0% | 0 | 0% | -7 | -91% | T1 | D |
| Hungary | 786 | 466 | 415 | 4.0% | -51 | -11% | -371 | -47% | D | D |
| Latvia | 98 | 93 | 76 | 0.7% | -17 | -18% | -22 | -22% | T2 | D |
| Lithuania | 775 | 488 | 475 | 4.5% | -13 | -3% | -300 | -39% | T1 | D |
| Malta | 20 | 16 | 15 | 0.1% | -1 | -6% | -5 | -25% | D | CS |
| Poland | 1,134 | 873 | 890 | 8.5% | 17 | 2% | -245 | -22% | D | CS,D |
| Romania | 228 | 835 | 838 | 8.0% | 3 | 0% | 610 | 268% | D | D |
| Slovakia | 388 | 368 | 357 | 3.4% | -11 | -3% | -30 | -8% | T1 | CS |
| Slovenia | 107 | 141 | 144 | 1.4% | 2 | 2% | 37 | 35% | T1 | CS,D |
| **EU-27** | **13,272** | **10,511** | **10,470** | **100.0%** | **-41** | **0%** | **-2,802** | **-21%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

$N_2O$ from 6B2 Domestic and Commercial wastewater accounts for 0.27 % of total EU-27 GHG emissions. Between 1990 and 2009 EU-27 emissions increased by 4 % (Table 23.6). Four out of twelve new MS increased their emissions in that period (the Czech Republic, Malta, Poland and Romania), but these MS are responsible for only 13 % of EU-27 $N_2O$ from 6B2 Domestic and Commercial wastewater in 2009.

After a decline in emissions 1994 – 1995, Romania's emissions increased since 1995, following the trend in population connected to sewerage as described above. The new MS contributed to a reduction of the total emissions in EU-27. Largest reductions in absolute terms could be found for Bulgaria, Slovakia and Hungary. Poland's share in EU-27 emissions in 2009 is highest among EU-12. The MS neither increased nor decreased its emissions significantly during the time series. According to Table 23.6, none of the new MS calculated $N_2O$ emissions from Domestic and Commercial wastewater by applying higher tier methodologies.

The largest decrease in $N_2O$ emissions from commercial wastewater during 2008 and 2009 could be found for Slovakia. In the period 1990-2009 the number of population served by waste water treatment (WWT) plants increased by 42 %. Consequently, the emissions from untreated discharge have decreased by 50 %. Since 1998 the nitrification/denitrification process is introduced in existing WWT plants and in 2009 more than 68 % of all treated wastewater is treated in modernized WWT plants with nitrification/denitrification stage.

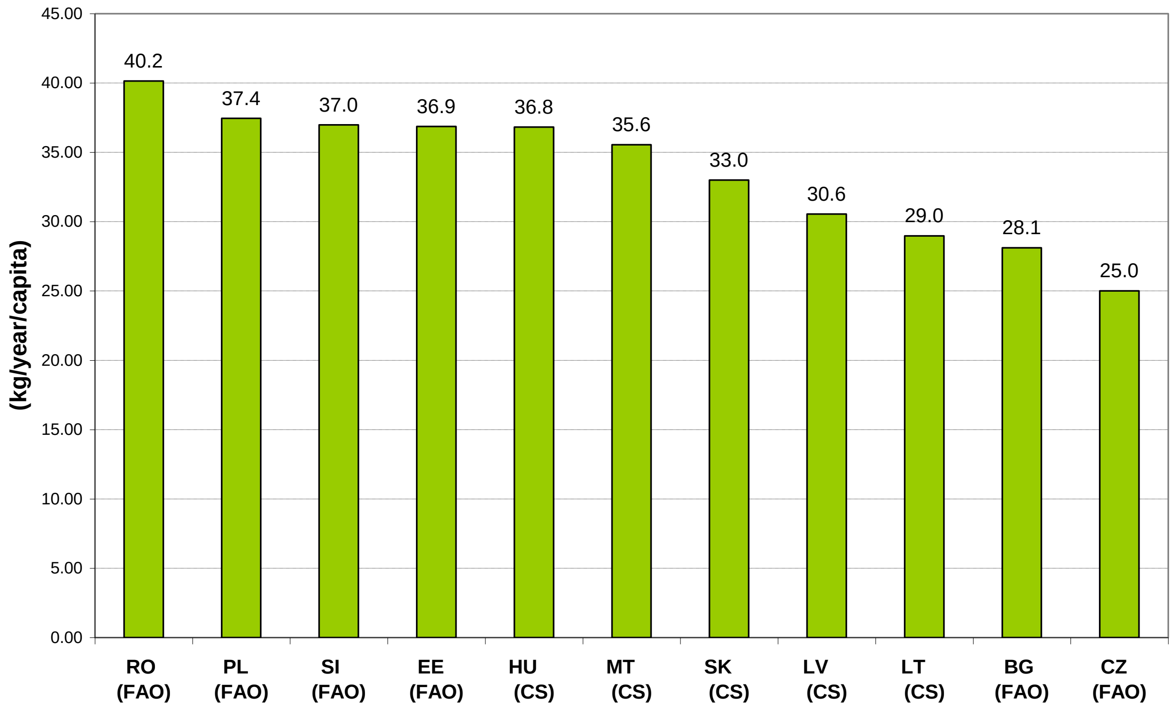
**Table 23.6 6B2 Domestic and Commercial Wastewater: $N_2O$ emissions of EU-27**

| Member State | $N_2O$ emissions (Gg $CO_2$ | | | Share in EU27 emissions in 2009 | Change 2008- | | Change 1990- | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| EU-15 | 9,589 | 10,080 | 10,038 | 81.4% | -42 | 0% | 449 | 5% | | |
| Bulgaria | 218 | 167 | 166 | 1.3% | -1 | -1% | -52 | -24% | D | D |
| Cyprus | IE,NE | IE,NE | IE,NE | - | - | - | - | - | T1 | D |
| Czech Republic | 162 | 204 | 204 | 1.7% | 0 | 0% | 43 | 27% | D | D |
| Estonia | 75 | 72 | 72 | 0.6% | -0.03 | 0% | -3 | -4% | T1 | D |
| Hungary | 214 | 198 | 198 | 1.6% | 0 | 0% | -16 | -7% | D | D |
| Latvia | 64 | 54 | 54 | 0.4% | -0.23 | 0% | -10 | -15% | D | D |
| Lithuania | 80 | 76 | 75 | 0.6% | -0.25 | 0% | -4 | -6% | T1 | D |
| Malta | 10 | 11 | 11 | 0.1% | -0.02 | 0% | 1 | 14% | D | D |
| Poland | 1,096 | 1,113 | 1,114 | 9.0% | 0.91 | 0% | 18 | 2% | D | D |
| Romania | 174 | 289 | 290 | 2.3% | 0 | 0% | 115 | 66% | D | D |
| Slovakia | 76 | 51 | 51 | 0.4% | 0 | 1% | -24 | -32% | T1 | D |
| Slovenia | 60 | 59 | 59 | 0.5% | 0.42 | 1% | -1 | -1% | T1 | D |
| **EU-27** | **11,817** | **12,374** | **12,333** | **100.0%** | **-41** | **0%** | **516** | **4%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

Emissions are mainly driven by the daily per capita protein consumption, being one relevant component for the calculation of nitrous oxide emissions from household wastewater according to the IPCC method. For daily per capita protein consumption country-specific values are used by five new MS; an overview of the values is given in Figure 23.8.

