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Annexes published on CD-ROM and the EEA website only:

Annex I: Key category analysis

Annex II: Uncertainty assessment (included in NIR section 1.6)

Annex III: Detailed methodological descriptions for individual source or sink categories

Annex IV: not included (see explanation in chapter 1.8.4)

Annex V: Additional information

ES-1 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 years between 1990 and the current calendar year (t) minus two (t-2), for emissions and removals within the area covered by its Member States (i.e. emissions taking place within its territory).

The present report is the official inventory submission of the European Union for 2018 under the UNFCCC and the Kyoto Protocol (KP).

The EU, its Member States and Iceland have agreed to fulfil their quantified emission limitation and reduction commitments under Article 3 of the Kyoto Protocol for the second commitment period to the Kyoto Protocol jointly, in accordance with the provisions of Article 4 thereof. The Union, its Member States and Iceland agreed to a quantified emission reduction commitment that limits their average annual emissions of greenhouse gases during the second commitment period to 80 % of the sum of their base year emissions, which is reflected in the Doha Amendment. Article 4 of the Kyoto Protocol requires parties that agree to fulfil their commitments under Article 3 of the Kyoto Protocol jointly to set out in the relevant joint fulfilment agreement the respective emission level allocated to each of the parties. Council Decision (EU) 2015/1339 sets out the terms of the joint fulfilment agreement as well as the respective emission levels of each Party to that agreement. The emission levels define the Member States' and Iceland's assigned amounts for the second commitment period. These emission levels have been determined on the basis of the existing Union legislation for the period 2013-2020 under the 'Climate and Energy package'.

This report, therefore, refers to the totals of the EU-28 plus Iceland. For reasons of clarity, please note that in some cases the terms '(EU-28) Member States' and 'EU-28'/'EU' may be used. As a general rule, these terms also refer to Iceland.

The EU should not be held liable for any remaining errors caused by the CRF Reporter in the review of the information submitted.

The legal basis for the compilation of the EU inventory is Regulation (EU) No 525/2013 of the European Parliament and of the Council of 21 May 2013 on a mechanism for monitoring and reporting GHG emissions and for reporting other information at national and EU level relevant to climate change and repealing Decision No 280/2004/EC[1].

This Regulation establishes a mechanism for:

a) ensuring the timeliness, transparency, accuracy, consistency, comparability and completeness of reporting by the EU and its Member States to the UNFCCC Secretariat;
b) reporting and verifying information relating to commitments of the EU and its Member States pursuant to the UNFCCC, to the Kyoto Protocol and to decisions adopted thereunder, and evaluating progress towards meeting those commitments;
c) monitoring and reporting all anthropogenic emissions by sources, and removals by sinks, of GHGs not controlled by the Montreal Protocol on substances that deplete the ozone layer in Member States;
d) monitoring, reporting, reviewing and verifying GHG emissions and other information pursuant to Article 6 of Decision No 406/2009/EC;
e) reporting the use of revenue generated by auctioning allowances under Article 3d(1) or (2) or Article 10(1) of Directive 2003/87/EC, pursuant to Article 3d(4) and Article 10(3) of that Directive;

[1] http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32013R0525&qid=1527153180542&from=EN

f) monitoring and reporting on the actions taken by Member States to adapt to the inevitable consequences of climate change in a cost-effective manner;
g) evaluating progress by the Member States towards meeting their obligations under Decision No 406/2009/EC.

The new Monitoring Mechanism Regulation has enhanced the reporting rules on GHG emissions to meet the requirements arising from international climate agreements, as well as the 2009 EU climate and energy package. Since in 2014, GHG inventory reporting has taken place under this new legal instrument, which replaces and expands the previous Monitoring Mechanism Decision 280/2004/EC.

The EU GHG inventory comprises the direct sum of emissions from the national inventories compiled by the EU Member States making up the EU-28. 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 28 Member States plus Iceland, the European Commission Directorate-General for 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).

The annual process of compiling the EU GHG inventory is described below:

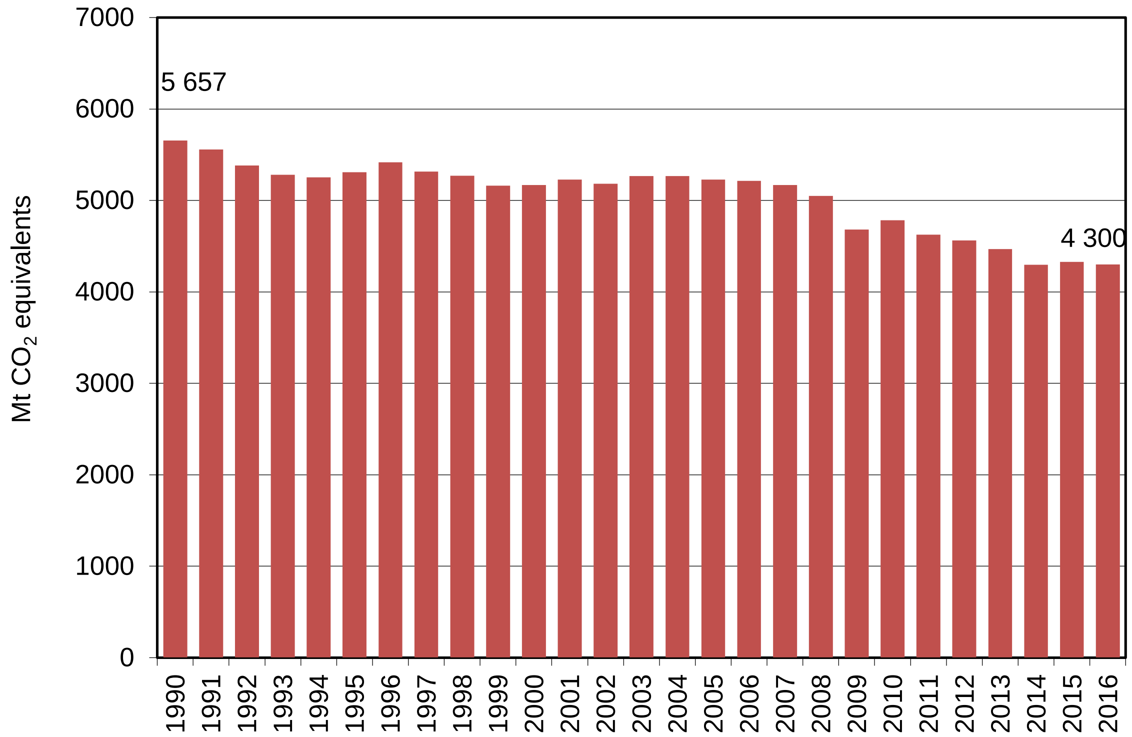
1. Member States submit their annual GHG inventories by 15 January each year to the European Commission (DG CLIMA), with a copy to the EEA.
2. The EEA and its ETC/ACM, Eurostat, and the JRC then perform initial checks on the data submitted. Specific findings from the initial quality assurance/quality control (QA/QC) checks are communicated to Member States by 28 February. In addition, the draft EU GHG inventory and inventory report are circulated to Member States for review and comments by 28 February.
3. Member States check their national data and the information presented in the EU GHG inventory report, respond to specific findings from the initial QA/QC checks by the EU inventory team, send updates if necessary and review the EU inventory report by 15 March.
4. The EEA and its ETC/ACM review final inventory submissions from Member States and their responses to the initial checks, and prepare the final EU GHG inventory and inventory report by 15 April so that they can be submitted to the UNFCCC.
5. A resubmission is prepared by 27 May if needed.

ES-2 SUMMARY OF GREENHOUSE GAS EMISSIONS TRENDS IN THE EU

Total GHG emissions — excluding Land Use, Land Use Change and Forestry (LULUCF) — in the EU-28 plus Iceland amounted to 4 300 million tonnes CO_2 equivalent in 2016 (including indirect CO_2 emissions). All GHG emission totals provided in this report include indirect CO_2 emissions[2].

In 2016, total GHG emissions were 24.0 % (1 356 million tonnes CO_2 equivalents) below 1990 levels. Emissions decreased by 0.6 % (-27 million tonnes CO_2 equivalent) between 2015 and 2016 (Figure ES. 1).

Figure ES. 1 EU-28 plus Iceland GHG emissions (excl. LULUCF)



Notes: GHG emissions data for the EU-28 plus Iceland as a whole refer to domestic emissions (i.e. within the territory), include indirect CO_2, 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 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 Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC).

1.1 Main trends by source category, 1990-2016

Total GHG emissions (excluding LULUCF) decreased by 1356 million tonnes since 1990 (or 24.0 %) reaching their lowest level during this period in 2014 (4298 Mt CO_2 eq.). There has been a progressive

[2] According to the UNFCCC reporting guidelines, Annex I Parties may report indirect CO_2 from the atmospheric oxidation of CH_4, CO and NMVOCs. For Parties that decide to report indirect CO_2, the national totals will be presented with and without indirect CO_2. The EU national total includes indirect CO_2 emissions if Member States have reported them. The CRF tables include national totals, including and excluding indirect CO_2 emissions.

decoupling of gross domestic product (GDP) and GHG emission compared to 1990, with an increase in GDP of about 53 % alongside a decrease in emissions of 24 % over the period.

The reduction in greenhouse gas emissions over the 26-year period was due to a variety of factors, including the growing share in the use of renewables, the use of less carbon intensive fuels and improvements in energy efficiency, as well as to structural changes in the economy and the economic recession. Demand for energy to heat households has also been lower, as Europe on average has experienced milder winters since 1990, which has also helped reduce emissions.

GHG emissions decreased in the majority of sectors between 1990 and 2016, with the notable exception of transport, including international transport, and refrigeration and air conditioning. At the aggregate level, emission reductions were largest for manufacturing industries and construction, electricity and heat production, and residential combustion.

A combination of factors explains lower emissions in industrial sectors, such as improved efficiency and carbon intensity as well as structural changes in the economy, with a higher share of services and a lower share of more-energy-intensive industry in total GDP. The economic recession that began in the second half of 2008 and continued through to 2009 also had an impact on emissions from industrial sectors. Emissions from electricity and heat production decreased strongly since 1990. In addition to improved energy efficiency there has been a move towards less carbon intense fuels. Between 1990 and 2016, the use of solid and liquid fuels in thermal stations decreased strongly whereas natural gas consumption doubled, resulting in reduced CO_2 emissions per unit of fossil energy generated. Emissions in the residential sector also represented one of the largest reductions. Energy efficiency improvements from better insulation standards in buildings and a less carbon-intensive fuel mix can partly explain lower demand for space heating in the EU as a whole over the past 26 years. Since 1990, there has been a warming of the autumn/winter in Europe; although there is high regional variability. The very strong increase in the use of biomass for energy purposes has also contributed to lower GHG emissions in the EU.

In terms of the main GHGs, CO_2 was responsible for the largest reduction in emissions since 1990. Reductions in emissions from N_2O and CH_4 have been substantial, reflecting lower levels of mining activities, lower agricultural livestock, as well as lower emissions from managed waste disposal on land and from agricultural soils. A number of policies (both EU and country-specific) have also contributed to the overall GHG emission reduction, including key agricultural and environmental policies in the 1990s and climate and energy policies in the 2000s.

Almost all EU Member States reduced emissions compared to 1990 and thus contributed to the overall positive EU performance. The UK and Germany accounted for about 48% of the total net reduction in the EU of the past 26 years.

Table ES. 1 shows those sources that made the largest contribution to the change in total GHG emissions in the EU plus Iceland between 1990 and 2016.

Table ES. 1 Overview of EU-28 plus Iceland source categories whose emissions increased or decreased by more than 20 million tonnes CO_2 equivalent in the period 1990–2016

Source category	Million tonnes (CO_2 equivalents)
Road Transportation (CO_2 from 1.A.3.b)	163
Refrigeration and Air conditioning (HFCs from 2.F.1)	97
Aluminium Production (PFCs from 2.C.3)	-21
Agricultural Soils: Direct N_2O Emissions From Managed Soils (N_2O from 3.D.1)	-26
Fugitive emisisons from Natural Gas (CH_4 from 1.B.2.b)	-26
Cement Production (CO_2 from 2.A.1)	-28
Fluorochemical Production (HFCs from 2.B.9)	-29
Commercial/Institutional (CO_2 from 1.A.4.a)	-40
Enteric Fermentation: Cattle (CH_4 from 3.A.1)	-44
Nitric Acid Production (N_2O from 2.B.2)	-46
Adipic Acid Production (N_2O from 2.B.3)	-57
Manufacture of Solid Fuels and Other Energy Industries (CO_2 from 1.A.1.c)	-61
Coal Mining and Handling (CH_4 from 1.B.1.a)	-69
Managed Waste Disposal Sites (CH_4 from 5.A.1)	-73
Residential: Fuels (CO_2 from 1.A.4.b)	-109
Iron and steel production (CO_2 from 1.A.2.a +2.C.1)	-120
Manufacturing industries (excl. Iron and steel) (Energy-related CO_2 from 1.A.2 excl. 1.A.2.a)	-278
Public Electricity and Heat Production (CO_2 from 1.A.1.a)	-420
Total	**-1356**

Notes: As the table only presents sectors whose emissions have increased or decreased by at least 20 million tonnes CO_2 equivalent, the sum for each sector grouping does not match the total change listed at the bottom of the table.

1.2 Main trends by source category, 2015–2016

Total GHG emissions (excluding LULUCF) decreased in 2016 by 26.8 million tonnes, or - 0.6 % compared to 2015, to reach 4300 Mt CO_2 equivalent in 2016. This small decrease in emissions came along with an increase in GDP of 2 %. The United Kingdom and Spain accounted for the largest decreases in GHG emissions in absolute terms in the EU in 2016. Reductions in these countries were largely because of lower consumption of solid fuels in the power sector. On the other hand, there was a relatively large increase in emissions in Poland, particularly in the road transport sector.In terms of sectors, emissions decreased in energy supply (mostly in electricity and heat production) and industry (mostly in iron and steel). The overall 0.6% net decrease in total GHG emissions was partly offset by increased fuel-use for road transportation as well as by higher heat consumption in the residential/commercial sectors due to colder winter conditions in 2016. This increase in road transportation can be attributed mainly to higher diesel consumption in passenger cars, but also in heavy- and light-duty vehicles.

In terms of fuels, there was a very strong decline in coal consumption (in the power sector) and a large increase in the consumption of natural gas (in the residential sector). Oil consumption also increased in 2016. Based on Eurostat data, the decline in nuclear electricity in 2016 was offset by a larger increase in the use of renewable energy sources.

Other positive developments in 2016 are the continued decoupling of GHG from GDP, the improved energy intensity of the economy and the better carbon intensity of the energy system compared to 2015. The improvement in energy intensity was largely driven by lower transformation losses and better energy efficiency. The improvement in carbon intensity was driven by higher consumption of renewables and of natural gas and lower consumption of solid fuels.

Table ES. 2 shows the source categories making the largest contribution to the change in GHG emissions in the EU-28 between 2015 and 2016.

Table ES. 2 Overview of EU-28 plus Iceland source categories whose emissions increased or decreased by more than 3 million tonnes CO_2 equivalent in the period 2015–2016

Source category	**Million tonnes (CO_2 equivalents)**
Road Transportation (CO_2 from 1.A.3.b)	19
Residential: Fuels (CO_2 from 1.A.4.b)	15
Commercial/Institutional (CO_2 from 1.A.4.a)	4
Iron and steel production (CO_2 from 1.A.2.a +2.C.1)	-8
Public Electricity and Heat Production (CO_2 from 1.A.1.a)	-49
Total	**-27**

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

Table ES.3 gives an overview of total GHG emissions by Member States, illustrating where the main changes occurred.