**Figure 23.8 6B Waste Water Handling: Protein consumption**




*Source: CRF 2011, Table 6 B; NIR 2011*
*CS= Country-specific value; FAO = FAO data basis*
*CS MT: Bellizzi et al. 1993; CS SK: Statistical Office of the Slovak Republic; CS LV: Latvian State Institute of Agrarian Economy; CS LT: Nutrition Centre under the Ministry of Health.*

### 23.2.3 Waste incineration (CRF Source Category 6C) (EU-27)

This category includes incineration of waste, not including waste-to-energy facilities. Emissions from waste burnt for energy are reported under 1A Fuel combustion activities. Emissions from burning of agricultural wastes should be reported under 4 Agriculture. Table 23.7 summarizes greenhouse gas emission trends by Member State. $CO_2$ emissions from waste incineration account for 0.07 % of total EU-27 GHG emissions.

Between 1990 and 2009, $CO_2$ emissions from waste incineration decreased by 29 % in the EU-27. All new MS increased their $CO_2$ emissions from waste incineration during 1990 and 2009, except for Lithuania, Poland and Slovakia. The largest increase in absolute terms could be found for the Czech Republic contributing the most to EU-12 emissions (9.6 % of EU-27 emissions in 2009). This increase could be explained by the increased amount of municipal solid waste being incinerated (+419 % during 1990 and 2009). Consequently the share of waste going to waste incineration increased from 0 % (1995) to 10 % in 2009 (compare Figure 23.4).

During 1990 and 2009, Poland and Slovakia had the largest decreases in absolute terms. Poland, besides the Czech Republic has the largest share in EU-12 emissions, see Table 23.47. In Slovakia, the reduction in emissions was caused by the decrease of the number of incineration plants due to the expiration of transition period for selected incinerators in 2006, as defined in the EU accession agreement. Table 23.7 suggests that a share of 10 % of EU-12 $CO_2$ emissions from waste incineration was calculated by using higher tier methodologies (Tier 2).

**Table 23.7 6C Waste incineration: $CO_2$ emissions of EU-27**

| Member State | $CO_2$ emissions in Gg | | | Share in EU27 emissions in 2009 | Change 2008-2009 | | Change 1990-2009 | | Method applied | Emission factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2008 | 2009 | | (Gg $CO_2$ equivalents) | (%) | (Gg $CO_2$ equivalents) | (%) | | |
| EU-15 | 3,898 | 2,227 | 2,531 | 79.4% | 305 | 14% | -1,367 | -35% | | |
| Bulgaria | 20 | 43 | 34 | 1.1% | -9 | -22% | 14 | 67% | T1 | D |
| Cyprus | NA | NA | NA | - | - | - | - | - | NA | NA |
| Czech Republic | 60 | 342 | 306 | 9.6% | -36 | -10% | 247 | 413% | T1 | D |
| Estonia | NA | NA | NA | - | - | - | - | - | NA | NA |
| Hungary | NA | 64 | 68 | 2.1% | 4 | 6% | 68 | - | T2 | D |
| Latvia | NO | 1 | 0 | 0.0% | 0 | -33% | 0 | - | D | D |
| Lithuania | 4 | 1 | 1 | 0.0% | 0 | 6% | -3 | -84% | T1 | D |
| Malta | 0.37 | 0.35 | 0.47 | 0.0% | 0 | 35% | 0 | 28% | CS | CS |
| Poland | 447 | 236 | 231 | 7.2% | -5 | -2% | -216 | -48% | D | CS |
| Romania | NE,NO | 9 | 8 | 0.3% | 0 | -5% | 8 | - | D | D |
| Slovakia | 63 | 6 | 5 | 0.2% | -1 | -12% | -58 | -92% | T1a | D |
| Slovenia | 1 | 4 | 4 | 0.1% | 1 | 24% | 3 | 230% | D | D |
| **EU-27** | **4,494** | **2,931** | **3,190** | **100.0%** | **259** | **9%** | **-1,304** | **-29%** | | |

*Abbreviations explained in the Chapter 'Units and abbreviations'.*

# 24 OTHER (CRF SECTOR 7)

The 2010 GHG inventory does not include any GHG emissions in CRF sector 7.

# 25 RECALCULATIONS AND IMPROVEMENTS

## 25.1 Explanations and justifications for recalculations

Table 25.1 to Table 25.2 provide an overview of the main reasons for recalculating emissions in the year 1990 and 2008 for each Member State, which provided the relevant information, and by source categories, for the largest recalculations (>+/- 500 Gg). For more details see the information provided by the Member States' submissions in Annex 2.12.

**Table 25.1 Main recalculations by source category for 1990 and Member States' explanations for recalculations given in the CRF or in the NIR**

| | | 1990 | | Main explanations |
|---|---|---|---|---|
| | | Gg $CO_2$ equiv. | Percent | |
| 4D_Agricultural soils $N_2O$ | Romania | 5,960 | 29.9 | - Addition of Lucerne and clover to the N-fixing crops.<br>- The industrial fibre crops (flax for fibre, hemp for fibre) and other industrial crops (tobacco, medicinal and aromatic plant) crop production values have been included within the non-N-fixing crops production. New data on annual cultivated organic soils areas have been provided by the National Institute of Research and Development in Soil Science, Agrochemistry and Environment and by the Ministry of Agriculture and Rural Development. |
| 1A4_Other sectors $CO_2$ | Bulgaria | 2,096 | 39.0 | Updated country specific EFs for solid fuels were applied for the full timeseries |
| 1B2_Oil and natural gas $CH_4$ | Romania | 1,998 | 10.3 | Estimation of new source categories under 1B2 previously not estimated |
| 4D_Agricultural soils $N_2O$ | Bulgaria | 1,829 | 25.6 | Revision of activity data |
| 1A3_Transport $CO_2$ | Lithuania | 1,727 | 30.5 | - $CO_2$ emission factors for Motor gasoline, Jet kerosen, Gas/Diesel Oil, Residual Fuel Oil, LPG and Non liquified petroleum gas were updated based on country specific data.<br>- Change of statistical data. |
| 2B_Chemical industries $CO_2$ | Bulgaria | 1,467 | 85.4 | - Revision of the activity data of the entire time series by using IPPC permit reports, EPRTR reports, ETS data and plant specific data as well as statistical data for<br>crosscheck.<br>- Introduction of a higher tier estimation method in line with 1996 IPCC Guidelines and 2006 IPCC Guidelines taking into account ammonia production, fuel requirement per unit of output (provided by plant operators) and $CO_2$ recovered for downstream use (provided by plant operators)<br>- Development of country specific emission factor for ammonia production based on the plant specific data for the entire time series |
| 4B_Manure management $CH_4$ | Bulgaria | 923 | 72.2 | - Revised animal weights<br>- Revision of animal population size and animal weight |
| 4B_Manure management $N_2O$ | Bulgaria | 518 | 54.4 | Revised emission factors |
| 4D_Agricultural soils $N_2O$ | Lithuania | -525 | -10.0 | Data on histosol area corrected |
| 4D_Agricultural soils $N_2O$ | Poland | -664 | -2.8 | Country specific methodology and $N_2O$ emission factors for processes undergoing within agricultural soils were exchanged with the default ones recommended by [IPCC 2000] |

| | | 1990 | | Main explanations |
|---|---|---|---|---|
| | | Gg $CO_2$ equiv. | Percent | |
| 2B_Chemical industries $N_2O$ | Bulgaria | -752 | -33.3 | - Revision of the activity data of the entire time series by using IPPC permit reports, EPRTR reports and plant specific data as well as statistical data for crosscheck. Plant specific data on emissions were available for the period 2005 – 2008 and on nitric acid production from for the whole time period (1988 – 2008).<br>- Introduction of a higher tier estimation method based on 1996 IPCC Guidelines and 2000 Good Practice Guidance taking into account Nitric acid production (plant specific and statistical data) and $N_2O$ emissions (provided by plant operators)<br>- Development of country specific emission factor for nitric acid production based on the plant specific data. |
| 1A5_Other $CO_2$ | Bulgaria | -977 | -97.1 | |
| 1A1_Energy Industries $CO_2$ | Bulgaria | -1,035 | -2.6 | - change of emission factors<br>- change in the calculation model for disaggregating fuels |
| 1A2_Manufacturing Industries and Construction $CO_2$ | Bulgaria | -1,233 | -5.7 | Updated country specific EFs for solid fuels were applied for the full timeseries. Revised activity data. |
| 1A4_Other sectors $CO_2$ | Lithuania | -1,280 | -18.4 | - $CO_2$ emission factors for Motor gasoline, Jet kerosen, Gas/Diesel Oil, Residual Fuel Oil, LPG and Non liquified petroleum gas were updated based on country specific data.<br>- Emissions from use of Motor Gasoline and Diesel Oil realocated to Transport off-road mashinery |
| 1A3_Transport $CO_2$ | Bulgaria | -4,265 | -39.3 | - Incorporation of the Eurostat energy balance, which provides a split between Gasoline, Diesel Oil, Liquefied Petroleum Gases (LPG), Other Liquid Fuels (Residual Fuel Oil) and Gaseous Fuels<br>- Using country specific Net Caloric Values (NCV) / Gross Caloric Value (GCV)<br>- Using 2006 IPCC default emission factor |
| 6A_Solid waste disposal on land $CH_4$ | Bulgaria | -6,079 | -56.3 | - Update of activity data<br>- The DOC value are recalculated for the period 1950-2001, technical error |

**Table 25.2 Main recalculations by source category for 2008 and Member States' explanations for recalculations given in the CRF or in the NIR**

| | | 2008 | | Main explanations |
|---|---|---|---|---|
| | | Gg $CO_2$ equiv. | Percent | |

| | | 2008 | | Main explanations |
|---|---|---|---|---|
| | | Gg $CO_2$ equiv. | Percent | |
| 4D_Agricultural soils $N_2O$ | Romania | 4,525 | 41.3 | - Addition of Lucerne and clover to the N-fixing crops.<br>- The industrial fibre crops (flax for fibre, hemp for fibre) and other industrial crops (tobacco, medicinal and aromatic plant) crop production values have been included within the non-N-fixing crops production. New data on annual cultivated organic soils areas have been provided by the National Institute of Research and Development in Soil Science, Agrochemistry and Environment and by the Ministry of Agriculture and Rural Development. |
| 1A1_Energy Industries $CO_2$ | Romania | 1,843 | 4.0 | Review Energy Balance for 2008- for natural gas. |
| 1A3_Transport $CO_2$ | Poland | 1,442 | 3.4 | - Fuel consumption in 1990-2008 for the following subcategories: 1.A.3.a Civil aviation 1.A.3.c Railways, 1.A.3.d Navigation (inland navigation) and for international bunker, were corrected based on updated Eurostat database;<br>- Fuel consumption for category 1.A.3.e. Other transportation were corrected based on publication "Energy statistics 2008/2009" by GUS 2010; |
| 1B2_Oil and natural gas $CH_4$ | Romania | 1,187 | 15.0 | Estimation of new source categories under 1B2 previously not estimated |
| 1A2_Manufacturing Industries and Construction $CO_2$ | Poland | 658 | 2.0 | - Activity data on fuel consumption for years 1990-2008 were updated due to changes made in EUROSTAT database<br>- Empirical function, that links the content of carbon in hard coal with the corresponding net calorific value of this fuel was corrected<br>- Values of GHG emission for the years 2005-2008 were estimated according to methodology applied for the years 1988-2004 – i.e. based on statistical data on fuel consumption (in energy units) and country specific emission factors for hard coal and lignite or default EFs (from IPCC guidelines) for other fuels respectively. |
| 4A_Enteric fermentation $CH_4$ | Romania | 624 | 10.8 | |
| 4D_Agricultural soils $N_2O$ | Bulgaria | 621 | 21.6 | Revision of activity data |
| 1A1_Energy Industries $CO_2$ | Poland | -508 | -0.3 | - Activity data on fuel consumption for years 1990-2008 were updated due to changes made in EUROSTAT database<br>- Empirical function, that links the content of carbon in hard coal with the corresponding net calorific value of this fuel was corrected<br>- Values of GHG emission for the years 2005-2008 were estimated according to methodology applied for the years 1988-2004 – i.e. based on statistical data on fuel consumption (in energy units) and country specific emission factors for hard coal and lignite or default EFs (from IPCC guidelines) for other fuels respectively. |
| 2C_Metal production $CO_2$ | Poland | -512 | -5.3 | Activity data on coke production and associated $CO_2$ emission estimates were updated for the years: 1988-2008. Carbon emission factors for hard coal in mass balance of coke production process for the entire period were corrected. This change was the result of the correction of the empirical function, that links the content of carbon in hard coal with the corresponding net calorific value of this fuel. Additionally, for the years: 1990-2008, input data for the mass balance were updated based on updates made at EUROSTAT database. |
| 4D_Agricultural soils $N_2O$ | Poland | -573 | -3.0 | Country specific methodology and $N_2O$ emission factors for processes undergoing within agricultural soils were exchanged with the default ones recommended by [IPCC 2000] |
| 1A2_Manufacturing Industries and Construction $CO_2$ | Bulgaria | -631 | -8.3 | Updated country specific EFs for solid fuels were applied for the full timeseries. Revised activity data. |