Table ES. 3 GHG emissions in million tonnes CO_2 equivalent (excl. LULUCF)

	1990 (million tonnes)	2016 (million tonnes)	2015 - 2016 (million tonnes)	Change 2015 - 2016 (%)	Change 1990-2016 (%)
Austria	78.7	79.7	0.8	1.0%	1.2%
Belgium	146.7	117.7	0.1	0.1%	-19.7%
Bulgaria	104.0	59.1	-2.7	-4.4%	-43.2%
Croatia	31.9	24.3	0.1	0.5%	-23.8%
Cyprus	5.6	8.8	0.4	5.3%	56.9%
Czech Republic	199.6	130.3	1.9	1.5%	-34.7%
Denmark	70.4	50.5	2.0	4.1%	-28.3%
Estonia	40.4	19.6	1.6	8.7%	-51.4%
Finland	71.3	58.8	3.4	6.1%	-17.6%
France	546.4	458.2	0.1	0.0%	-16.1%
Germany	1251.6	909.4	2.7	0.3%	-27.3%
Greece	103.1	91.6	-3.7	-3.9%	-11.1%
Hungary	93.8	61.5	0.5	0.7%	-34.5%
Ireland	55.5	61.5	2.1	3.6%	10.9%
Italy	518.4	427.9	-5.0	-1.2%	-17.5%
Latvia	26.5	11.3	0.0	-0.2%	-57.3%
Lithuania	48.1	20.1	-0.1	-0.5%	-58.3%
Luxembourg	12.8	10.0	-0.2	-2.4%	-21.6%
Malta	2.1	1.9	-0.3	-14.2%	-9.1%
Netherlands	221.3	195.2	0.5	0.2%	-11.8%
Poland	467.3	395.8	10.7	2.8%	-15.3%
Portugal	59.9	67.8	-1.8	-2.6%	13.1%
Romania	246.7	112.5	-3.7	-3.2%	-54.4%
Slovakia	74.0	41.0	0.1	0.3%	-44.5%
Slovenia	18.6	17.7	0.9	5.1%	-4.9%
Spain	287.7	324.7	-11.1	-3.3%	12.9%
Sweden	71.5	52.9	-0.9	-1.6%	-26.0%
United Kingdom	796.6	482.8	-25.1	-4.9%	-39.4%
EU-28	5650.4	4292.7	-26.7	-0.6%	-24.0%
Iceland	3.6	4.7	-0.1	-1.7%	28.5%
United Kingdom (KP)	799.1	485.5	-25.0	-4.9%	-39.2%
EU-28 + ISL	5656.5	4300.1	-26.8	-0.6%	-24.0%

ES-3 SUMMARY OF EMISSIONS AND REMOVALS BY MAIN GREENHOUSE GAS

Table ES. 4 gives an overview of the main trends in the EU-28 plus Iceland GHG emissions and removals for the period 1990–2016. By far the most important GHG is CO_2, which accounted for 81°% of total EU-28 emissions in 2016, excluding LULUCF. In 2016, EU-28 CO_2 emissions excluding LULUCF were 3 497 million tonnes, which was 22°% below 1990 levels. Compared to 2015, CO_2 emissions decreased by 0.6°%. Emissions of CH_4 decreased whereas NF_3 emissions increased. Emissions of HFCs, N_2O, PFCs and SF_6 were stable.

Table ES. 4 Overview of EU-28 plus Iceland GHG emissions and removals from 1990 to 2016 in million tonnes CO_2 equivalent

GREENHOUSE GAS EMISSIONS	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Net CO_2 emissions/removals	4 208	3 922	3 855	3 974	3 969	3 957	3 824	3 479	3 608	3 473	3 413	3 320	3 153	3 188	3 182
CO_2 emissions (without LULUCF)	4 481	4 221	4 185	4 310	4 316	4 270	4 170	3 827	3 946	3 800	3 742	3 654	3 484	3 518	3 496
CH_4	730	669	611	549	535	528	515	504	493	483	480	468	461	461	457
N_2O	397	360	318	298	287	288	278	263	253	248	246	246	249	249	248
HFCs	29	44	55	77	83	91	97	98	104	106	109	112	115	110	110
PFCs	26	17	12	7	7	6	6	4	4	4	4	4	4	4	4
Unspecified mix of HFCs and PFCs	6	6	2	1	1	1	1	1	0	0	1	1	1	1	1
SF_6	11	15	11	8	7	7	7	6	7	6	6	6	6	6	7
NF_3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total (with net CO_2 emissions/removals)	**5 407**	**5 033**	**4 864**	**4 915**	**4 890**	**4 879**	**4 727**	**4 355**	**4 469**	**4 321**	**4 259**	**4 158**	**3 988**	**4 019**	**4 009**
Total (without CO2 from LULUCF)	**5 680**	**5 332**	**5 194**	**5 250**	**5 237**	**5 192**	**5 072**	**4 703**	**4 807**	**4 649**	**4 588**	**4 491**	**4 320**	**4 349**	**4 323**
Total (without LULUCF)	**5 657**	**5 307**	**5 169**	**5 227**	**5 215**	**5 168**	**5 051**	**4 680**	**4 785**	**4 627**	**4 564**	**4 469**	**4 298**	**4 327**	**4 300**

Notes: CO_2 emissions include indirect CO_2

More detailed information can be found in Chapter 2.

ES-4 SUMMARY OF EMISSIONS AND REMOVALS BY MAIN SOURCE AND SINK CATEGORY

Table ES. 5 gives an overview of EU-28 plus Iceland GHG emissions in the main source categories for the period 1990–2016. The most important sector by far is energy (i.e. combustion and fugitive emissions), which accounted for 78°% of total EU emissions in 2016. The second largest sector is agriculture (10°%), followed by industrial processes (9°%). More detailed trend descriptions are included in the individual sector chapters (chapters 3-7).

Table ES. 5 Overview of EU-28 GHG emissions (in million tonnes CO_2-equivalent) in the main source and sink categories for the period 1990 to 2016

GHG SOURCE AND SINK	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
1. Energy	4 355	4 088	4 022	4 123	4 121	4 066	3 985	3 701	3 800	3 651	3 607	3 518	3 339	3 375	3 352
2. Industrial Processes	518	499	457	467	466	478	453	379	396	392	379	378	384	379	377
3. Agriculture	543	473	459	435	431	434	431	426	421	421	419	422	429	430	431
4. LULUCF	-250	-275	-305	-312	-325	-289	-324	-325	-317	-306	-306	-312	-310	-307	-291
5. Waste	236	244	229	200	194	188	179	173	166	161	157	150	144	141	139
6. Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
indirect CO_2 emissions	4	4	3	2	2	2	2	2	2	2	2	2	2	2	1
Total (with net CO_2 emissions/removals)	**5 407**	**5 033**	**4 864**	**4 915**	**4 890**	**4 879**	**4 727**	**4 355**	**4 469**	**4 321**	**4 259**	**4 158**	**3 988**	**4 019**	**4 009**
Total (without LULUCF)	**5 657**	**5 307**	**5 169**	**5 227**	**5 215**	**5 168**	**5 051**	**4 680**	**4 785**	**4 627**	**4 564**	**4 469**	**4 298**	**4 327**	**4 300**

Notes: CO_2 emissions include indirect CO_2

ES-5 SUMMARY OF EU MEMBER STATE EMISSION TRENDS

Table ES. 6 gives an overview of Member State contributions to EU GHG emissions for the period 1990–2016. Member States show large variations in GHG emissions trends.

Table ES. 6 Overview of EU-28 plus Iceland contributions to total GHG emissions, excluding LULUCF, from 1990 to 2016 in million tonnes CO_2-equivalent

Member State	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Austria	79	80	80	93	90	87	87	80	85	82	80	80	76	79	80
Belgium	147	155	150	145	143	139	139	126	133	122	119	120	114	118	118
Bulgaria	104	75	60	64	64	68	67	58	61	66	61	56	59	62	59
Croatia	32	23	26	30	30	32	30	29	28	28	26	25	24	24	24
Cyprus	5.6	7.0	8.3	9.2	9.5	9.8	10.0	9.7	9.4	9.1	8.6	7.9	8.3	8.3	8.8
Czech Republic	200	159	150	148	149	151	146	138	141	138	134	129	127	128	130
Denmark	70	78	71	66	74	69	66	63	63	58	53	55	51	49	50
Estonia	40	20	17	19	18	22	20	17	21	21	20	22	21	18	20
Finland	71	72	70	70	81	79	71	68	76	68	62	63	59	55	59
France	546	541	551	553	541	532	525	502	512	484	485	484	454	458	458
Germany	1252	1123	1045	993	1000	973	975	908	943	920	925	942	903	907	909
Greece	103	109	126	136	132	135	132	124	118	115	112	103	99	95	92
Hungary	94	75	73	76	75	73	71	65	65	64	60	57	58	61	61
Ireland	55	59	69	70	69	68	67	62	61	57	58	58	57	59	62
Italy	518	533	554	581	570	562	548	495	504	491	472	441	425	433	428
Latvia	26	13	11	11	12	12	12	11	12	12	11	11	11	11	11
Lithuania	48	22	19	23	23	25	24	20	21	21	21	20	20	20	20
Luxembourg	13	10	10	13	13	12	12	12	12	12	12	11	11	10	10
Malta	2.1	2.7	2.8	3.0	3.0	3.1	3.1	2.9	3.0	3.0	3.2	2.9	2.9	2.2	1.9
Netherlands	221	231	219	214	209	208	207	201	213	199	195	194	187	195	195
Poland	467	438	390	398	412	413	405	388	406	405	398	395	382	385	396
Portugal	60	70	83	87	82	80	77	74	70	69	67	65	65	70	68
Romania	247	180	141	148	150	153	148	128	122	128	125	115	115	116	113
Slovakia	74	54	50	51	51	49	50	45	46	45	43	43	40	41	41
Slovenia	19	19	19	21	21	21	22	20	20	20	19	18	17	17	18
Spain	288	327	386	439	432	443	410	371	356	355	349	322	324	336	325
Sweden	72	74	69	67	67	65	63	58	64	60	57	55	54	54	53
United Kingdom	797	749	713	693	686	674	653	597	612	564	581	566	526	508	483
EU-28	5650	5301	5162	5220	5208	5160	5042	4673	4777	4620	4557	4462	4291	4319	4293
Iceland	3.6	3.5	4.1	4.0	4.6	4.9	5.3	5.0	4.9	4.6	4.6	4.6	4.7	4.7	4.7
United Kingdom (KP)	799	752	716	696	689	677	656	600	615	567	584	569	528	511	485
EU-28 + ISL	5657	5307	5169	5227	5215	5168	5051	4680	4785	4627	4564	4469	4298	4327	4300

The overall EU GHG emissions trend is dominated by the two largest emitters, Germany (21 %) and the United Kingdom (11 %), which accounted for nearly one third of total EU-28 GHG emissions in 2016. By 2016, these two Member States had achieved total domestic GHG emissions reductions of 656 million tonnes CO_2 equivalent compared to 1990, not counting carbon sinks and the use of Kyoto mechanisms. The main reasons for the favourable trend in Germany were an increase in the efficiency of power and heating plants and the economic restructuring of the five new Länder after the German reunification, particularly in the iron and steel sector. Other important reasons include a reduction in the carbon intensity of fossil fuels (with the switch from coal to gas), a strong increase in renewable energy use and waste management measures that reduced the landfilling of organic waste. Lower GHG emissions in the United Kingdom were primarily the result of liberalising energy markets and the subsequent fuel switch from oil and coal to gas in electricity production. Other reasons include the shift towards more efficient combined cycle gas turbine stations, decreasing iron and steel production and the implementation of methane recovery systems at landfill sites.

ES-6 OTHER INFORMATION

INTERNATIONAL AVIATION AND MARITIME TRANSPORTATION

GHG emissions from international aviation increased by 115 % between 1990 and 2016. GHG emissions from international shipping increased by 33 % during the same period. For the first time in 2015, emissions from international aviation overtook emissions from international shipping. In 2016 international aviation accounted for 149 million tonnes CO_2 equivalent and international shipping for 147 million tonnes CO_2 equivalent.

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

INFORMATION ON RECALCULATIONS

According to UNFCCC Reporting Guidelines, the inventory for the whole time series should be estimated using the same methodologies, and the underlying activity data and emissions factors should be used in a consistent manner, ensuring that changes in emissions trends are not introduced as a result of changes in estimation methods. Thus, recalculations of past emissions data occur every year based on GHG inventory improvements by Member States, and should ensure the consistency of the time series and be carried out to improve the accuracy and/or completeness of the inventory.

Based on EU Member States' GHG inventories in 2018, total EU GHG emissions (excluding LULUCF) for 2015 were 0.2 % higher than those reported in the 2017 GHG inventories. Total EU emissions in 1990, reported in 2018 GHG inventories, were 0.1 % higher than the 1990 emissions reported in 2017 inventories.

For detailed information on recalculations see Chapter 10 and the sector-specific recalculations in the sectoral chapters of the main report.

PART 1: ANNUAL INVENTORY SUBMISSION (EU-28)

1 INTRODUCTION TO THE EU GREENHOUSE GAS INVENTORY

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 years between 1990 and the current calendar year (t) minus two (t-2), for emissions and removals within the area covered by its Member States (i.e. emissions taking place within its territory).

The present report is the official inventory submission of the European Union for 2018 under the UNFCCC and the Kyoto Protocol (KP).

The EU, its Member States and Iceland have agreed to fulfil their quantified emission limitation and reduction commitments under Article 3 of the Kyoto Protocol for the second commitment period to the Kyoto Protocol jointly, in accordance with the provisions of Article 4 thereof. The Union, its Member States and Iceland agreed to a quantified emission reduction commitment that limits their average annual emissions of greenhouse gases during the second commitment period to 80 % of the sum of their base year emissions, which is reflected in the Doha Amendment. Article 4 of the Kyoto Protocol requires parties that agree to fulfil their commitments under Article 3 of the Kyoto Protocol jointly to set out in the relevant joint fulfilment agreement the respective emission level allocated to each of the parties. Council Decision (EU) 2015/1339 sets out the terms of the joint fulfilment agreement as well as the respective emission levels of each Party to that agreement. The emission levels define the Member States' and Iceland's assigned amounts for the second commitment period. These emission levels have been determined on the basis of the existing Union legislation for the period 2013-2020 under the 'Climate and Energy package'.

This report, therefore, refers to the totals of the EU-28 plus Iceland. For reasons of clarity, please note that in some cases the terms '(EU-28) Member States' and 'EU-28'/'EU' may be used. As a general rule, these terms also refer to Iceland.

The EU should not be held liable for any remaining errors caused by the CRF Reporter in the review of the information submitted.

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. As the data used in the EU inventory are the aggregation of the scope-relevant data of the Member States inventories, the detailed sectoral methodologies used in the EU inventory are fully consistent with the methodologies reported by the Member States to the UNFCCC. As such, the complete details on the methodologies used by the Member States are available in the national inventory reports of the Member States, which are submitted to the UNFCCC and published in the UNFCCC website. To facilitate the work of the expert review teams during the annual UNFCCC review process, and as follow up to previous review recommendations, the EU submission in 2018 includes an Annex (Annex III) with a summary description of the methodologies used by each Member State for the EU key categories. The more detailed descriptions can be found in Member State's own submissions. Note that all Member States' submissions (common reporting format (CRF) tables and inventory reports), are considered to be part of the EU inventory. 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 Regulation (EU) No 525/2013 of the European Parliament and of the Council of 21 May 2013 on a mechanism for monitoring and reporting greenhouse gas emissions and for reporting other information at other information at national and Union level relevant to climate change and repealing Decision No 280/2004/EC[3] (hereafter referred to as the Monitoring Mechanism Regulation or MMR). Decision No 280/2004/EC has been revised in

[3] OJ L 165, 18.06.2013, p. 13.

order to enhance the reporting rules on GHG emissions to meet requirements arising from current and future international climate agreements as well as the 2009 EU Climate and energy package. 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 emissions from the combustion of fossil fuels.