| | | 2008 | | Main explanations |
|---|---|---|---|---|
| | | Gg $CO_2$ equiv. | Percent | |
| 1A2_Manufacturing Industries and Construction $CO_2$ | Slovakia | -799 | -10.2 | Correction of activity data |
| 1A2_Manufacturing Industries and Construction $CO_2$ | Romania | -862 | -4.8 | Review Energy Balance ; 1.Was modified in EB reviewed for 2008 the value for gasoline : review before 13,834.704 and after review 1,300.779; 2.Was modified in EB reviewed for 2008 the value for refinery gas : review before 7,288.581 and after review 7,258.841. |
| 1A1_Energy Industries $CO_2$ | Bulgaria | -2,580 | -7.5 | - change of emission factors<br>- change in the calculation model for disaggregating fuels |
| 6A_Solid waste disposal on land $CH_4$ | Bulgaria | -2,707 | -40.3 | - Update of activity data<br>- The DOC value are recalculated for the period 1950-2001, technical error |

## 25.2 Implications for emission levels

In the EU-27, 1990 GHG emissions excluding LULUCF have increased by 21764 Gg (+0.4 %). For 2008, they increased by 29843 Gg (+0.6 %) (Table 25.3).

**Table 25.3 Overview of recalculations of EU-27 total GHG emissions (difference between latest submission and previous submission in Gg $CO_2$ equivalents)**

| | 1990 | 1995 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Total $CO_2$ equivalent emissions including LULUCF (absolute) | 20,995 | 28,530 | 53,152 | 46,005 | 60,636 | 54,518 | 60,850 | 52,456 | 32,062 | 9,739 | 30,988 |
| Total $CO_2$ equivalent emissions including LULUCF (percent) | 0.4% | 0.6% | 1.1% | 1.0% | 1.3% | 1.1% | 1.3% | 1.1% | 0.7% | 0.2% | 0.7% |
| Total $CO_2$ equivalent emissions excluding LULUCF (absolute) | 21,764 | 17,256 | 23,620 | 28,269 | 33,202 | 28,786 | 32,983 | 32,414 | 29,695 | 32,805 | 29,843 |
| Total $CO_2$ equivalent emissions excluding LULUCF (percent) | 0.4% | 0.3% | 0.5% | 0.6% | 0.7% | 0.6% | 0.6% | 0.6% | 0.6% | 0.7% | 0.6% |

Table 25.4 and Table 25.5 give an overview of absolute and percentage changes of new Member States' emissions due to recalculations for 1990 and 2008. Large recalculations in absolute terms were made in Bulgaria and Romania. Recalculations in relative terms of more than 2 % were made in Bulgaria, Estonia and Romania.

**Table 25.4 Contribution of Member States to EU-27 recalculations of total GHG emissions without LULUCF for 1990–2008 (difference between latest submission and previous submission Gg of $CO_2$ equivalents)**

| | 1990 | 1995 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| EU-15 | 20,260 | 18,755 | 25,289 | 26,251 | 30,959 | 26,864 | 34,234 | 32,863 | 28,872 | 33,535 | 27,526 |
| Bulgaria | -5,962 | -7,987 | -5,844 | -3,171 | -3,424 | -3,457 | -3,370 | -3,223 | -3,114 | -3,901 | -3,919 |
| Cyprus | 1 | 2 | 2 | 2 | 3 | -1 | -1 | -4 | -3 | -1 | -38 |
| Czech Republic | 339 | 113 | -87 | -34 | -6 | -97 | -658 | -646 | -901 | -408 | -281 |
| Estonia | 210 | -624 | -377 | -308 | -314 | -340 | -299 | -248 | -201 | -452 | -182 |
| Hungary | -541 | -470 | -377 | -397 | -391 | -411 | -387 | -351 | -338 | -236 | -43 |
| Latvia | -217 | 105 | 95 | 101 | 89 | 142 | 287 | 63 | 72 | 64 | 14 |
| Lithuania | -164 | -82 | -222 | -254 | -264 | -311 | -358 | -363 | -310 | -317 | -294 |
| Malta | 11 | 14 | 16 | 18 | 19 | 20 | 22 | 26 | 30 | 41 | 57 |
| Poland | -379 | 1 | -780 | -839 | -845 | -1,087 | -1,104 | -1,946 | -669 | 817 | 166 |
| Romania | 7,990 | 7,411 | 5,887 | 6,902 | 7,474 | 7,487 | 4,628 | 6,213 | 6,226 | 3,571 | 7,503 |
| Slovakia | 216 | 17 | 17 | -1 | -97 | -24 | -8 | 10 | 22 | 94 | -665 |
| Slovenia | 0 | 1 | 0 | 0 | 0 | 1 | -1 | 20 | 10 | -3 | 1 |
| **EU-27** | **21,764** | **17,256** | **23,620** | **28,269** | **33,202** | **28,786** | **32,983** | **32,414** | **29,695** | **32,805** | **29,843** |

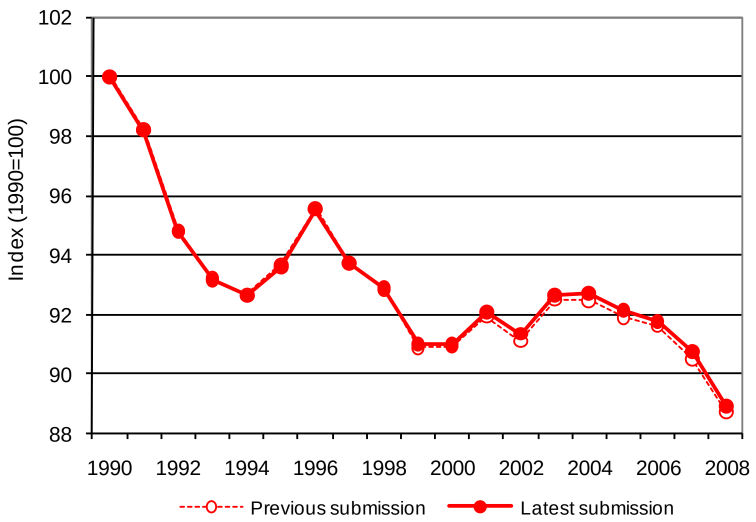
**Table 25.5** **Contribution of Member States to EU-27 recalculations of total GHG emissions without LULUCF for 1990–2008 (difference between latest submission and previous submission in percentage)**

| | 1990 | 1995 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| EU-15 | 0.5 | 0.5 | 0.6 | 0.6 | 0.7 | 0.6 | 0.8 | 0.8 | 0.7 | 0.8 | 0.7 |
| Bulgaria | -5.1 | -9.0 | -8.4 | -4.6 | -5.2 | -4.8 | -4.8 | -4.6 | -4.4 | -5.2 | -5.4 |
| Cyprus | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | -0.4 |
| Czech Republic | 0.2 | 0.1 | -0.1 | 0.0 | 0.0 | -0.1 | -0.5 | -0.4 | -0.6 | -0.3 | -0.2 |
| Estonia | 0.5 | -3.0 | -2.1 | -17 | -18 | -17 | -15 | -13 | -11 | -2.0 | -0.9 |
| Hungary | -0.6 | -0.6 | -0.5 | -0.5 | -0.5 | -0.5 | -0.5 | -0.4 | -0.4 | -0.3 | -0.1 |
| Latvia | -0.8 | 0.8 | 0.9 | 0.9 | 0.8 | 13 | 2.6 | 0.6 | 0.6 | 0.5 | 0.1 |
| Lithuania | -0.3 | -0.4 | -11 | -12 | -13 | -15 | -16 | -16 | -13 | -12 | -12 |
| Malta | 0.5 | 0.6 | 0.6 | 0.7 | 0.7 | 0.7 | 0.8 | 0.9 | 10 | 14 | 19 |
| Poland | -0.1 | 0.0 | -0.2 | -0.2 | -0.2 | -0.3 | -0.3 | -0.5 | -0.2 | 0.2 | 0.0 |
| Romania | 3.3 | 4.1 | 4.3 | 4.9 | 5.1 | 4.9 | 3.0 | 4.2 | 4.0 | 2.3 | 5.1 |
| Slovakia | 0.3 | 0.0 | 0.0 | 0.0 | -0.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.2 | -14 |
| Slovenia | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 |
| **EU-27** | **0.4** | **0.3** | **0.5** | **0.6** | **0.7** | **0.6** | **0.6** | **0.6** | **0.6** | **0.7** | **0.6** |

## 25.3 Implications for emission trends, including time series consistency

As the recalculations were made for across all years in a similar order of magnitude, the trend was hardly affected by the recalculations. In the EU-27, the trend of GHG excluding LULUCF between 1990 and 2008 was – 11.3 % in the previous submission and -11.1 % in the latest submission (Figure 25.1).

**Figure 25.1** **Comparison of EU-27 GHG emission trends 1990–2008 (excl. LULUCF) of the latest and the previous submission**



# 25.4 Recalculations, including in response to the review process, and planned improvements to the inventory

## 25.4.1 EU response to UNFCCC review

The EU-27 inventory has not been reviewed.

## 25.4.2 Member States' responses to UNFCCC review

Since the improvement of the EU inventory depends on Member States' efforts regarding completeness of estimation and improvement of methods and parameters used, Table 25.6 provides an overview of Member States' responses to the UNFCCC review (48). The table shows that a considerable amount of improvements were made compared since the previous submissions of Member States. In addition to the response to the UNFCCC review, a large number of additional improvements were implemented by Member States. However, an aggregation of all improvements conducted in all Member States would be too much information and too detailed to be included in this report.

**Table 25.6 Improvements made by new Member States in response to the UNFCCC review**

| Member State | Improvements as recommended by the review team | Improvements in response to UNFCCC review as indicated in the NIR |
|---|---|---|
| **Bulgaria** | The ERT identified the following cross-cutting issues for improvement:<br><br>(a) Addressing recommendations from the previous expert review in relation to transparency, accuracy, completeness, consistency and comparability of its annual submission; | The following general improvements are planned for the next submissions (15/04/2011)<br><br>• Update and revision of activity data, emission factor and related parameters;<br><br>• Conduct further studies for verification of emission factors and assumptions;<br><br>• Implementation of model COPERT into the National transport emissions inventory;<br><br>• Improvement of uncertainty assessment;<br><br>• Improvement of the relation with Branch Business Associations;<br><br>• Executive Environment Agency (ExEA) Communication & Information Centre (Data management);<br><br>• Further collaboration with external organizations as Denkstatt, University of Forest, Bulgarian Academy of Science, etc.;<br><br>• QA/QC activities and audit;<br><br>• Documentation and archiving;<br><br>[NIR 2011, p.437]<br><br>Documentation on the use of activity data and emission factors has been improved. Especially in the Industrial processes sector. [NIR 2011. p.441-443]]<br><br>e) Not yet addressed.<br><br>f) Partly addressed, e.g. implementation of model COPERT in sub sector "Road transport".<br><br>c), h) Revision of QA/QC check lists following the recom- |
| | (b) Transparency in relation to improved documentation of category-level methodologies, AD, EFs and other parameters used to estimate emissions, references to sources of AD and the rationale for selecting a methodology; | |
| | (c) Transparency in relation to the use of EU ETS data in the inventory and information demonstrating how its use is in line with the IPCC good practice guidance; | |
| | (d) Transparency in relation to providing information that demonstrates that the use of an EF from the *2006 IPCC Guidelines for National Greenhouse Gas Inventories* (hereinafter referred to as the 2006 IPCC Guidelines) instead of a corresponding EF from the Revised 1996 IPCC Guidelines and/or the IPCC good practice guidance better suits national circumstances; | |
| | (e) Accuracy in relation to reporting the uncertainty analysis in line with the requirements of the UNFCCC reporting guidelines, the IPCC good practice guidance and the IPCC good practice guidance for LULUCF, including reporting of uncertainty estimates for KP-LULUCF; | |
| | (f) Exploring higher tier methods for key categories; | |
| | (g) Consistency in relation to the inventory time series of some emission estimates (e.g. F-gases); | |

(48) Issues related to the NIR are not included in this table as already addressed in Table 1.11.