The EU-28 Member States are: Austria, Belgium, Bulgaria, Croatia, Cyprus, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden and the United Kingdom. Croatia is the newest Member State and accessed the EU in July 2013. Even though not all Member States were part of the European Union in 1990, GHG emissions in the EU are time-series consistent since 1990 and account for all sources and sinks of the current 28 EU MS.

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 EU GHG Monitoring Mechanism Regulation, 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, and with respect to EU legislation for reduction of GHG emissions[4]. 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 used for the evaluation of actual progress.

The legal basis of the compilation of the EU inventory is the MMR. The MMR establishes a mechanism for inter alia: (1) ensuring the timeliness, transparency, accuracy, consistency, comparability and completeness of reporting by the Union and its Member States to the UNFCCC Secretariat; (2) reporting and verifying information relating to commitments of the Union and its Member States pursuant to the UNFCCC, to the Kyoto Protocol and to decisions adopted thereunder and evaluating progress towards meeting those commitments; (3) monitoring and reporting all anthropogenic emissions by sources and removals by sinks of greenhouse gases not controlled by the Montreal Protocol on substances that deplete the ozone layer in the Member States; (4) monitoring, reporting, reviewing and verifying greenhouse gas emissions and other information pursuant to Article 6 of Decision No 406/2009/EC; (5) evaluating progress by the Member States towards meeting their obligations under Decision No 406/2009/EC.

Under the provisions of Article 7 of the MMR, 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 I of the MMR (same as in Annex A to the Kyoto Protocol) for the year X-2, in accordance with UNFCCC reporting requirements

[4] Decision No 406/2009/EC of the European Parliament and of the Council of 23 April 2009 on the effort of Member States to reduce their greenhouse gas emissions to meet the Community's greenhouse gas emission reduction commitments up to 2020 (OJ L 140, 05.06.2009, p.136).

- data in accordance with UNFCCC reporting requirements on their anthropogenic emissions of carbon moNOxide (CO), sulphur dioxide (SO_2), nitrogen oxides (NO_x) and volatile organic compounds, for the year X-2
- their anthropogenic greenhouse gas emissions by sources and removals of CO_2 by sinks resulting from LULUCF, for the year X-2, in accordance with UNFCCC reporting requirements
- any changes to the information referred to in points above relating to the years between 1990 and the year three-years previous (year X – 3);
- information from their national registry on the issue, acquisition, holding, transfer, cancellation, retirement and carry-over of AAUs, RMUs, ERUs, CERs, tCERs and lCERs for the year X-1;
- 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.

Submissions of updated or additional inventory data and complete national inventory reports by Member States shall be reported by 15 March.

Specific requirements on structure, format, submission processes under the MMR are detailed in an implementing Act since June 2014[5]. According to the MMR and its implementing decision the reporting requirements are exactly the same as for the UNFCCC, regarding content and format. The EU and its Member States prepare the inventory according to the relevant provisions under the UNFCCC.

1.2 A description of the institutional arrangements

1.2.1 Institutional, legal and procedural arrangements

In accordance with the MMR Article 6(1), a Union Inventory system is established to ensure the timeliness, transparency, accuracy, consistency, comparability and completeness of national inventories with regard the Union greenhouse gas inventory. The Commission's Staff Working Document (SWD (2013) 308 final[6]) outlines the main elements of the Union inventory system. An overview is presented in Figure 1.1.

The Directorate General Climate Action of the European Commission has overall responsibility for 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) [7].

[5] Commission Implementing Regulation (EU) No 749/2014 of 30 June 2014 on structure, format, submission process and review of information reported by Member States pursuant to Regulation (EU) No 525/2013 of the European parliament and of the Council (OJ L 203, 11.07.2014, p.23).

[6] https://ec.europa.eu/clima/sites/clima/files/strategies/progress/monitoring/docs/swd_2013_308_en.pdf

[7] 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.

Figure 1.1 Inventory system of the European Union

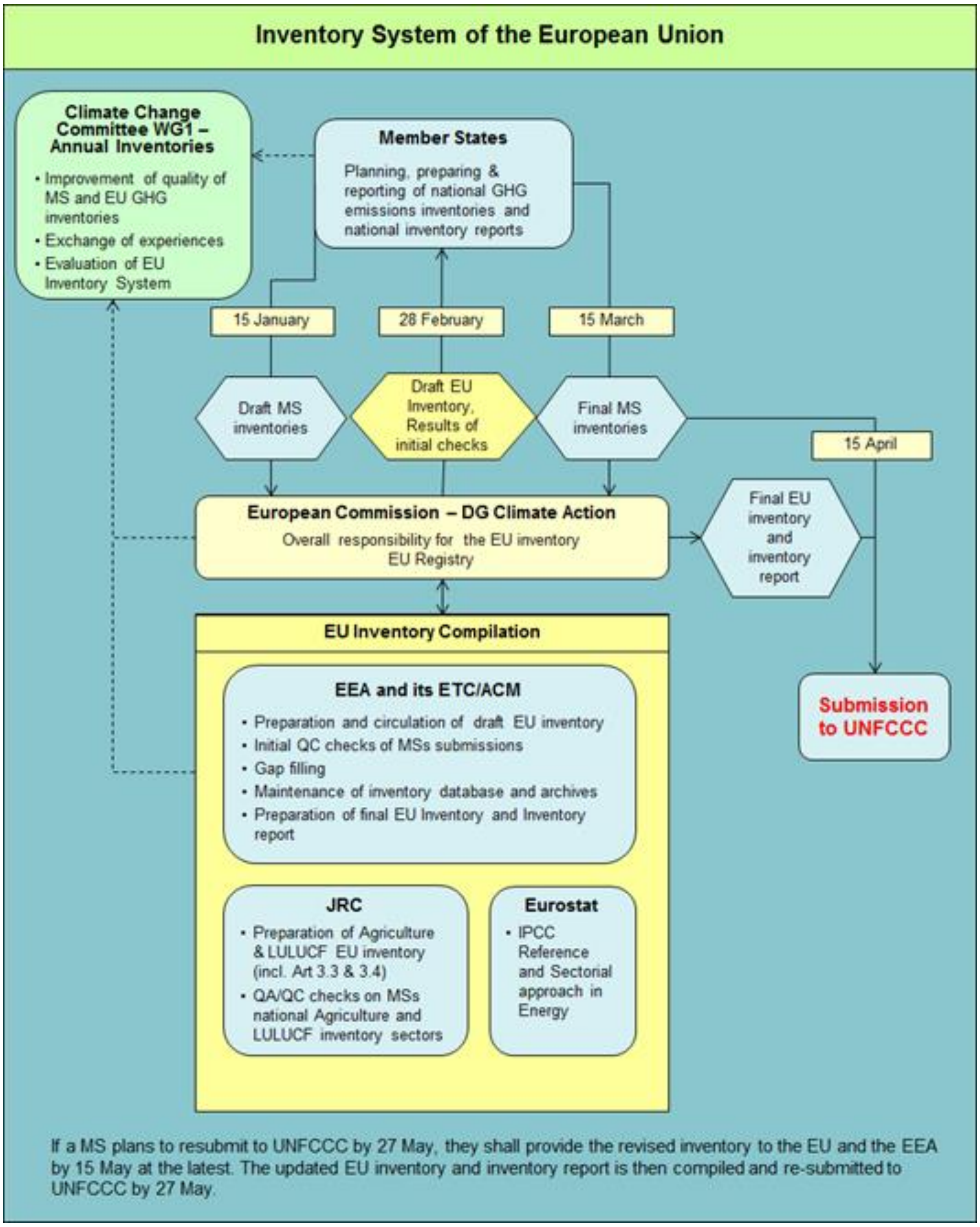


Table 1.1 shows the main institutions and persons involved in the compilation and submission of the EU inventory.

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
Austria	Elisabeth Rigler Umweltbundesamt elisabeth. rigler@umweltbundesamt.at

Member State/EU institution	Contact address
Belgium	Laurence de Clock (NFP) Federal Service of Climate Change - DG Environment (FPS Health) Laurence.declock@environment.belgium.be Olivier Biernaux (NIC) Belgian Interregional Environment Agency (IRCEL-CELINE)
Bulgaria	Detelina Petrova Executive Environment Agency dpetrova@moew.government.bg
Croatia	Ms Iva Švedek Ekonerg - Energy and Environmental Protection InstituteMs Vlatka Palčić Ministry of Environment and Energy vlatka.palcic@mzoe.hr Ms Tatjana Obučina Croatian Agency for the Environment and Nature Tatjana.obucina@haop.hr
Cyprus	Theodoulos Mesimeris Department of Environment tmesimeris@environment.moa.gov.cy
Czech Republic	Ing. Eva Krtkova Czech Hydrometeorological Institute (CHMI) eva.krtkova@chmi.cz
Denmark	Ole-Kenneth Nielsen Aarhus University okn@envs.au.dk
Estonia	Cris-Tiina Türkson Estonian Environmental Research Centre Adviser Cris-Tiina.Turkson@klab.ee Katre Kets Ministry of the Environment Adviser, Climate and Radiation Department Katre.Kets@envir.ee
Finland	Riitta Pipatti Statistics Finland riitta.pipatti@stat.fi
France	Pascale Vizy Ministère de l'Environnement, de l'Energie et de la Mer (MEEM) Pascale.VIZY@developpement-durable.gouv.fr Jean-Pierre Chang Centre Interprofessionel Technique d'Etudes de la Pollution Atmosphérique (CITEPA) jean-pierre.chang@citepa.org
Germany	Michael Strogies Federal Environmental Agency michael.strogies@uba.de
Greece	Mr. Kyriakos Psychas Ministry of Environment and Energy k.psychas@prv.ypeka.gr
Hungary	Mr. Gábor KIS-KOVÁCS Hungarian Meteorological Service kiskovacs.g@met.hu
Ireland	Paul Duffy Environmental Protection Agency p.duffy@epa.ie
Italy	M. Contaldi, R. de Lauretis, D. Romano

Member State/EU institution	Contact address
	National Environment Protection Agency (ANPA) riccardo.delauretis@isprambiente.it, daniela.romano@isprambiente.it
Latvia	Agita Gancone Ministry of Environmental Protection and Regional Development agita.gancone@varam.gov.lv
Lithuania	Ms. Jolanta Merkeliene, Climate Change Policy Division of the Ministry of Environment Lithuanian Ministry of Environment j.merkeliene@am.lt
Luxembourg	Eric De Brabanter Département de l'Environnement Ministère du Développement durable et des Infrastructures eric.debrabanter@mev.etat.lu Dr Marc Schuman Administration de l'Environnement marc.schuman@aev.etat.lu
Malta	Saviour Vassallo Malta Resources Authority saviour.vassallo@mra.org.mt
Netherlands	Wim van der Maas National Institute for Public Health and the Environment wim.van.der.maas@rivm.nl
Poland	Anna Olecka National Centre for Emissions Management Institute of Environmental Protection - National Research Institute anna.olecka@kobize.pl
Portugal	Eduardo Santos Agência Portuguesa do Ambiente, Departamento de Alterações Climáticas (DCLIMA)
Romania	Sorin Deaconu National Environmental Protection Agency sorin.deaconu@anpm.ro
Slovakia	Milos Grajcar Ministry of the Environment of the Slovak Republic Climate Change Department (National Focal Point) and Janka Szemesova Department of Emissions, Slovak Hydrometeorological Institute janka.szemesova@shmu.sk
Slovenia	Tajda Mekinda Majaron Environmental Agency of the Republic of Slovenia tajda.mekinda-majaron@gov.si
Spain	Martin Fernandez Diez-Picazo Dirección General de Calidad y Evaluación Ambiental y Medio Natural Ministerio de Agricultura y Pesca, Alimentación y Medio Ambiente
Sweden	Johan Kristensson The Ministry of the Environment and Energy, Frida Löfström The Swedish Environmental Protection Agency frida.lofstrom@naturvardsverket.se
United Kingdom	Roger Littlewood Green Finance and Emissions Reporting Team, Department of Business, Energy and Industrial Strategy roger.littlewood@beis.gov.uk

Member State/EU institution	Contact address
European Commission	Ana Maria Danila European Commission, DG Climate Action Ana.DANILA@ec.europa.eu
European Environment Agency (EEA)	Ricardo Fernandez, Claire Qoul European Environment Agency Ricardo.Fernandez@eea.europa.eu, Claire.Qoul@eea.europa.eu,
European Topic Centre on Air Pollution and Climate Change Mitigation (ETC/ACM)	Nicole Mandl, Michael Gager, Elisabeth Rigler European Topic Centre on Air Pollution and Climate Change Mitigation Environment Agency Austria nicole.mandl@umweltbundesamt.at, michael.gager@umweltbundesmat.at
Eurostat	Michael Goll Statistical Office of the European Communities (Eurostat), Michael.Goll@ec.europa.eu
Joint Research Centre (JRC)	Giacomo Grassi, Adrian Leip Joint Research Centre, Institute for Environment and Sustainability, Climate Change Unit Giacomo.GRASSI@ec.europa.eu, Adrian.LEIP@ec.europa.eu

1.2.1.1 The Member States

All EU Member States are Annex I parties to the UNFCCC Therefore, all Member States have committed themselves to prepare individual national GHG inventories in accordance with UNFCCC reporting guidelines and to submit those inventories to the UNFCCC secretariat by 15 April.

In this context, all Member States are required to establish, operate and seek to continuously improve national inventory systems in accordance to Article 5 of the MMR. Detailed information on institutional arrangements/national systems of each Member State is included in the respective national inventory reports.

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 2006 IPCC Guidelines. 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.

For the EU to be able to provide the GHG inventory to the UNFCCC on time, all Member States are required to report individual GHG inventories prepared in accordance with UNFCCC reporting guidelines to the European Commission and to the European Environment Agency (EEA) by 15 January every year.

After the submission of national GHG inventories and inventory reports, QA/QC checks are performed by the EU team. The outcome of these 'initial checks', together with the draft EU inventory report is sent to Member States for checking, reviewing and providing of comments. The Member States take part in the review and comment phase of the draft EU inventory report. 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, answer to the initial checks findings and send updates, as relevant by the 15th March. In addition, they can comment on the general aspects of the EU inventory report by the same deadline.

During the UNFCCC review of the Union inventory, Member States are also required to provide answers related to the issues under their responsibility as soon as possible. In these cases, the issues are forwarded directly as requested by the EU team.

The inventory authorities of the Member States take part in the Working Group 1 'Annual Inventories' (WG1) of the Climate Change Committee established under the MMR. The purpose of the Climate Change Committee is to assist the European Commission in its tasks under the MMR. Information on the WG1 tasks and responsibilities can be found in the next paragraph, but the main task of the WG1 members is to ensure the coordination of inventory activities between the Union system and the national inventory systems.

1.2.1.2 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 the Monitoring Mechanism Regulation 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, on behalf of the European Union. In the actual compilation of the EU inventory and inventory report, the European Commission, DG Climate Action, is assisted by the EEA including the EEA's 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 26 of the MMR. 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, working groups have been established, one of which is Working Group 1 on 'Annual inventories'. 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.

1.2.1.3 The European Environment Agency

Under MMR Article 24 the role of the European Environment Agency (EEA) is defined as providing assistance to the Commission in its work. In relation to the inventories, this assistance includes the following:

(a) Compilation of the Union greenhouse gas inventory and preparation of the Union greenhouse gas inventory report;
(b) Performance of the quality assurance and quality control procedures for the preparation of the Union greenhouse gas inventory;
(c) Preparation of estimates for data not reported in the national greenhouse gas inventories;
(d) Conduction of the reviews of MS inventories.