| Member State | Improvements as recommended by the review team | Improvements in response to UNFCCC review as indicated in the NIR |
|---|---|---|
| | (h) Consistency in relation to addressing discrepancies between the NIR and CRF tables, including expanding QA/QC procedures to include explicit provisions for this activity; | mendations of ERT have been made, a manual for using of documentation and archiving system is prepared.<br>i) Most of the ERT recommendations are implemented in the preliminary 2011 GHGs inventory. [NIR 2011, p.443] |
| | (i) Comparability in relation to ensuring that the allocation of emissions is in line with the Revised 1996 IPCC Guidelines and/or the IPCC good practice guidance (e.g. for limestone and dolomite use and soda ash use); | |
| | (j) Definition of the role and responsibilities of the many actors in the QA/QC system, and to consider the outcomes of the key category analysis, uncertainty analysis and QA/QC procedures in the revision of the inventory improvement plan.<br>(**FCCC/ARR/2010/BGR, para 60)** | |
| **Czech Republic** | The ERT identified the following cross-cutting issues for improvement:<br>(a) The full implementation of the QA/QC plan, including the planning and implementation of tier 2 QC procedures for the key categories; | a) A new QA/QC plan has been prepared. The main aspects of the newly developed QA/QC plan are presented Chapter 1.5, in the section devoted to QA/QC procedures. The implementation of higher tier methods requires some time and financial resources and thus implementation is proceeding gradually. [NIR 2011, p.188] |
| | (b) The implementation of planned improvements to the archiving system; | b) A temporary archiving system has already been developed and is functional and its next improvement is planned for the 2012 submission. [NIR 2011, p.188] |
| | (c) The provision of more information on the methods, AD and EFs used and the provision of consistent information reported in the various sections of the NIR and between the NIR and the CRF tables; | c) More information on methods, AD and EFs was already partly implemented in the 2009 submission and the implementation continued in 2010 and 2011. [NIR 2011, p.188] |
| | (d) The improvement of time series consistency in cases where different methods and data sources are used for different years, in particular in the energy and waste sectors; | d) Recalculations in order to improve the time series consistency have been made in the energy and waste sector. [NIR 2011, p.190-192] |
| | (e) The correct use of the notation keys in the CRF tables; | e) Implemented since the 2010 submission. [NIR 2011, p.188] |
| | (f) The provision of more detailed, documented and verifiable information demonstrating that the litter, deadwood and soil organic carbon pools for forest management are not net sources of emissions individually.<br>(**FCCC/ARR/2010/CZE, para 38)** | f) This issue was resolved in time by providing further clarification and additional evidence based on empirical data from the available forest and landscape inventory programs in the country (see Chapter 11). [NIR 2011, p.188] |
| **Estonia** | The ERT identifies the following cross-cutting issues for improvement:<br>(a) Further improve and strengthen the national system, in particular with respect to the LULUCF sector and KP-LULUCF activities, and report on the progress in the next annual submission; | a) Estonia has improved the completeness of the LULUCF estimates. In 2011 submission many land conversions are reported. Estonia will continue to improve missing land conversions in future submissions. [NIR 2011, p.336] |
| | (b) Use the key category analysis and uncertainty analyses results as a basis for prioritizing improvements to the national inventory; | b) The recommendation has been added to the Estonia's inventory improvement plan and will be carried out when more financial support is available. [NIR 2011, p.336] |
| | (c) Improve QC checks of the CRF tables and NIR prior to submission, report on the implementation of the quality management system and develop more specific QA/QC proce- | c) More specific QC checks have been carried out. [NIR 2011, p.338] |

| Member State | Improvements as recommended by the review team | Improvements in response to UNFCCC review as indicated in the NIR |
|---|---|---|
| | dure for key categories; | |
| | (d) Further improve the transparency related to the explanation/justification of recalculations trends, EFs and parameters, and to the application of the notation keys consistent with the UNFCCC reporting guidelines; | d) The information has been described more transparent in the NIR. Table 10.1 and in sector specific chapters. [NIR 2011, p.338] |
| | (e) Further improve archiving.<br>(**FCCC/ARR/2010/EST, para 33)** | e) The archiving system has been improved. [NIR 2011, p.339] |
| **Hungary** | Review report (In-country review 2010) not yet available. | |
| **Latvia** | The ERT identifies the following cross-cutting issues for improvement:<br>(a) Improve the use of notation keys in the CRF tables; | Latvia has improved the reporting of notation keys. [NIR 2011, p.311] |
| | (b) Resolve inconsistencies in the NIR and between the NIR and the CRF tables, as part of the implementation of the QA/QC procedures; | Not yet addressed. |
| | (c) Improve the use of country-specific EFs and parameters and move to higher tier methods for some categories, including energy ($CH_4$ emissions from oil and natural gas), industrial processes ($CO_2$ emissions from cement production, and HFCs and $SF_6$ from the production and use of fire extinguishers, consumption of halocarbons and $SF_6$), agriculture ($CH_4$ emissions from enteric fermentation, $N_2O$ emissions from manure management, direct $N_2O$ emissions from soils), and LULUCF ($CO_2$ emissions/removals from forest land remaining forest land, $CO_2$ emissions from cropland remaining cropland); | Improvements in transparency on methods and AD: The methodology information for $CH_4$ emissions from the company operating natural gas supply system was updated and received from the company. It is planned to translate the methodology or its summary to Submission 2012. [NIR 2011, p. 308] |
| | (d) Improve transparency and provide further clarification for the methods and trends in emissions for subcategories in the following sectors: energy (road transportation: liquid fuels – $CO_2$ and $N_2O$, and stationary combustion: all fuels – $CO_2$, navigation: liquid fuels – $CO_2$, $CH_4$ and $N_2O$ and civil aviation: liquid fuels – $CO_2$, $CH_4$ and $N_2O$); industrial processes (lime production and limestone and dolomite use – $CO_2$); agriculture (enteric fermentation – $CH_4$ , manure management – $CH_4$); LULUCF (cropland remaining cropland – $CO_2$, land converted to forest land – $CO_2$, grassland remaining grassland – $CO_2$); and waste (solid waste disposal on land – $CH_4$, wastewater handling – $CH_4$); | Not yet addressed. |
| | (e) Improve the completeness and the transparency of the inventory in the LULUCF sector and for KP-LULUCF, specifically: report all mandatory categories in LULUCF and pools from activities under Article 3, paragraphs 3 and 4, of the Kyoto Protocol (paying particular attention to the consistent representation of land area and changes in carbon stocks and emissions/removals from different pools); | Not yet addressed. |
| | (f) Implement a qualitative key category assessment; | Use a qualitative approach in key category analysis. Scheduled for 2012, For submission 2011, only for year 2009, [NIR 2011, p.308] |
| | (g) Include the list of key categories for activities under Article 3, paragraphs 3 and 4, of the Kyoto Protocol and demonstrate that these key categories have been identified according to the IPCC good practice guidance for LULUCF; | Not yet addressed. |
| | (h) Provide tier 2 uncertainty estimates; | Uncertainty analysis with Tier 2 is scheduled for 2012 [NIR 2011, p.308] |
| | (i) Conduct and report the uncertainty assessment associated with estimates of changes in carbon stocks in pools and emissions and removals from activities under Article 3, paragraphs 3 and 4, of the Kyoto Protocol; | Not yet addressed. |
| | (j) Elaborate on changes in Regulation No. 157 in order to include activities under Article 3, paragraphs 3 and 4, of the Kyoto Protocol, as well as QA/QC updates and other changes which improve the national system; | Not yet addressed. |
| | (k) Explore further steps in implementing the provisions un- | Not yet addressed. |

| Member State | Improvements as recommended by the review team | Improvements in response to UNFCCC review as indicated in the NIR |
|---|---|---|
| | der Article 3, paragraph 14, of the Kyoto Protocol and report on how Latvia is striving to implement its commitments under Article 3, paragraph 14, of the Kyoto Protocol; | |
| | (l) Enhance the reporting of changes in the national registry since the last annual submission, in accordance with section I.G of the annex to decision 15/CMP.1 by clearly stating whether each item was changed or not compared with information reported the previous year.<br>(**FCCC/ARR/2010/LVA, para 27)** | The detailed information of changes performed in 2009 was included in Submission 2010 and was successfully reviewed during SIAR 2010 cycle. No significant changes were done for Latvia's Emission Trading Registry in 2010. [NIR 2011, p.315] |
| **Lithuania** | Review report (Centralized review 2010) not yet available. | |
| **Poland** | The ERT identifies the following cross-cutting issues for improvement:<br>(a) Improve the transparency of the NIR by explaining the changes and the factors contributing to the changes in the time series, the methods, the basic assumptions and the sources of EFs and parameters used; | a), b) Not yet addressed. |
| | (b) Include, in the NIR, category-specific uncertainty estimates, QA/QC and verification activities and further planned improvements for all sectors; | |
| | (c) Develop country-specific values for EFs and parameters of key category emission estimates; | c) Country specific EFs are applied for most of the key category estimates. [NIR 2011] |
| | (d) Complete the reporting of CRF table 8(b) on recalculations; | d) Not yet addressed. |
| | (e) Complete CRF table 9(a) on categories reported as "NE" and "IE"; | e) Table 9(a) is completed in the 2011 submission. [CRF 2011] |
| | (f) Provide a key category tier 2 analysis according to the methodologies provided by the IPCC good practice guidance and the IPCC good practice guidance for LULUCF in future annual submissions; | f) Depending on methodology used for emission estimation within categories Tier 1 or Tier 2 check procedures are carried out. The extended QC procedure for checking the correctness of emissions estimations is used for these categories where country specific emission factors are established. [NIR 2011] |
| | (g) Improve reporting of all mandatory information items on activities under Article 3, paragraphs 3 and 4, of the Kyoto Protocol so that the KP-LULUCF reporting is complete and consistent with the requirements of paragraphs 6–9 of the annex to decision 15/CMP.1.<br>(**FCCC/ARR/2010/POL, para 29)** | g) Accounting of net emissions and removals of $CO_2$ related to activities under Articles 3.3 and 3.4 of the Kyoto Protocol will be made in 2014 for the entire commitment period 2008−2012. This way of reporting enables more exact assessment of activities taking into account cyclic measurements and case studies undertaken in the Polish forestry sector. [NIR 2011, p.204] |
| **Romania** | The ERT identifies the following cross-cutting issues for improvement:<br>(a) Strengthening the institutional arrangements and funding of the national system, ensuring that it is able to conduct all the specific functions in accordance with the annex to decision 19/CMP.1; e. | No information available in NIR 2011. |
| | (b) Implementing the annual inventory improvement plans and raising the methodological tier level in accordance with the IPCC good practice guidance, in particular for key categories; | No information available in NIR 2011 |
| | (c) Continuing to improve the completeness of the inventory, in particular by estimating the remaining emissions reported as "NE" in the energy sector (see paras. 73–75 below); | 1.B.2.A.2, 1.B.2A.3, 1.B.2.B.2, 1.B.2.B.3 and 1.B.2.C.1.1 - The adjustments proposed by the European Commission in activity data and $CH_4$ and $CO_2$ emissions using the emissions factors the Bulgaria's in CRF tables. |
| | (d) Strengthening the arrangements of the national system to enable the compliance with the requirements for the preparation of the information required for the KP-LULUCF activi- | No information available in NIR 2011 |

| Member State | Improvements as recommended by the review team | Improvements in response to UNFCCC review as indicated in the NIR |
|---|---|---|
| | ties; | |
| | (e) Improving the transparency of reporting with regard to the description of methodologies, assumptions and background data for country-specific EFs, the assumptions behind uncertainty values, and the reporting of implied emission factors (IEFs) and their trends when AD are confidential; | Not yet addressed. |
| | (f) Performing recalculations for the complete time series in accordance with the IPCC good practice guidance; | No information available in NIR 2011 |
| | (g) Including the KP-LULUCF activities in the key category analysis; | Not yet addressed. |
| | (h) Reporting recalculations and changes in the national system that occur between successive submission years and not between submissions; | No information available in NIR 2011 |
| | (i) Improving the reporting of QA/QC procedures by including information on the results of the implementation of these procedures during the preparation of the inventory submission; | No information available in NIR 2011 |
| | (j) Improving the completeness of the inventory for the LULUCF sector, in particular for the land uses that represent the majority of the land area in Romania (cropland and grassland). | Not yet addressed. |
| **Slovakia** | The ERT identifies the following cross-cutting issues for improvement:<br><br>(a) Improve the completeness of the inventory for the early years in the time series for waste (1990–2001), and report non-reported categories in LULUCF and non estimated pools for mandatory activities under Article 3, paragraph 3, of the Kyoto Protocol; | a) In the LULUCF sector reporting has been improved. [NIR 2011, p.183]<br><br>The improvement of the time series in the waste sector has not been addressed so far. [NIR 2011, p.198] |
| | (b) Include more transparent information in the specific-sector chapters of the NIR, including information on the comparison of the reference and sectoral approaches, the allocation of fuels and emissions between the energy and the industrial processes sectors, the AD, EFs and assumptions used for the LULUCF and waste sectors, and for sector specific QA; | b) Information on the comparison of the reference and the sectoral approach has been provided in the 2011 submission. [NIR 2011, p.75] |
| | (c) Explain how the key categories for activities under Article 3, paragraph 3, of the Kyoto Protocol have been identified and provide information on uncertainty estimates associated with emissions and removals from activities under Article 3, paragraph 3, of the Kyoto Protocol; | c) Not yet addressed. |
| | (d) Provide the information required for the reporting and accounting of carbon pools for activities under Article 3, paragraph 3, of the Kyoto Protocol during the commitment period, given that the second cycle of the new NFI, which is expected to provide data and information, is planned to take place in 2015–2016, which is beyond the end of the commitment period; | d) Estimated removals from afforestation/reforestation AR activities are included in the 2011 submission. [NIR 2011, p.237] |
| | (e) Ensure that all recalculations are fully explained in the NIR and update CRF table 8(b) with information on the rationale for changes in the inventory estimates; | e) Not yet addressed. |
| | (f) Implement the recommendations identified in the NIR and those outstanding improvements from previous review reports; | f) Some outstanding recommendations have been implemented in the 2011 submission. |
| | (g) Enhance the availability of public information referred to in paragraphs 46 and 47 of the annex to decision 13/CMP.1 | g) Not yet addressed. |