The tasks of the EEA 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[8] (see http://eionet.eea.europa.eu). Member States report the information reported pursuant to Article 7 of the MMR to the Commission with a copy to the European Environment Agency, and for this reason they are making use of the EEA's ReportNet's Central Data Repository under the Eionet ('CDR', see http://cdr.eionet.europa.eu/).

[8] EEA member countries include the EU Member States, Iceland, Liechtenstein, Norway, Switzerland and Turkey.

Apart from the data capturing processes, and as part of its responsibility to compile the GHG inventory and prepare the Union GHG inventory report, the EEA is also responsible for the implementation of the QA/QC Programme of the EU, by performing inter alia a number of QA/QC checks focused on ensuring the completeness and consistency of the Union and Member States inventories.

Finally, in the end of the process the EEA is publishing the GHG inventory dataset and the EU National Inventory Report on its website. To facilitate the access of the GHG information to the general public, the EEA data viewer is also provided.

The EEA is further assisted by its European Topic Centre on Air Pollution and Climate Change Mitigation (ETC/ACM), which is an international consortium working with the EEA under a framework partnership agreement. The activities of the EEA's ETC/ACM are further deployed in the next paragraph.

1.2.1.4 The European Topic Centre on Air Pollution and Climate Change Mitigation

The EEA's 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 2014-2018. The EEA's ETC/ACM involves 14 organisations and institutions in eight European countries. The technical annex for the 2014 work plan for the EEA's ETC/ACM and an implementation plan specify the specific tasks of the EEA's ETC/ACM partner organisations with regard to the preparation of the EU inventory. Environment Agency Austria is the task leader for the compilation of the EU annual inventory in the EEA's ETC/ACM. The specific tasks undertaken by EEA's ETC/ACM include:

- Initial QA/QC checks of Member States' submissions in cooperation with Eurostat, and the JRC, up to 28 February documented in the EEA review tool and compilation of results from initial checks (status and consistency reports);
- consultation with Member States in order to clarify data and other information provided;
- preparation 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);

The EEA's ETC/ACM provides the CRF Aggregator developed to ensure the EU submission is fully consistent with member state's (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.

1.2.1.5 Eurostat

Eurostat collects national energy statistics reported under the EU Energy Statistics Regulation on an annual basis. These data are used for the estimation of the IPCC Reference Approach and the Sectoral Approach. The EEA compares the results of the two approaches with MS CRF submissions. These comparisons are sent to MS during the consultation on the Draft EU GHG inventory by 28 February. The Energy Statistics Regulation (Regulation EC/1099/2008) as amended by Commission Regulation (EU) No 147/2013 of 13 February 2013 is the basis for MS reporting of energy data to Eurostat. Article 6(2) of the Energy statistics regulation stipulates: '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'. The consistency of energy balances and CRF activity data is essential for good quality GHG estimates in the energy sector, and therefore it is at the core of the QA/QC activities at EU level.

1.2.1.6 Joint Research Centre

The Joint Research Centre (JRC) performs the QA/QC of the LULUCF and Agriculture sectors and is responsible of the writing of the respective chapters. The QA/QC main activity is the annual checking of early versions of the each national GHG inventory. Focus is on errors and inconsistencies, with numerous interactions with national representatives for clarifications and improvements. Specific completeness and consistency checks are also carried out. For LULUCF, additional efforts to help member states in improving their reporting include annual technical workshops (http://forest.jrc.ec.europa.eu/activities/lulucf/workshops/), dedicated EU-funded projects, the AFOLU database, and a forest growth model whose results which may be used by countries to compare with their estimates. More information is provided in the QAQC sections of the LULUCF and Agriculture chapters.

1.2.2 Overview of inventory planning, preparation and management

1.2.2.1 A description of the process of inventory preparation

The annual process of compilation of the EU inventory is summarised in Table 1.2 . The Member States submit their annual GHG inventory by 15 January each year to the European Commission's DG Climate Action using the EEA's ReportNet Central Data Repository. Then, EEA's 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 developed 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. Any information reported by MS in categories that do not have standardized UIDs or in categories for which several country settings are possible have to be included in the CRF Reporter manually.

Table 1.2 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 7(1) of Regulation (EU) No 525/2013 and Article 3 of the implementing regulation (EU) No 749/2014
2. 'Initial checks' of Member States submissions	Commission (incl. Eurostat, the JRC), assisted by the EEA	For the Member State submission from 15 January at the latest until 28 February	Initial checks and consistency checks (by EEA). Comparison of energy data provided by Member States in the CRF with Eurostat energy data (sectoral and reference approach) by Eurostat and EEA. Check of Member States' agriculture and land use, land- use change and forestry (LULUCF) inventories by JRC (in consultation with Member States). The findings of the initial checks will be documented.
3. Compilation of draft EU inventory	Commission (incl. Eurostat, the JRC), assisted by the EEA	up to 28 February	Draft Union inventory and inventory report (compilation of Member State information), based on Member State inventories and additional information where needed (as submitted on 15 January).
4. Circulation of 'initial check' findings including notification of potential gap-filling	Commission (DG Climate Action) assisted by the EEA	28 February	Circulation of 'initial check' findings including notification of potential gap-filling and making available the findings
5. Circulation of draft **Union** inventory and inventory report	Commission (DG Climate Action) assisted by the EEA	28 February	Circulation of the draft Union inventory on 28 February to Member States. Member States check data.

Element	Who	When	What
6. 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 national inventory reports.
7. Member State commenting on the draft Union inventory	Member States	15 March	If necessary, provide corrected data and comments to the draft Union inventory
8. Member State responses to the 'initial checks'	Member States	15 March	Member States respond to 'initial checks' if applicable.
9. Circulation of follow-up initial check findings	Commission assisted by EEA 31 March	Commission assisted by EEA 31 March	Circulation of follow-up initial check findings and making available the findings
10. 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.
11. Comments from Member States regarding the Commission estimates for missing data	Member States	7 April	Member States provide comments on the Commission estimates for missing data, for consideration by the Commission.
12. Member States responses to follow-up 'initial checks'	Member States	7 April	Member States provide responses to follow up of 'initial checks'.
13. Member States submissions to the UNFCCC	Member States	15 April	Submissions to the UNFCCC (with a copy to EEA)
14. Final annual Union inventory (incl. EU inventory report)	Commission (DG Climate Action) assisted by EEA	15 April	Submission to UNFCCC of the final annual Union inventory.
15. Any resubmissions by Member States	Member States	By 8 May	Member States provide to the Commission the resubmissions which they submit to the UNFCCC secretariat. The Member States must clearly specify which parts have been revised in order to facilitate the use for the Union resubmission. Resubmissions should be avoided to the extent possible. As the Union resubmission also has to comply with the time-limits specified in the guidelines under Article 8 of the Kyoto Protocol, the Member States have to send their resubmission, if any, to the Commission earlier than the period foreseen in the guidelines under Article 8 of the Kyoto Protocol, provided that the resubmission corrects data or information that is used for the compilation of the Union inventory.
16. **Union** inventory resubmission in response to Member States' resubmissions		27 May	If necessary, resubmission to UNFCCC of the final annual Union inventory.
17. 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.

By 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 Member States' UNFCCC submissions.

The final EU GHG inventory and inventory report is prepared by the EEA's 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 8 May, Member States provide to the Commission any resubmission in response to the UNFCCC initial checks which affect the EU inventory, in order to guarantee that the EU resubmission to the UNFCCC Secretariat is consistent with the Member States' resubmissions. By the end of May 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 service (http://www.eea.europa.eu/data-and-maps/data/national-emissions-reported-to-the-unfccc-and-to-the-eu-greenhouse-gas-monitoring-mechanism-9) and the EEA GHG data viewer

(http://www.eea.europa.eu/data-and-maps/data/data-viewers/greenhouse-gases-viewer.

Table 1.3 summarises timeliness and completeness of the EU-28 and Iceland submissions in 2018 that were taken into account for the compilation EU GHG inventory.

Table 1.3 Date, mode and content of submission of EU-28 Member States and Iceland in 2018 that were taken into account for the compilation of EU GHG inventory

MS	Date	Submission mode	XML	CRF	NIR
AUT	12.04.2018	CDR	AUT_2018_3_10042018_19165433493930198398 05825.xml	1990-2016	x
BEL	13.04.2018	CDR	BEL_2018_2_13042018_01023449198979302515 40309.xml	1990-2016	x
BGR	16.04.2018	CDR	BGR_2018_1_13042018_08100476993530677513 86745.xml	1988-2016	x
CYP	08.05.2018	CDR	CYP_2018_8_07052018_15284517989073202679 69031.xml	1990-2016	x
CZE	12.04.2018	CDR	CZE_2018_1_06042018_15063315170437829069 11264.xml	1990-2016	x
DEU	02.05.2018	CDR	DEU_2018_1_05042018_08465441204409265011 41822.xml	1990-2016	x
DNM	15.03.2018	CDR			x
	13.04.2018	CDR	DNM_2018_2_12042018_21370741455032948860 83220.xml	1990-2016	
ESP	02.04.2018	CDR	ESP_2018_1_02042018_12520060512643996236 33505.xml	1990-2016	x
EST	07.05.2018	CDR	EST_2018_4_07052018_16062160498847281183 65920.xml	1990-2016	x
FIN	09.04.2018	CDR	FIN_2018_3_06042018_15491431697791190970 9839.xml	1990-2016	x
FRK	15.03.2018	CDR			x
FRK	07.05.2018	CDR	FRK_2018_2_13042018_06555347923981077211 60791.xml	1990-2016	
GBE	15.03.2018	CDR			x
	08.05.2018	CDR	GBE_2018_1_08052018_10300680828845897073 78949.xml	1990-2016	
GBK	15.03.2018	CDR			x
	08.05.2018	CDR	GBK_2018_2_08052018_09522468906553975453 37385.xml	1990-2016	
GRC	30.04.2018	CDR	GRC_2018_1_04042018_12430835617362163125 89109.xml	1990-2016	x
HRV	07.05.2018	CDR	HRV_2018_2_07052018_10525622624825989273 97277.xml	1990-2016	x
HUN	07.05.2018	CDR	HUN_2018_3_13042018_04303854991692646650 91328.xml	1986-2016	x
IRL	18.04.2018	CDR	IRL_2018_2_12042018_17241861882688735205 50097.xml	1990-2016	x
ITA	13.04.2018	CDR	ITA_2018_1_12042018_20370940992006584478 34393.xml	1990-2016	x
LTU	30.04.2018	CDR	LTU_2018_1_13042018_15134969257681899026 84636.xml	1990-2016	x
LUX	07.05.2018	CDR	LUX_2018_1_07052018_09141925195879524596 20798.xml	1990-2016	x
LVA	15.03.2018	CDR			x
	06.05.2018	CDR	LVA_2018_3_03052018_14110058784905742560 09077.xml	1990-2016	
MLT	12.04.2018	CDR	MLT_2018_9_12042018_00175567838415435890 18026.xml	1990-2016	x
NLD	13.04.2018	CDR	NLD_2017_6_Inventory_10042018_195605377581440318046 1957.xml	1990-2016	x
POL	15.03.2018	CDR			x
	04.05.2018	CDR	POL_2018_3_02052018_11311511427255767923 61009.xml	1988-2016	
PRT	07.05.2018	CDR	PRT_2018_3_04052018_13013223654077923985 14788.xml	1990-2016	x
ROU	07.05.2018	CDR	ROU_2018_3_07052018_11490270535184669306 02620.xml	1989-2016	x
SVK	15.03.2018	CDR			x
	02.05.2018	CDR	SVK_2018_3_02052018_16012035122440934550 44194.xml	1990-2016	
SVN	16.04.2018	CDR	SVN_2018_4_13042018_02041718192743028879 38984.xml	1986-2016	x
SWE	19.01.2018	CDR			x
	07.05.2018	CDR	SWE_2017_3_Inventory_11042018_225734804214221811972 0612.xml	1990-2016	
ISL	7.04.2018	CDR			x
	07.05.2018	CDR	ISL_2018_3_04052018_181603.xml	1990-2016	

Table 1.4 gives an overview on people involved in the compilation of the EU GHG inventory submission in 2018 and their individual responsibilities in this process.

Table 1.4 Responsibility list for the compilation of the EU GHG inventory submission in 2018

	Name	EU GHG inventory/inventory report compilation				Initial Checks			
		Overall responsibility	Project manager	Sector experts	Quality expert	Overall responsibility	QA/QC coordinator	Sector experts/ expert	Quality expert
	Ana Danila (DG Clima) Ana.DANILA@ec.europa.eu	X		Chapter 13 Changes national system	**QA NIR:** Executive summary, chapter 1	X			
	Ronald Velghe (DG Clima) ronald.velghe@ec.europa.eu			Chapter 12, Chapter 14 , EU-SEF Tables					
	Breffni Lynch (DG CLIMA) breffni.lynch@ec.europa.eu			Chapter 12, Chapter 14 , EU-SEF Tables					
	Adrian Leip (JRC) adrian.leip@ec.europa.eu			sector 3				sector 3	sector3
	Janka Szemesova (JRC) janka.szemesova@shmu.sk				**QA NIR:** sector 3			sector 3	
	Gema Carmona (JRC) gema.carmona-garcia@ec.europa.eu			sector 3				sector 3	
	Giacomo Grassi (JRC) giacomo.grassi@ec.europa.eu				**QA NIR:** sector LULUCF and KP LULUCF				LULUCF and KP-LULUCF
	Tibor Priwitzer (JRC) tibor.priwitzer@ec.europa.eu			LULUCF and KP LULUCF				LULUCF and KP LULUCF	
	Raul Abad-Vinas (JRC) raul.abad-vinas@ec.europa.eu			LULUCF and KP LULUCF				LULUCF and KP LULUCF	
	Michael Goll (Eurostat) Michael.Goll@ec.europa.eu			1A Reference approach				1A Reference approach	
EEA and ETC-ACM	Ricardo Fernandez (EEA) ricardo.fernandez@eea.europa.eu	X			**QA NIR:** Executive summary, chapter 1, trend chapter, chapter 10	X			
	Claire Qoul (EEA) claire.qoul@eea.europa.eu	X			**QA NIR:** sector 3	X			sector3
	Melanie Sporer (EEA) melanie.sporer@eea.europa.eu					X			
	Herdis Gudbrandsdottir (EEA) herdis.gudbrandsdottir@eea.europa.eu			Data checks					