| Member State | Improvements as recommended by the review team | Improvements in response to UNFCCC review as indicated in the NIR |
|---|---|---|
| | and report on any changes to that public information available on the public user interface of the national registry; | |
| | (h) Explore further steps in implementing Article 3, paragraph 14, of the Kyoto Protocol and report information on how Slovakia is striving to implement its commitments under Article 3, paragraph 14.<br><br>(**FCCC/ARR/2010/SVK, para 27)** | h) A chapter on the information on minimization of adverse effects has been provided. [NIR 2011, p.242] |
| **Slovenia** | The ERT identifies the following cross-cutting issues for improvement:<br><br>(a) To continue to improve the completeness of the inventory by including estimates of $SF_6$ from the filling of soundproof windows for the period 1995–1997; | a) Estimates have been included. (CRF tables and NIR - see relevant Sectors). [NIR 2011, p.255] |
| | (b) To improve the basic QC procedures for checking the NIR and the CRF tables to ensure that data are accurate and consistent and that the appropriate notation keys are used. In addition, the ERT encourages Slovenia to implement tier 2 category-specific QC checks and a peer review (QA) for key categories, where possible; | b) Basic QC procedures have been improved. [NIR 2011, p.255] |
| | (c) To continue to improve the transparency of the NIR by providing more detailed descriptions of country-specific methodologies and data sources and analysis of trends; | c) Improvements are made in every submission. [NIR 2011, p.255] |
| | (d) To report the key categories, including for activities under Article 3, paragraphs 3 and 4, following the guidance provided in the IPCC good practice guidance for LULUCF; | d) Changes will be made in April submission. [NIR 2011, p.254] |
| | (e) To improve the uncertainty estimates and include the required documentation in the NIR.<br><br>(**FCCC/ARR/2010/SVN, para 29)** | e) Changes will be made in April submission, explanation will be provided. [NIR 2011, p.254] |

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# UNITS AND ABBREVIATIONS

| | |
|---|---|
| t | 1 tonne (metric) = 1 megagram (Mg) = 106 g |
| Mg | 1 megagram = 106 g = 1 tonne (t) |
| Gg | 1 gigagram = 109 g = 1 kilotonne (kt) |
| Tg | 1 teragram = 1012 g = 1 megatonne (Mt) |
| TJ | 1 terajoule |

| | |
|---|---|
| AWMS | animal waste management systems |
| BEF | biomass expansion factor |
| BKB | lignite briquettes |
| C | confidential |
| CCC | Climate Change Committee (established under Council Decision No 280/2004/EC) |
| $CH_4$ | methane |
| $CO_2$ | carbon dioxide |
| COP | conference of the parties |
| CRF | common reporting format |
| CV | calorific value |
| EC | European Community |
| EEA | European Environment Agency |
| EF | emission factor |
| Eionet | European environmental information and observation network |
| EMAS | Ecomanagement and Audit Scheme |
| ETC/ACC | European Topic Centre on Air and Climate Change |
| ETS | European Emissions Trading System |
| EU | European Union |
| FAO | Food and Agriculture Organisation of the United Nations |
| GHG | greenhouse gas |
| GPG | good practice guidance and uncertainty management in national greenhouse gas inventories (IPCC, 2000) |

| | |
|---|---|
| GWP | global warming potential |
| HFCs | hydrofluorocarbons |
| JRC | Joint Research Centre |
| F-gases | fluorinated gases (HFCs, PFCs, $SF_6$) |
| IE | included elsewhere |
| IPCC | Intergovernmental Panel on Climate Change |
| KP | Kyoto Protocol |
| LULUCF | land-use, land-use change and forestry |
| MNP | Milieu-en Natuurplanbureau |
| MS | Member State |
| MRG | monitoring and reporting guidelines |
| N | nitrogen |
| NH3 | ammonia |
| $N_2O$ | nitrous oxide |
| NA | not applicable |
| NE | not estimated |
| NFI | national forest inventory |
| NIR | national inventory report |
| NO | not occurring |
| PFCs | perfluorocarbons |
| QA | quality assurance |
| QA/QC | quality assurance/quality control |
| QM | quality management |
| QMS | quality management system |
| RIVM | National Institute of Public Health and the Environment (The Netherlands) |
| $SF_6$ | sulphur hexafluoride |
| SNE | Single National Entity |
| UNFCCC | United Nations Framework Convention on Climate Change |
| VOCs | Volatile Organic Compounds |

## Abbreviations in the source category tables in Chapters 3 to 9 and 18-24

| **Methods applied** | **EF: methods applied for determining the emission factor** | **AD: methods applied for determining the activity data** | **Estimate: assessment of completeness** | **Quality: assessment of the uncertainty of the estimates** |
|---|---|---|---|---|
| C — Corinair | C — Corinair | AS — associations, business organizations | All — full | H — high |
| CS — country-specific | CS — country-specific | IS — international statistics | F — full | M — medium |
| COPERT X — Copert Model X = version | D — default | NS — national statistics | Full — full | L — low |
| D — default | M — model | PS — plant specific data | IE — included elsewhere | |
| M — model | MB — mass balance | Q — specific questionnaires, surveys | NE — not estimated | |
| NA — not applicable | PS — plant-specific | RS — regional statistics | NO — not occurring | |
| RA — reference approach | | | P — partial | |
| T1 — IPCC Tier 1 | | | Part — partial | |
| T1a — IPCC Tier 1a | | | | |
| T1b — IPCC Tier 1b | | | | |
| T1c — IPCC Tier 1c | | | | |
| T2 — IPCC Tier 2 | | | | |
| T3 — IPCC Tier 3 | | | | |