Name	EU GHG inventory/inventory report compilation				Initial Checks			
	Overall responsibility	Project manager	Sector experts	Quality expert	Overall responsibility	QA/QC coordinator	Sector experts/ expert	Quality expert
Johannes Burgstaller (ETC-ACM; EAA) johannes.burgstaller@umweltbundesamt.at			uncertainties, support EAA work,					
Michael Gager (ETC-ACM; EAA) michael.gager@umweltbundesamt.at		Data manager						
Bernd Gugele (ETC-ACM, EAA) bernd.gugele@umweltbundesamt.at			1A Reference approach	**QA NIR:** sector 1			1A Reference approach	QA EAA work, QA sector 1(1A1, 1A2, 1A4, 1A5)
Nicole Mandl (ETC-ACM, EAA) nicole.mandl@umweltbundesamt.at		X	Executive summary, Chapter 1, trend chapter			X	cross-cutting issues	
Lorenz Moosmann (ETC-ACM, EAA) lorenz.moosmann@umweltbundesamt.at			2C, 2D, 2G3-2G4, 2H				2C, 2D, 2G3-2G4, 2H	sector 2 f-gases only
Henrik Neier (ETC-ACM; EAA) henrik.neier@umweltbundesamt.at			1A1, support EAA work				sector 1A1	
Marion Pinterits (ETC-ACM; EAA) marion.pinterits@umweltbundesamt.at		X	1B, 1C, Chapter 10			X	sectors 1B, 1C	
Stephan Poupa (ETC-ACM; EAA) stephan.poupa@umweltbundesamt.at			1A2, 1A4, 1A5				sectors 1A2, 1A4, 1A5	
Maria Purzner (ETC-ACM; EAA) maria.purzner@umweltbundesamt.at			2C, 2D, 2G3-2G4, 2H				2C, 2D, 2G3-2G4, 2H	sector 2 f-gases only
Günther Schmidt (ETC-ACM; EAA) guether.schmidt@umweltbundesamt.at			Data manager					
Giorgos Mellios (ETC-ACM; Emisia) giorgos.m@emisia.com			1A3 + bunkers				sectors 1A3 + bunkers	
Matina Kastori (ETC-ACM; Emisia) matina.k@emisia.com			1A3 + bunkers				sectors 1A3 + bunkers	
Barbara Gschrey (ETC-ACM; Oeko Recherche) b.gschrey@oekorecherche.de			F-gases 2E, 2F, 2G1-2				F-gases 2E, 2F, 2G1-2	
Winfried Schwarz (ETC_ACM; Oeko Recherche) w.schwarz@oekorecherche.de			F-gases 2E, 2F, 2G1-2				F-gases 2E, 2F, 2G1-2	
Kristina Warncke (ETC_ACM; Oeko Recherche) kristina.warncke@oekorecherche.de			F-gases 2E, 2F, 2G1-3				F-gases 2E, 2F, 2G1-3	

	Name	EU GHG inventory/inventory report compilation				Initial Checks			
		Overall responsibility	Project manager	Sector experts	Quality expert	Overall responsibility	QA/QC coordinator	Sector experts/ expert	Quality expert
	Margarethe Scheffler (ETC-ACM; Oeko) m.scheffler@oeko.de			sector 5				sector 5	
	Anke Herold (ETC-ACM; Oeko) a.herold@oeko.de			Chapter 3.14 Coordinate Oeko work				cross-cuttting issues	QA/QC Oeko work
	Graham Anderson (ETC-ACM; Oeko) g.anderson@oeko.de			sectors 2A, 2B				sectors 2A, 2B	
	Sabine Gores (ETC-ACM; Oeko) s.gores@oeko.de			1A3a + Aviation bunkers, comparison with Eurocontrol				1A3a + Aviation bunkers, comparison with Eurocontrol	
	Carina Zell - Ziegler (ETC-ACM; Oeko) C.Zell-Ziegler@oeko.de			1A3a + Aviation bunkers, comparison with Eurocontrol				1A3a + Aviation bunkers, comparison with Eurocontrol	
	Ralph Harthan (ETC-ACM; Oeko) r.harthan@oeko.de								sector 1 (1A3, 1B, 1C)
	Lukas Emele (ETC-ACM; Oeko) l.emele@oeko.de			EU ETS				EU ETS	
	Ils Moorkens (ETC-ACM; VITO) ils.moorkens@vito.be				**QA NIR:** sector 2				sector 2 (excl. f-gases)
	Kaat Jespers (ETC-ACM; VITO) kaat.jespers@vito.be				**QA NIR:** sector 5				sector 5

1.2.3 Quality assurance, quality control of the European Union inventory

1.2.3.1 Quality assurance and quality control procedures in the EU

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 EU QA/QC programme is established in Chapter II of the Commission's Staff Working Document (SWD(2013) 308). In the EU QA/QC programme the general responsibilities for the QA/QC are defined as follows:

- The Member States are responsible for the quality of activity data, emission factors and other parameters used for their inventories, for adherence to the IPCC methodologies and the establishment of the national QA/QC programmes. As EU Member States inventories form part of the EU inventory submission information on the individual Member States QA/QC procedures can be found in their national inventory reports.
- The European Commission (DG Clima) is responsible for setting up the QA/QC Programme, ensuring the establishment and fulfilment of its objectives and ensuring the development of a QA/QC plan.
- The EEA, together with its ETC/ACM, are responsible for the practical implementation and coordination of QA/QC procedures for the Union inventory, as well as for the archiving and documentation.

The following part focuses on QA/QC procedure at EU level.

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

- To establish quality objectives for the EU GHG inventory taking into account its specific nature of the EU GHG inventory as a compilation of MS GHG inventories:
- To implement the quality objectives in the design of the QA/QC plan defining general and specific QC procedures for the EU GHG inventory submission taking into account the specific nature of the EU GHG inventory:
- 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 submitted to the EU and covering the EU geographical area:
- to ensure the timeliness of MS GHG inventory submissions to the EU for the compilation of the EU's GHG inventory;
- to ensure the completeness of the EU GHG inventory, inter alia by implementing procedures to estimate any data missing from the national inventories, in consultation with the MS concerned;
- 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. The quality objectives are implemented via the QA/QC plan that, among others, aims at ensuring the consistency of the Union inventory with the sum of Member States inventories so that the inventory is complete in terms of both geographical and sectoral coverage. The QA/QC plan describes the quality control procedures that take place before the EU inventory compilation, for checking the consistency, completeness and correctness of the Member States inventories, as well as during the compilation of the EU GHG inventory, for ensuring the correctness of the EU data prior to its submission. 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 also included.

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 Environment Agency Austria and the implementation of the annual QA/QC procedures are coordinated by Environment Agency 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 fulfils the requirements of EN ISO/IEC 17020 (Type A); 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 and supporting processes) of the quality management system (Table 1.5).

Table 1.5 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 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 Environment Agency 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:

QUALITY CONTROL MS SUBMISSIONS

The QC activities of MS submissions include:

Completeness checks

- Check if all gases (CO_2, CH_4, N_2O, HFCs, PFCs, SF_6, NF_3) are available for all years
- Check correct use of notation keys related to completeness
  - Check categories where a MS report the notation key “NE” and where the current guidelines include methods/emission factors
  - Check categories where MS report a notation key (“NE”, “NO”, “NA”, “IE”) and >= 20 MS report emissions
  - Check categories where MS report “NE” and in the previous years they reported emissions
- Check blank cells

Time series consistency checks

- Check time series of emissions
- Check time series of implied emission factors
- Check if identical values have been used for the last two reporting years.

Comparisons of implied emission factors across Member States

Recalculations

- Check categories where MSs provide recalculations and focus on those of more than 0.05% of national total emissions for each main gas and assess if there are potential over- or underestimates (excluding the effect of GWPs).
- Explanations for recalculations also need to be checked
- Check recalculations at more detailed category level compared to submission of the same year (e.g. recalculations between 15 January submission and 15 March submission of the same year)

EU ETS

- Check of consistency/transparency of EU ETS data with the CRF

Eurostat energy data

- Check of consistency of Eurostat energy data with the CRF

Recommendations

- Check whether recommendations from earlier Union or UNFCCC reviews, have been implemented by the Member State

Potential over- and underestimations in key categories

- Assess whether there are potential overestimations or underestimations relating to a key category in a Member State’s inventory

For the communication with Member States and the documentation of the observations made by sector experts during the ‘initial checks’ phase the EEA Emission Review Tool (EMRT; https://emrt.eea.europa.eu/) is used. For this reason Member States nominations have been made to DG Clima and the EEA. The workflow in the tool allows the implementation of the ‘four-eye’ principle since the questions of the ‘sectoral experts’ are approved by the ‘quality experts’ team. Issues related to ‘completeness’, especially the ones that might need to be followed up by ‘gap filling procedures’ are also highlighted. All the issues identified in the EMRT are archived and can be accessed by the future EU sectoral and quality experts in the annual QA/QC procedures, to avoid repetition of questions on known issues.

According to the timeline provided above, the checks are performed between 15th January and 28th February.

On 28 February MS receive the EIONET/WG1 consultation package. In particular, Member States are asked to check:

1. the QA/QC findings flagged in the EMRT;
2. if the correct data/information has been included in the draft CRF tables/draft inventory report, including the information on methodologies and EFs used for the EU key categories (Annex III).

Both responses to the findings included in the EMRT and comments to the draft EU GHG inventory and inventory report are provided by latest 15 March to the EU inventory team. By that date Member States can resubmit their inventories, also correcting issues that came up in the initial checks. In order to follow up on significant issues, as provided for in the MMR, all the tools supporting the checks are re-produced and the findings in the EMRT are followed up. Between 15th March and 7th April follow-up questions and questions on new material received from MS may be asked in the EMRT,

Observations by the EU review team (first step ESD review[9]) that are not followed-up in step two and remain unresolved or partly resolved at the end of the QA/QC process in one submission year will be followed-up in the consecutive year.

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 ETC/ACM CRF aggregator database is maintained and managed by Environment Agency Austria. The new CRF Aggregator has been designed in a way that the EEA can also perform the aggregation to ensure that there is always a back-up option and minimizing the risk of not submitting to the UNFCCC.

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. These checking procedures are performed by the EEA and the results are shared with the ETC/ACM and are archived. Comments to these results are then provided and used as relevant for approving the inventory prior to its submission. All the checks are carried out for the original submission by 15 April each year and for any resubmission. Two checklists from the QA/QC manual are used for this purpose: ‘Inventory preparation/consistency’ and ‘Data file integrity’.

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’ as defined in the QA/QC manual They cover e.g. 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. Since 2014 the EU team has also been reinforced by ‘quality control’ experts who have the additional task of reviewing the content and the consistency between the CRF data and tables and the NIR.

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

[9] See explanation of annual and comprehensive review within this chapter.

should guarantee that the EU submission to the UNFCCC secretariat is consistent with the Member States UNFCCC submissions.

EU peer review

A collaborative internal review mechanism is established within the European Union such 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 through WG1 and normally 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.

In 2014, such activities included the identification of areas where inconsistent reporting between different Member States could have taken place, in cases where the 2006 IPCC Guidelines are not sufficiently clear, and discussions on how the ETS data are used in the inventories. These discussions were followed up in 2016 and 2017, after analysing the inventory reporting of the Member States and the conclusions from the UNFCCC reviews.

In 2017, a team of Member States' experts reviewed the EU GHG NIR and provided recommendations for improvements. Several of these recommendations have been implemented in the current submission, whereas others will be taken into account in future submissions. See chapter 10.4.2 for more information.

EU internal reviews (reviews under the 'Effort Sharing Decision')

Since 2012, five EU internal inventory reviews have been carried out in order to determine the emission allocations 2013-2020 for the EU internal GHG emission reduction targets for 2020 and in order to determine compliance with the ESD targets. In the climate and energy package the European Union has committed itself to reduce greenhouse gas emissions by 20% below 1990 levels by 2020. The package comprises two pieces of legislation related to GHG emissions:

1. A revision and strengthening of the Emissions Trading System (ETS), the EU's key tool for cutting emissions cost-effectively. A single EU-wide cap on emission allowances will apply from 2013 and will be cut annually, reducing the number of allowances available to businesses to 21% below the 2005 level in 2020. The free allocation of allowances will be progressively replaced by auctioning, and the sectors and gases covered by the system will be somewhat expanded.
2. An 'Effort Sharing Decision' (ESD) governing emissions from sectors not covered by the EU ETS, such as transport, housing, agriculture and waste. Under the Decision each Member State has agreed to a binding national emissions limitation target for 2020 which reflects its relative wealth. The targets range from an emissions reduction of 20% by the richest Member States to an increase in emissions of 20% by the poorest. These national targets will cut the EU's overall emissions from the non-ETS sectors by 10% by 2020 compared with 2005 levels.

The ESD sets out the 2020 emission limit of a Member State in relation to its 2005 emissions, and its emission limits from 2013 to 2020 form a linear trajectory. In accordance with Article 3.2 of the ESD, the starting point of the linear trajectory is defined as the average annual ESD emissions during 2008, 2009 and 2010 in 2009 (for Member States with positive limits under Annex II of the ESD) or in 2013 (for Member State with negative limits). The annual emission allocations shall be determined using reviewed and verified emission data. Thus, complete emission inventories for the reference years (2005, and 2008-2010) had to be available and reviewed prior to determining the annual emission allocations in 2012. In order to determine compliance with the ESD targets accurate, reliable and verified information on annual greenhouse gas emissions is needed from the inventory year 2013 onwards.

The ESD reviews are coordinated by the EEA, and are carried out in two steps: Step 1 is implemented by the EU team and makes use of the procedures available in the EU QA/QC system, taking into account both the existing quality assurance/quality control procedures for Member States' emission inventory submissions under the MMR and the separate inventory review process occurring under the UNFCCC. Step 2 is implemented by independent review teams comprising of lead reviewers and sector experts. The ESD reviews are carried out either as comprehensive review or as annual review (see separate box). Further information on the ESD review can be found in the MMR (Article 19) and its implementing act (Chapter III).

The reviews under the ESD can be seen as a more robust and consistent QA of MS GHG inventories that have led to improvements in the quality of the EU and its Member States' GHG inventory submissions to UNFCCC in the years thereafter.

Specific activities for the LULUCF sector are described under Ch. 7.10 Quality Assurance and Quality control.

Annual and comprehensive ESD review

In 2012 the first comprehensive ESD review was carried out in order to determine the emission allocations 2013-2020 for the EU internal GHG emission reduction targets 2020 and respective trajectories. All 28 Member States have been reviewed by a team of 22 reviewers.

From 2015 onwards the GHG emission inventories are reviewed annually in the context of the "ESD review". The MMR enhanced the reporting rules on GHG emissions to meet reporting requirements to the UNFCCC Secretariat and introduced requirements concerning the monitoring, reporting, reviewing and verifying of GHG emissions and other information pursuant to Article 6 of the Effort Sharing Decision.

The ESD and the MMR introduced an annual compliance cycle requiring a review of Member States' greenhouse gas inventories within a shorter time frame than the current UNFCCC inventory review to enable the use of flexibilities and the application of corrective action, where necessary, at the end of each relevant year.

Article 19 of the MMR establishes an EU-internal review process to ensure that compliance with annual GHG emission limits is assessed in a credible, consistent, transparent and timely manner. The reviewed inventory data will be used to check Member States' compliance with their annual ESD targets. There are two types of reviews: annual and comprehensive. Comprehensive reviews will be carried out in 2016 and 2022 – for all other years an annual review is carried out. The annual review consists of two steps. The first step verifies the transparency, accuracy, consistency, comparability and completeness of the national inventory data. The checks of step 1 are made by the same team that carries out the initial checks before the compilation of the EU GHG inventory. If the first step of the annual review reveals a significant issue as defined by Article 19(4) of the MMR, such as overestimations or underestimations relating to a key category in a Member State's inventory, a review team performs the second step checks of the national inventory data of this Member State to identify cases where inventory data is prepared in a manner which is inconsistent with UNFCCC guidance documentation or Union rules. Where appropriate, the review team calculates the resulting technical corrections, in consultation with the concerned Member State, to correct originally submitted estimates.

In 2015, due to the problems with the CRF reporting software the annual review had to be postponed to 2016. However, the European Commission decided to organize a trial review in order to support Member States in improving their GHG inventories and to gain experience organizing reviews and reviewing under the new guidelines. In 2015, step 1 checks were made for all 28 Member States whereas step 2 was carried out only for 18 Member States which volunteered to participate in step 2.

In April-August 2016, the second comprehensive review was carried out. All 28 Member States have been reviewed by a team of 22 reviewers. As it was not possible to carry out the ESD review in 2015 due to the problems with CRF reporter software the ESD comprehensive review 2016 has been an extended review and covered the years 2005, 2008-2010 and 2013-2014. The review considered the six GHGs CO_2, CH_4, N_2O, HFCs, PFCs, and SF_6. It did not consider NF3 because NF3 is not covered by the ESD. All sectors were considered with the exception of LULUCF; domestic and international aviation was also reviewed but no technical corrections were made because aviation is covered under the EU ETS and excluded under the ESD.

In 2017 and 2018 annual reviews have been performed. The annual review is a two steps process

where all 28 MS have to undergo step 1 and only those Ms are subject to step 2 for which significant issues are identified during step 1. In 2017 15 MS were subject to step 2.
The 3rd comprehensive review will happen in 2022.

Capacity building activities based on the ESD reviews

After the ESD review in autumn each year capacity building workshops/webinars are organized in order to discuss cases where MS had problems with implementing the 2006 IPCC guidelines and/or where the guidelines are not clear enough or where there are gaps and/or errors in the guidelines. In 2017 four webinars were organized for following the sectors Energy, IPPU, Agriculture, and Waste. Overall experts from 26 Member States + Iceland and Norway participated in the webinars. The webinar conclusions include 55 issues, 47 of which were considered to be resolved by 30 November 2017. Eight issues have been subject to follow-up activities.

UNFCCC reviews

In addition, European Union QA procedures 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 WG1, including identification and documentation of follow-up actions that are considered as necessary within WG1;
- 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.

Improvement plan

Based on the findings of the UNFCCC reviews, the EU peer review, and the EU ESD 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.

1.2.3.2 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. Sector-specific workshops are conducted under the Monitoring Mechanism that aim to address specific inventory issues and develop follow-up activities with the aim to address problems, clarify approaches and to improve the quality of Member States' inventory submissions. The follow-up activities are subsequently addressed in meetings of WG 1 under the Climate Change Committee.

A number of other workshops and expert meetings have been organised in recent years with a focus on sector-specific quality improvements. Table 1.6 lists the most recent workshops.

Table 1.6 Overview of GHG inventory related workshops and expert meetings organised by the EU national system

Workshop/expert meeting	Date and venue
Joint Workshop of the Europestat Working Group Agro-Environmental Statistics and DG CLIMA Working Group 1	30 November 2017, ESTAT Luxembourg
JRC technical LULUCF workshop under the UNFCCC, the Kyoto Protocol (KP) and the EU LULUCF Decision No 529/2013	26-27 April 2017, Stresa, Italy

Workshop/expert meeting	Date and venue
JRC technical LULUCF workshop under the UNFCCC, the Kyoto Protocol (KP) and the EU LULUCF Decision No 529/2013	02-03 May 2016, Stresa, Italy
Capacity building workshop for MS GHG inventory experts	18 February 2016, European Commission, Brussels
Three webinars to support EU MS in the calculation of aviation emissions under UNFCCC and LRTAP reporting based on EUROCONTROL data	November 2017,
JRC technical workshop on LULUCF reporting under the Kyoto Protocol,	26-27 May 2015 Arona (NO) Italy.
Improving national GHG inventories for the agriculture sector	5 Nov 2014, Seventh International Symposium on Non-CO_2 GHG (NCGG7), Amsterdam
JRC technical workshop on LULUCF reporting under the Kyoto Protocol,	05-07 May 2014, Arona (NO), Italy.
II JRC technical workshop on LULUCF reporting under the Kyoto Protocol,	04-06 November 2013, Arona (NO), Italy.
Energy balances, ETS and CRF activity data	27-28 June 2013, Eurostat, Luxembourg
Improvement of Fluorinated-gas inventories	21 May 2013, EEA, Copenhagen
LULUCF and KP-LULUCF technical workshop	27 February – 01 March 2013, JRC, Ispra
ESD capacity building workshop 2015	18 February, Brussels
ESD capacity building webinars 2016	4 October (IPPU); 5 October (Energy); 7 October; 10 October (Waste)
ESD capacity building webinars 2017	19 September (IPPU); 21 September (Energy); 25 September; 28 September & 6 November (Waste)
Joint workshop of the Eurostat Working Group Agro-Environmental Statistics and DG CLIMA Working Group 1	30 November 2017, Luxembourg

Most of the workshop reports are available at the website of the EEA/ETC-ACM: http://acm.eionet.europa.eu/meetings/past_html

LULUCF workshops organized by Joint Research Center of the European Commission are all available at http://forest.jrc.ec.europa.eu/activities/lulucf/workshops/

1.2.4 Changes in the national inventory arrangements since previous annual GHG inventory submission

There have been no major changes to the structure and functioning of the EU national inventory arrangements.

1.3 Inventory preparation and data collection, processing and storage

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/CP/2013/10/Add.3), to the extent possible. In addition, the *2006 IPCC guidelines for national greenhouse gas inventories* have been applied where appropriate and feasible. Finally, for the compilation of the EU GHG inventory, the Monitoring Mechanism Regulation and its implementing legislation is applicable.

The EU-28 GHG inventory is compiled on the basis of the inventories of the 28 Member States. The emissions of each source category are the sum of the emissions of the respective source and sink categories of the 28 Member States. For the reporting under the KP, this is also valid for the base year estimate of the EU-as fixed in the initial review report. As the information the initial report for the CP2 has not been included by the time of writing this report, this information cannot be provided yet.

The reference approach is calculated for the EU-28 on the basis of Eurostat energy data (see Section 3.6) and the key category analysis (Section 1.5) is separately performed at EU-28 level[10].

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 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. The EU submission in 2016 includes an Annex with a summary description of the methodologies used by each Member State for the EU key categories. The more detailed descriptions can be found in Member State's own submissions, which are considered to be part of the EU inventory.

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-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-28 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 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" or in categories that do not have standardized UIDs which then need to be included in the CRF reporter manually.

Table 1.7 lists the procedures applied for the EU-28 and Iceland.

[10] 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 1.7 Manual changes in the CRF Reporter

Year	Sector	Source category	Parameter	Manual changes/inclusion in the CRF Reporter
1990-2016	Energy	1.AB, 1.AC, 1.AD	all	Enter Reference Approach data from EUROSTAT
2013-2016	Energy	2.C.7, 2.H.1, 1.A.1, 1.A.2, 1.B.2	CO_2, CH_4, N_2O, CO	Shift differences due to SE confidential data into 'Other fossil fuels' within the same sub-category, if 'All fuels' values are provided. Shift differences due to SE confidential data into 'Other' sub-category if 'All fuels' values are not provided for 2 or more sub-categories.
1990-2016	IPPU	2.B, 2.C, 2.E, 2.F, 2.G, 2.H	f-gases	Enter country-specific f-gases
1990-2016	IPPU		all	Enter user-specific data from MS to solve difference between EU totals and sum of MS
1990-2016	Agriculture	3	CH_4, N_2O, NMVOC	Enter aggregated data from JRC: Option A - Option B - Option C
1990-2016	Agriculture	3.B.2.2, 3.B.2.3	AD	Correct addition information with aggregated data from JRC
1990-2016	LULUCF	4.G	all	Enter aggregated data for Approach A (consumed) - Approach B (harvest) - Approach C
1990-2016	KP.LULUCF		all	Incorporate aggregated data and comments by JRC
2016	IPPU	2.A, 2.B	AD	Replace aggregated AD data with gap-filled AD data provided by SE
1990-2016	IPPU	2.A, 2.B, 2.C, 2.D, 2.G	AD	Replace aggregated AD data with notation key 'NE' if an aggregation makes no sense due to inhomogeneous AD
2016	Waste	5.A, 5.B, 5.C	AD	Replace aggregated AD data with gap-filled AD data provided by SE
2016	Waste	5.A, 5.B, 5.C	AD	Replace aggregated AD data with notation key 'NE' if an aggregation makes no sense due to inhomogeneous AD

1.3.2 Documentation and archiving

The documentation consists of quality management documentation in forms, checklists, inventory reports and correspondence. Archiving includes archiving of inventory documents and QM documents; a systematic archiving procedure is a prerequisite for a transparent inventory system.

All the material used for the compilation of the EU GHG inventory including inventory documents and QM documents are posted in the following directory:

\\Umweltbundesamt.at\projekte\1000\1840_ETC_ACC\Intern\0 ETC ACM 2016\1.3.1.1 EU Data Capture GHG and Inventory Report

There are four sub-directories under this directory:

1. \Inventory
2. \Archive
3. \Quality manual
4. \General

The Member States submissions and all correspondence are stored in the sub-directory\Archive. The central tool for documenting all the material received from MS (including correspondence) is the MS archive database which includes references, short characterisations and links to e-mails for all MS submissions. The MS archive database can be searched for documents (CRF, XML, NIR, etc.) or for mails. Each submission is numbered consecutively.

1.4 Brief general description of methodologies and data sources used

For the key categories (see Chapter 1.5) the most accurate methods for the estimation of the greenhouse gas inventory should be used. Table 1.8 gives an overview on the share of higher tiers used in the EU 28 and Iceland for all key categories for which this estimation was possible.

Table 1.8 Share of higher tier methodologies used on the total of each EU key categories (excl. LULUCF)

Source category gas	**share of higher Tier**
1.A.1.a Public Electricity and Heat Production: Gaseous Fuels (CO_2)	93.8%
1.A.1.a Public Electricity and Heat Production: Liquid Fuels (CO_2)	94.7%
1.A.1.a Public Electricity and Heat Production: Other Fuels (CO_2)	97.3%
1.A.1.a Public Electricity and Heat Production: Peat (CO_2)	96.7%
1.A.1.a Public Electricity and Heat Production: Solid Fuels (CO_2)	95.8%
1.A.1.b Petroleum Refining: Gaseous Fuels (CO_2)	98.3%
1.A.1.b Petroleum Refining: Liquid Fuels (CO_2)	93.3 %
1.A.1.b Petroleum Refining: Solid Fuels (CO_2)	94.6%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries: Gaseous Fuels (CO_2)	86.9%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries: Solid Fuels (CO_2)	96.9%
1.A.2.a Iron and Steel: Gaseous Fuels (CO_2)	81%
1.A.2.a Iron and Steel: Liquid Fuels (CO_2)	85%
1.A.2.a Iron and Steel: Solid Fuels (CO_2)	92%
1.A.2.b Non-Ferrous Metals: Gaseous Fuels (CO_2)	87%
1.A.2.b Non-Ferrous Metals: Liquid Fuels (CO_2)	80%
1.A.2.b Non-Ferrous Metals: Solid Fuels (CO_2)	61%
1.A.2.c Chemicals: Gaseous Fuels (CO_2)	92%
1.A.2.c Chemicals: Liquid Fuels (CO_2)	93%
1.A.2.c Chemicals: Solid Fuels (CO_2)	73%
1.A.2.d Pulp, Paper and Print: Gaseous Fuels (CO_2)	94%
1.A.2.d Pulp, Paper and Print: Liquid Fuels (CO_2)	89%
1.A.2.d Pulp, Paper and Print: Solid Fuels (CO_2)	80%
1.A.2.e Food Processing, Beverages and Tobacco: Gaseous Fuels (CO_2)	88%
1.A.2.e Food Processing, Beverages and Tobacco: Liquid Fuels (CO_2)	78%
1.A.2.e Food Processing, Beverages and Tobacco: Solid Fuels (CO_2)	69%
1.A.2.f Non-metallic minerals: Gaseous Fuels (CO_2)	87%
1.A.2.f Non-metallic minerals: Liquid Fuels (CO_2)	90%
1.A.2.f Non-metallic minerals: Other Fuels (CO_2)	72%
1.A.2.f Non-metallic minerals: Solid Fuels (CO_2)	85%
1.A.2.g Other Manufacturing Industries and Constructions: Gaseous Fuels (CO_2)	96%
1.A.2.g Other Manufacturing Industries and Constructions: Liquid Fuels (CO_2)	91%
1.A.2.g Other Manufacturing Industries and Constructions: Solid Fuels (CO_2)	95%
1.A.3.a Domestic Aviation: Jet Kerosene (CO_2)	92.3 %
1.A.3.b Road Transportation: Diesel Oil (CO_2)	86.5 %
1.A.3.b Road Transportation: Diesel Oil (N_2O)	99.2 %
1.A.3.b Road Transportation: Gaseous Fuels (CO_2)	82.9 %
1.A.3.b Road Transportation: Gasoline (CH_4)	98.5 %
1.A.3.b Road Transportation: Gasoline (CO_2)	90.3 %
1.A.3.b Road Transportation: Liquefied Petroleum Gases (LPG) (CO_2)	95.9 %
1.A.3.c Railways: Liquid Fuels (CO_2)	74.6 %
1.A.3.d Domestic Navigation: Gas/Diesel Oil (CO_2)	80.4 %
1.A.3.d Domestic Navigation: Residual Fuel Oil (CO_2)	82.5 %
1.A.4.a Commercial/Institutional: Gaseous Fuels (CO_2)	83%
1.A.4.a Commercial/Institutional: Liquid Fuels (CO_2)	69%
1.A.4.a Commercial/Institutional: Other Fuels (CO_2)	97%
1.A.4.a Commercial/Institutional: Solid Fuels (CO_2)	65%
1.A.4.b Residential: Biomass (CH_4)	43%
1.A.4.b Residential: Gaseous Fuels (CO_2)	84%
1.A.4.b Residential: Liquid Fuels (CO_2)	77%
1.A.4.b Residential: Solid Fuels (CH_4)	10%

Source category gas	**share of higher Tier**
1.A.4.b Residential: Solid Fuels (CO_2)	63%
1.A.4.c Agriculture/Forestry/Fishing: Gaseous Fuels (CO_2)	54%
1.A.4.c Agriculture/Forestry/Fishing: Liquid Fuels (CO_2)	63%
1.A.4.c Agriculture/Forestry/Fishing: Solid Fuels (CO_2)	50%
1.A.5.a Other Other Sectors: Solid Fuels (CO_2)	NA
1.A.5.b Other Other Sectors: Liquid Fuels (CO_2)	NA
1.B.1.a Coal Mining and Handling: Operation (CH_4)	68%
1.B.2.a Oil: Operation (CO_2)	80%
1.B.2.b Natural Gas: Operation (CH_4)	73%
1.B.2.c Venting and Flaring: Operation (CO_2)	86%
2.A.1 Cement Production: no classification (CO_2)	100%
2.A.2 Lime Production: no classification (CO_2)	99.9%
2.A.4 Other Process Uses of Carbonates: no classification (CO_2)	NA
2.B.1 Ammonia Production: no classification (CO_2)	92%
2.B.10 Other chemical industry: no classification (CO_2)	92%
2.B.2 Nitric Acid Production: no classification (N_2O)	100%
2.B.3 Adipic Acid Production: no classification (N_2O)	100%
2.B.8 Petrochemical and Carbon Black Production: no classification (CO_2)	88%
2.B.9 Fluorochemical Production: no classification (HFCs)	100%
2.B.9 Fluorochemical Production: no classification (Unspecified mix of HFCs and PFCs)	100%
2.C.1 Iron and Steel Production: no classification (CO_2)	96 %
2.C.3 Aluminium Production: no classification (PFCs)	100 %
2.D.3 Other non energy products: no classification (CO_2)	66 %
2.F.1 Refrigeration and Air conditioning: no classification (HFCs)	95%
2.F.2 Foam Blowing Agents: no classification (HFCs)	95%
2.F.3 Fire Protection: no classification (HFCs)	95%
2.F.4 Aerosols: no classification (HFCs)	95%
3.A.1 Enteric Fermentation: Dairy Cattle (CH_4)	100%
3.A.1 Enteric Fermentation: Mature Dairy Cattle (CH_4)	100%
3.A.1 Enteric Fermentation: Non-Dairy Cattle (CH_4)	100%
3.A.1 Enteric Fermentation: Other Cattle (CH_4)	100%
3.A.2 Enteric Fermentation: Other Sheep (CH_4)	**90%**
3.A.4 Enteric Fermentation: Other livestock (CH_4)	**31%**
3.B.1 CH_4 Emissions: Farming (CH_4)	**84%**
3.B.2 N_2O and NMVOC Emissions: Farming (N_2O)	**79%**
3.D.1 Agricultural Soils: Direct N_2O Emissions From Managed Soils (N_2O)	**9%**
3.D.2 Agricultural Soils: Farming (N_2O)	**5%**
5.A.1 Managed Waste Disposal Sites: Waste (CH_4)	96 %
5.A.2 Unmanaged Waste Disposal Sites: Waste (CH_4)	100 %
5.B.1 Waste Composting: Waste (CH_4)	27 %
5.B.1 Waste Composting: Waste (N_2O)	28 %
5.D.1 Wastewater Treatment and Discharge: Domestic Wastewater (CH_4)	36 %
5.D.1 Wastewater Treatment and Discharge: Domestic Wastewater (N_2O)	15 %
5.D.2 Wastewater Treatment and Discharge: Industrial Wastewater (CH_4)	35 %

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

1.4.1.1 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, based on Directive 2003/87/EC (European Community 2003). The European emissions trading system (EU ETS) covers around 11,700 installations in 31 participating countries. Besides the 28 Member States of the European Union, Norway, Iceland and Liechtenstein joined the EU ETS in 2008.

Emissions trading under the EU ETS has taken place in three ‘trading periods’ so far (2005–2007, also referred to as Phase I; 2008–2012 or Phase II; 2013–2020 or Phase III). The EU ETS Directive was amended in 2009 to improve and extend the EU ETS. The main changes in the third trading period compared to previous trading periods are:

- A single, EU-wide cap on emissions applies in place of the previous system of national caps;

- Auctioning, not free allocation, is the default method for allocating allowances. For allowances allocated for free, harmonised allocation rules apply which are based on EU-wide benchmarks of emissions performance;

- Inclusion of additional activities and gases, such as N_2O from production of nitric, adipic, glyoxal and glyoxylic acid production, PFCs and CO_2 from primary and secondary aluminium production, CO_2 from production and processing of ferrous metals and non-ferrous metals, CO_2 from manufacture of mineral wool, CO_2 from drying and calcination of gypsum or plaster boards, CO_2 emissions from carbon back production, CO_2 from ammonia production, CO_2 from bulk organic chemicals production, CO_2 from hydrogen production, CO_2 from soda ash and sodium bicarbonate production and CO_2 from CO_2 capture, transport and storage in storage sites).

- The aviation sector has been included in the EU ETS since 1 January 2012. The aviation sector, in the EU ETS context covering flights internal to the European Economic Area, has a separate cap to power stations and other fixed installations which is reduced at a slower rate. Surrender of emission allowances and reporting for 2013 is not required until 2015, and the inclusion of flights to and from countries outside the European Economic Area has been postponed until after 31st December 2016 (EU 2014);

- Regulations for accreditation and verification (EU 2012a) and for monitoring and reporting were adopted (EU 2012b).

Articles 14 and 15 of the Emission Trading Directive require Member States to ensure that emissions are monitored, reported and verified in accordance with legal requirements in the monitoring and reporting regulation (MRR) (EU 2012b) and in the accreditation and verification regulation (AVR) (EU 2012a), starting from 1 January 2013 (Phase III). All installations covered by the EU ETS have been required to monitor and report their emissions annually. Data for the installations covered by the EU ETS are reported by operators to national competent authorities based on a monitoring plan, elaborated by the operator and approved by the national competent authority, in accordance with the methodologies established in the monitoring and reporting regulation. The reported emissions for each installation are included in an annual emission report that must be verified by accredited verifiers in accordance with the provisions of the regulation on the verification of GHG emission reports (EU 2012a).

Similar to the IPCC 2006 Inventory Guidelines, the EU ETS monitoring and reporting regulation is based on a tier system which defines a hierarchy of different ambition levels for methods, activity data, calculation factors (such as emission factors, oxidation or conversion factors). The operator must, in principle, apply the highest tier level established in the MRR for his installation category, unless he can demonstrate to the competent authority that this is technically not feasible or would lead to unreasonably high costs. The operator must periodically prepare and submit to the competent authorities an improvement report, aiming at improvement of the accuracy of the greenhouse gas emissions.

Thus, the EU ETS generates an EU-28 data set on verified installation-specific emissions for the sectors covered by the scheme. For 2016 the main activities, number of entities and verified emissions reported under the EU ETS are presented in Table 1.9 .

Table 1.9 Activities and emissions covered by the EU ETS in 2016

Main activity	**Activity code**	**Number of entities**	**Verified emissions (Mt CO_2-eq.)**
Combustion of fuels	20	7,158	1.164
Refining of mineral oil	21	137	126
Production of coke	22	21	11
Metal ore roasting or sintering	23	9	3
Production of pig iron or steel	24	244	109
Production or processing of ferrous metals	25	236	10
Production of primary aluminium	26	23	5
Production of secondary aluminium	27	35	1
Production or processing of non-ferrous metals	28	81	6
Production of cement clinker	29	259	114
Production of lime, or calcination of dolomite/magnesite	30	300	30
Manufacture of glass	31	364	18
Manufacture of ceramics	32	1,079	16
Manufacture of mineral wool	33	47	2
Production or processing of gypsum or plasterboard	34	38	1
Production of pulp	35	155	5
Production of paper or cardboard	36	597	22
Production of carbon black	37	18	2
Production of nitric acid	38	36	5
Production of adipic acid	39	3	0
Production of glyoxal and glyoxylic acid	40	1	0
Production of ammonia	41	30	22
Production of bulk chemicals	42	341	37
Production of hydrogen and synthesis gas	43	44	9
Production of soda ash and sodium bicarbonate	44	14	3
Capture of greenhouse gases under Directive 2009/31/EC	45	257	1
Other activity opted-in under Art. 24	99	0	0
All stationary installations		11,527	1.723

Source: EEA, 2018

1.4.1.2 Mapping table between EU ETS activities and CRF categories (Table 1.10)

The previous review of the EU GHG inventory recommended including in the NIR a table indicating the mapping between the EU ETS activities and the IPCC/CRF categories, with supporting comments. Such table is provided below based on the scope of the EU ETS in the third phase and the CRF categories based on the revised UNFCCC reporting guidelines (decision 24/CP.19) that implemented the 2006 IPCC Guidelines.

The legal framework defining the scope and the methodologies for the reporting of greenhouse gas emissions under the EU ETS presents differences compared to the 2006 IPCC guidelines. These differences lead to a different way of reporting emissions under the EU ETS and in the GHG inventory. Some of these differences may also prevent inventory compilers from using verified emissions reported under the EU ETS directly for emission reporting in the national GHG inventory. In order to use greenhouse gas emissions reported under the EU ETS in the national inventories, the inventory compilers need to deal with these differences.

Table 1.10 Mapping table outlining the correspondence of CRF categories related to the EU ETS activities

EU ETS activity	CRF category	Comment
20 Combustion of fuels	1.A.1.a Public electricity and heat production 1.A.1.b Petroleum refining 1.A.2.a Iron and steel 1.A.2.b Non-ferrous metals 1.A.2.c Chemicals 1.A.2.d Pulp, paper and print 1.A.2.e Food processing, beverages and tobacco 1.A.2.f Non-metallic minerals 1.A.2.g Other 1.A.3.e Other transportation (pipeline transport) 1.A.4.a Commercial/ Institutional 1.A.4.c Agriculture/ Forestry / Fisheries 1.B Fugitive emissions from fuels	• For standalone combustion installations, EU ETS covers combustion of fuels in installation with a total rated thermal input exceeding 20 MW. For GHG inventories no such threshold applies. • In the GHG inventory, emissions are classified based on the purpose of the combustion activity, while such a differentiation does not exist in the definition of EU ETS activities. • Installations for the incineration of hazardous or municipal waste are excluded in the definition of 'combustion activities' under the EU ETS, but included in GHG inventories. Installations used for research, development and testing of new products and processes are also not covered by the ETS Directive according to Annex I paragraph 1. • In the EU ETS an installation with different types of activities is classified according to the activity with predominant emissions, while in the inventory such activities should be reported in separate categories if so defined. This difference mostly applies in cases of large integrated installations. • Usually a very small share of EU ETS emission from fuel combustion falls in the category of 1.A.4.a Commercial/ Institutional and 1.a.4.c Agriculture/ Forestry/ Fisheries as installations in these sectors mostly are below the EU ETS threshold. •
21 Refining of mineral oil	1.A.1.b Petroleum refining 1.A.1.c Manufacture of solid fuels and other energy industries 1.A.2.c Chemicals 1.B.2.c Venting and flaring 1.B.2.a.iv Fugitive emissions from oil refining/ storage 2.B.8 Petrochemical and carbon black production	EU ETS activity covers CO_2 emissions from combustion and also fugitive and process emissions. Emission sources reported under these activities are allocated to different CRF categories in the inventory: • Combustion emissions →1.A.1.b Petroleum refining • Flaring emissions → 1.B.2.c Venting and flaring • Refining → 1.B.2.a.iv Oil Refining/ storage • Hydrogen production → may be reported in 1.B.2.a.iv refining/ storage or in 2.B.10 Other chemical industry • Coke production / calcination → 1.A.1.c.i

EU ETS activity	CRF category	Comment
		Manufacture of solid fuels • Flue gas scrubbing → 1.A.1.b Petroleum refining • Gasification of heavy fuel oil, methanol production → 2.B.8 Petro-chemical and carbon black production • Production of terephtalic acid → 2.B.10 Other chemical industry • Claus plants → 1.A.1.b Petroleum refining
22 Production of coke	1.A.1.c Manufacture of solid fuels and other energy industries 1.B Fugitive emissions 1.A.2 Manufacturing Industries 2.C.2 Iron and Steel	• Scopes of EU ETS and 2006 IPCC Guidelines are generally consistent, however EU ETS emissions may be allocated to several CRF categories in the inventory. • The use of mass balance approaches in integrated iron and steel installations may complicate allocation between iron and steel categories and coke production.
23 Metal ore roasting or sintering, including palletisation	1.A.2a Iron and steel 2.C.1 Iron and steel production 2.C.5 Lead production 2.C.6 Zinc production 2.C.7 Other metal production	• No clear separate category for this EU ETS activity in the inventory, allocation depends on the metal type • Combustion emissions should be allocated to 1.A.2a Iron and steel • Process emissions should be allocated to 2.C.1 Iron and steel production or other metal production categories under industrial processes
24 Production of pig iron or steel including continuous casting	1.A.2.a Iron and steel 2.C.1 Iron and steel production 1.B Fugitive emissions 1.A.1.c Manufacture of solid fuels and other energy industries	• Emissions are included in EU ETS only for those pig iron or steel installations with a capacity exceeding a threshold of 2.5 tonnes per hour while in GHG inventories there is no threshold. • EU ETS activity includes combustion and process emissions. • Combustion emissions should be allocated to 1.A.2a Iron and steel • Process emissions should be allocated to 2.C.1 Iron and steel production • Emissions from coke production should be allocated to 1.A.1.c Manufacture of solid fuels and other energy industries • Clear separation of combustion and process emissions is not always possible when mass balance approaches are used. • Comparability of emissions is influenced by the allocation of the transfer of CO_2 in the process gases (coke oven gas, blast furnace gas, basic oxygen furnace gas) to EU ETS activities as well as to CRF categories. Article 48 of the EU ETS MRR specifies the allocation of inherent CO_2 which results from an EU ETS activity and is contained in a gas which transferred to other installations as a fuel. If transfers of inherent CO_2 take place between EU ETS installations, the CO_2 transferred should not be counted as emissions for the installation of origin, but for the installation where it is finally emitted. However, if the transfer occurs to an installation outside the EU ETS scope, the transferring installation has to account for the emissions.
25 Production or processing of ferrous metals	1.A.2.a Iron and steel 2.C.1. Iron and steel production 2.C.2 Ferroalloys production 1.A.1.c Manufacture of solid	• Emissions are included in EU ETS only for those ferroalloy production installations exceeding rated thermal input of 20 MW while in GHG inventories there is no threshold. • EU ETS scope of activity 25 covers CO_2 emissions related to the production or processing

EU ETS activity	CRF category	Comment
	fuels and other energy industries	of ferrous metals from: • conventional and alternative fuels, • reducing agents including coke, • graphite electrodes, • raw materials including limestone and dolomite, • carbon containing metal ores and concentrates, • secondary feed materials. • Combustion related emissions from EU ETS activity code 25 are included in in CRF 1.A.2.a. Iron and Steel • Process related emissions can be included in CRF 2.C.1 Iron and steel production or 2.C.2. Ferroalloys Production
26 Production of primary aluminium	2.C.3 Aluminium production 1.A.2.b Non-ferrous metals	• In EU ETS operators shall report emissions from the production of electrodes for primary aluminium smelting, including stand-alone-installations for the production of such electrodes. The operator shall considerCO_2 emissions from : fuels for the production of heat or steam, electrode production, reduction of Al_2O_3 during electrolysis which is related to electrode consumption, use of soda ash or other carbonates for waste gas scrubbing. • For PFC emissions resulting from anode effects the scope of the EU ETS activity and CRF category 2.C.3 are consistent. • CRF category 1.A.2.b Non-ferrous metals includes combustion emission and emission from waste gas scrubbing. • Emissions from electrode consumption in EU ETS activity code 26 are included in CRF 2.C.3 Aluminium Production. • PFC emissions are allocated to 2.C.3 Aluminium production.
27 Production of secondary aluminium	1.A.2.b Non-ferrous metals	• Emissions are included in EU ETS only for installations exceeding rated thermal input of 20 MW while in GHG inventories there is no threshold. • In secondary aluminium production no process emissions occur therefore all emissions in activity code 27 are from fuel combustion and are reported in CRF category 1.A.2.b Non-ferrous metals.
28 Production or processing of non-ferrous metals	1.A.2.b Non-ferrous metals 2.C.4 Magnesium production 2.C.5 Lead production 2.C.6 Zinc production 2.C.7 Other metal production	• Emissions are included in EU ETS only for non-ferrous metals production or processing installations exceeding rated thermal input of 20 MW (including reducing agents) while in GHG inventories there is no threshold. • EU ETS activity includes combustion and process emissions. • Process related emissions from EU ETS activity code 28 are included in CRF 2.C.4 Magnesium Production, 2.C.5 Lead production, 2.C.6 Zinc Production and 2.C.7 Other metal industry. • 2006 IPCC Guidelines do not provide methodologies for metals other than iron and steel, ferroalloys, aluminium, magnesium, lead and zinc while the EU ETS has a broader scope and covers, e.g. copper production.

EU ETS activity	CRF category	Comment
29 Production of cement clinker in rotary kilns	2.A.1 Cement Production 1.A.2.f Non-metallic minerals	• Emissions are included in EU ETS only for installations with production capacity exceeding 500 tonnes per day or in other furnaces with capacity exceeding 50 tonnes per day. Inventory methodology has no threshold. • EU ETS activity includes combustion and process emissions. • Process related emissions from EU ETS activity code 29 are included in CRF 2.A.1 Cement Production • Combustion related emissions from ETS activity code 29 are included in CRF 1.A.2.f. Non-metallic minerals
30 Production of lime, or calcination of dolomite/magnesite in rotary kilns or in other furnaces	2.A.2 Lime production 1.A.2.f Non-metallic minerals	• Emissions are included in EU ETS only for installations with production capacity exceeding 50 tonnes per day. Inventory methodology has no threshold. • EU ETS activity includes combustion and process emissions. • Process related emissions from EU ETS activity code 30 are included in CRF 2.A.2 Lime Production • Combustion related emissions from EU ETS activity code 30 are included in CRF 1.A.2.f. Non-metallic minerals • Non-marketed lime production in some industries such as iron and steel or sugar refining are included in the inventory in category 2.A.2, but may be included in the EU ETS in the dominant activity, e.g. iron and steel industry or fuel combustion.

EU ETS activity	CRF category	Comment
31 Manufacture of glass including glass fibre	2.A.3 Glass production 1.A.2.f Non-metallic minerals	• Emissions are included in EU ETS only for installations with a melting capacity exceeding 20 tonnes per day. Inventory methodology has no threshold. • EU ETS activity includes combustion and process emissions. • Process related emissions from EU ETS activity code 31 are included in CRF 2.A.3 Glass Production • Combustion related emissions from EU ETS activity code 31 are included in CRF 1.A.2.f. Non-metallic minerals
32 Manufacture of ceramic products by firing, in particular roofing tiles, bricks, refractory bricks, tiles, stoneware or porcelain	2.A.4 Other process uses of carbonates 1.A.2.f Non-metallic minerals	• Emissions are included in EU ETS only for installations with a production capacity exceeding 75 tonnes per day. Inventory methodology has no threshold. • EU ETS activity includes combustion and process emissions. • Process related emissions from EU ETS activity code 32 are included in CRF 2.A.4 Other process uses of carbonates • Combustion related emissions from EU ETS activity code 32 are included in CRF 1.A.2.f. Non-metallic minerals • EU ETS method A is based on carbonate input and is equivalent to IPCC tier 1 to 3 methods. EU ETS method B based on the alkali oxide output in the product has no equivalent method in the 2006 IPCC Guidelines. IPCC Guidelines also do not provide methods to estimate emissions from additives.
33 Manufacture of mineral wool insulation material using glass, rock or slag	2.A.3 Glass production 2.A.4 Other process uses of carbonates 2.A.5 Other 1.A.2.f Non-metallic minerals	• Emissions are included in EU ETS only for installations with a melting capacity exceeding 20 tonnes per day. Inventory methodology has no threshold. • EU ETS activity includes combustion and process emissions. • 2.A.3 Glass Production includes emissions from the production of glass wool, a category of mineral wool, where the production process is similar to glass making. Where the production of rock wool is emissive these emissions should be reported under IPCC Subcategory 2A5.
34 Drying or calcination of gypsum or production of plaster boards and other gypsum products	1.A.2.f Non-metallic minerals	• EU ETS covers CO_2 emissions from this activity, where combustion units have a total rated thermal input exceeding 20 MW. For GHG inventories no such threshold applies. • EU ETS activity only includes combustion-related emissions
35 Production of pulp from timber or other fibrous materials	1.A.2.d Pulp, paper and print 2.A.4 Other process uses of carbonates (soda ash use)	• EU ETS activity includes combustion and process emissions. • Combustion related emissions from EU ETS activity code 35 are included in CRF 1.A.2.d. • Process related emissions are included in 2.A.4. Other process uses of carbonates
36 Production of paper or cardboard	1.A.2.d Pulp, paper and print 2.A.4 Other process uses of carbonates (soda ash use)	• EU ETS activity includes combustion and process emissions. • Threshold in EU ETS: installations involved in the production of paper or card-board a production capacity exceeding 20 tonnes per day. Inventory methodology has no threshold. • Combustion related emissions from EU ETS

EU ETS activity	CRF category	Comment
		activity code 36 are included in CRF 1.A.2.d. • Process related emissions are included in 2.A.4 Other process uses of carbonates
37 Production of carbon black involving the carbonisation of organic substances such as oils, tars, cracker and distillation residues	2.B.8 Petrochemical and carbon black production 1.A.2.c Chemicals	• EU ETS covers CO_2 emissions from this activity, where combustion units have a total rated thermal input exceeding 20 MW. For GHG inventories no such threshold applies. • EU ETS activity includes combustion and process emissions.
38 Production of nitric acid	2.B.2. Nitric acid production 1.A.2.c Chemicals	• Scopes of EU ETS and 2006 IPCC Guidelines for CO_2 emissions from nitric acid production are consistent. • EU ETS activity includes combustion and process emissions. • For EU ETS activity 38 all N_2O emissions are process-related and should be allocated to 2.B.2 Nitric acid production • CO_2 emissions in activity code 38 are from fuel combustion and should be allocated to 1.A.2.c Chemicals
39 Production of adipic acid	2.B.3. Adipic acid production (CO_2) 1.A.2.c Chemicals	• Scopes of EU ETS and 2006 IPCC Guidelines for CO_2 emissions from Adipic Acid production are consistent. • EU ETS activity includes combustion and process emissions. • For EU ETS activity 39 all N_2O emissions are process-related and should be allocated to CRF code 2.B.3 Adipic Acid Production • CO_2 emissions in activity code 38 are from fuel combustion and should be allocated to 1.A.2.c Chemicals
40 Production of glyoxal and glyoxylic acid	2.B.4. Caprolactam, glyoxal and glyoxylic acid production 1.A.2.c Chemicals	• Scopes of EU ETS and 2006 IPCC Guidelines for N_2O emissions from glyoxal production and glyoxylic acid production are consistent. • EU ETS activity includes combustion and process emissions. • N_2O emissions should be allocated to CRF code 2.B.4 Caprolactam, glyoxal and glyoxylic acid production • CO_2 emissions in activity code 40 are from fuel combustion and should be allocated to 1.A.2.c Chemicals

41 Production of ammonia	2.B.1. Ammonia production
	CO_2 captured for urea production:
	3.H Urea Application
	1.A.3.b Road transport
	2.D.3 Other non-energy products from fuels and solvent use
		• EU ETS scope of activity code 41 ammonia production includes
		  • combustion of fuels supplying the heat for reforming or partial oxidation,
		  • fuels used as process input in the ammonia production process (reforming or partial oxidation),
		  • fuels used for other combustion processes including for the purpose of producing hot water or steam.
		• According to 2006 IPCC Guidelines to avoid double counting, fuel consumption in ammonia production should be reported under Ammonia production. In this regard EU ETS and IPCC scopes are consistent.
		• In the inventory CO_2 from ammonia production which is recovered and used for urea production is subtracted and reported by the users. Urea

EU ETS activity	CRF category	Comment
		use can be reported in different CRF sectors, e.g. in 1.A.3.b Road transport, 3.H Urea application in agriculture, 2.D.3 Other (e.g. in industry catalysts). Under the EU ETS the CO_2 transfer via urea out of the EU ETS system cannot be deducted from ammonia production.
42 Production of bulk organic chemicals by cracking, reforming, partial or full oxidation or by similar processes	2.B.8 Petrochemical and carbon black production 2.B.10 Other chemical industry 1.A.2.c Chemicals	• Emissions are included in EU ETS only for installations with a production capacity exceeding 100 tonnes per day. Inventory methodology has no threshold. • EU ETS activity includes combustion and process emissions. • The combustion related emissions are allocated to CRF code 1.A.2.c Chemicals. • Some of the emissions reported under this EU ETS activity could be allocated to CRF category 2.B.8 Petrochemical and carbon black production (e.g. CO_2 process emissions) • Some of the emissions reported under this EU ETS activity could be allocated to CRF category 2.B.10 Other chemical industry (e.g. CO_2 emissions from flaring in chemical industry)
43 Production of hydrogen and synthesis gas by reforming or partial oxidation	1.A.2.c Chemicals 2.B.1. Ammonia production 2.B.8 Petrochemical and carbon black production 2.B.10 Other chemical industry 1.B.2.a.iv Fugitive emissions from oil refining/ storage	• Emissions are included in EU ETS only for installations with a production capacity exceeding 25 tonnes per day. IPCC methodology has no threshold. • EU ETS activity includes combustion and process emissions. • In the CRF, there is no separate reporting category for emissions from hydrogen production. Hydrogen and synthesis gas production are recognised as part of integrated chemical production. Therefore MS have chosen different approaches for the inclusion of emissions from hydrogen production (e.g. 2.B.8 or 2.B.10) • Some emissions may also be reported under CRF category 1.B.2.a.iv Fugitive emissions from oil subcategory refining/ storage
44 Production of soda ash and sodium bicarbonate	1.A.2.c Chemicals 2.B.7 Soda ash production	• EU ETS activity includes combustion and process emissions. • Combustion related emissions from EU ETS activity code 44 for production are included in CRF 1.A.2.c Chemicals • Process related emissions are included in 2.B.7. Soda Ash Production
45 Capture of greenhouse gases under Directive 2009/31/EC	Capture of emissions would be reported under the respective inventory sector e.g. 1.A.1.a Public electricity and heat production.	• Consistent with scope and methodologies of inventory (currently no emissions reported under the EU ETS)
46 Transport of greenhouse gases by pipelines for geological storage in a storage site permitted under Directive 2009/31/EC	1.C.1 Transport of CO_2	• Consistent with scope and methodologies of inventory (currently no emissions reported under the EU ETS)
47 Geological storage of greenhouse gases in a storage site	1.C.2 Injection and storage	• Consistent with scope of inventory (currently no emissions reported under the EU ETS)

EU ETS activity	CRF category	Comment
permitted under Directive 2009/31/EC		
99 Other activity opted-in under Art. 24 of the ETS Directive	Depending on type of activity opted-in	Article 24 allows the unilateral inclusion of additional activities and gases under the EU ETS, These activities and gases are not allocated to a specific activity, but under a separate activity code.

In the GHG inventory, the emissions are reported per CRF categories. In the EU ETS a single installation can include several ETS activities as defined in Annex I of the EU ETS Directive. In the EU ETS emissions are attributed to a specific installation, independently from the Annex I activities covered. Nevertheless, the operator must report detailed information for each source stream of the installation, and include activities classification as per Annex I, in his annual report to the competent authorities. The different approaches can lead to differences in reported emissions if ETS activities and inventory categories are compared directly.

Scope of activities and installation boundaries

For several activities, the EU ETS includes installations only if they exceed certain capacity thresholds. Such capacity thresholds are not used for the inventory reporting. In addition, installation boundaries and the scope as to what constitutes an activity under the EU ETS may be different to a source category for the inventory reporting. Therefore the scope of activities and the installation boundaries need careful consideration before EU ETS data are used for inventory purposes.

Determination of tiers

Both IPCC guidelines are based on methodological tiers that require higher tier levels of accuracy for emission sources contributing to a significant extent to the total emissions in a country. 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 EU ETS the tiers are related to the admissible level of uncertainty for each parameter involved in the reporting. In the EU ETS tiers apply at installation level for each source stream activity data and calculation factor, and are defined in legislation on the basis of the installation emissions (thresholds are < 50 kt, ≥ 50 kt and ≤ 500 kt and > 500 kt CO_2eq). EU ETS verified emissions, if aggregated at sectoral level, may include contributions from small, medium and large emitters and are therefore based on different EU ETS tiers. When ETS data are used for key categories in the GHG inventory, it therefore has to be checked carefully whether the EU ETS tiers used for the monitoring of emissions are in conformity with the IPCC guidance related to the IPCC tiers for a particular source category.

In GHG inventories time series consistency is a mandatory requirement which has also implications on the choice of methodology. While methodological consistency is also required under the EU ETS (Article 6 of Regulation No 601/2012), the EU ETS only started in 2005 and plant-specific and measured data is often not available for the whole time series back to 1990 and it may be challenging to construct a consistent time series back to 1990.

The mapping table above shows that a direct comparison between verified emissions from EU ETS activities and emissions reported in CRF categories is not straightforward.

An analysis of data consistency between EU ETS and inventory data requires: (1) an assessment of the assignment of the detailed data reported by each individual EU ETS installation to national competent authorities with respect to the CRF categories; (2) a detailed comparison of the methodological parameters (methods, activity data, calculation parameters).

1.4.1.3 Use of EU ETS data in 2018

Under the MMR Article 7 (EU 2013), Member States are required to perform consistency checks between the emissions reported in the GHG inventories and the verified emissions reported under the EU ETS Directive. The installation-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 a number of careful checks, e.g. whether the coverage of the respective EU ETS emissions is complete for the respective source category and that EU ETS activities and CRF source categories follow the same definitions. If EU 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 EU 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 the latter 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 or for specific non-marketed fuels.
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 sub-categories become available from EU ETS.
6. EU 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 uncertainties of data reported by installations.

Based on the information submitted in the national inventory reports (NIRs) in 2018 to the European Commission, all 28 Member States indicated that they used EU ETS data at least for QA/QC purposes (Table 1.11). 20 Member States indicated to directly use the verified emissions reported by installations under the EU ETS. 27 Member States used EU ETS data to improve country-specific emission factors. 26 Member States reported that they used activity data (e.g. fuel use) provided under the EU ETS in the national inventory.

Table 1.11 Use of EU ETS data for the purposes of the national GHG inventory

Member State	Use of emissions	Use of Activity data	Use of emission factors	Use for quality assurance
Austria	✓	✓	✓	✓
Belgium	✓	✓	✓	✓
Bulgaria	✓	✓	✓	✓
Croatia	✓	✓		✓
Cyprus	✓	✓	✓	✓
Czech Republic	✓	✓	✓	✓
Denmark	✓	✓	✓	✓
Estonia		✓	✓	✓
France	✓	✓	✓	✓
Finland	✓	✓	✓	✓
Germany	✓	✓	✓	✓
Greece		✓	✓	✓
Hungary	✓	✓	✓	✓
Ireland	✓	✓	✓	✓
Italy	✓	✓	✓	✓
Latvia	✓	✓	✓	✓
Lithuania	✓	✓	✓	✓
Luxembourg	✓	✓	✓	✓
Malta		✓	✓	
Netherlands	✓	✓	✓	✓
Poland	✓	✓	✓	✓
Portugal		✓	✓	✓
Romania			✓	✓
Slovakia		✓	✓	✓
Slovenia		✓	✓	✓
Spain			✓	✓
Sweden	✓	✓	✓	✓
United Kingdom	✓	✓	✓	✓

Source: NIR 2018 submissions of Member States

1.4.1.4 References

EC 2003: Directive 2003/87/EC of the European Parliament and of the Council of 13 October 2003 establishing a scheme for greenhouse gas emission allowance trading within the Community and amending Council Directive 96/61/EC (OJ L275, 25.10.2003, p. 32) amended by Directive 2004/101/EC of the European Parliament and of the Council of 27 October 2004, Directive 2008/101/EC of the European Parliament and of the Council of 19 November 2008 and Directive 2009/29/EC of the European Parliament and of the Council of 23 April 2009.

EEA (European Environment Agency) 2018: EU Emissions Trading System (ETS) data viewer https://www.eea.europa.eu/data-and-maps/dashboards/emissions-trading-viewer-1

EU 2012a: Commission Regulation (EU) No 600/2012 of 21 June 2012 on the verification of greenhouse gas emission reports and tonne-kilometre reports and the accreditation of verifiers pursuant to Directive 2003/87/EC of the European Parliament and of the Council Text with EEA relevance (OJ L 181, 12.7.2012, p. 1–29).

EU 2012b: Commission Regulation (EU) No 601/2012 of 21 June 2012 on the monitoring and reporting of greenhouse gas emissions pursuant to Directive 2003/87/EC of the European Parliament and of the Council (OJ L 181, 12.7.2012, p. 1-28).

EU 2014: Regulation No 421/2014 of the European Parliament and of the Council of 16 April 2014 amending Directive 2003/87/EC establishing a scheme for greenhouse gas emission allowance trading within the Community, in view of the implementation by 2020 of an international agreement applying a single global market-based measure to international aviation emission (OJ L 129, 30.4.2014, p. 1–4).

1.4.2 Cooperation with EUROCONTROL

At the end of 2010 the European Commission signed a framework contract with EUROCONTROL, the European organization for the safety of air navigation, regarding ‘the support to the European Commission in relation to climate change policy and the implementation of the EU ETS’. This support project is organized in different Work Packages (WP) corresponding to the different areas identified in the framework contract and has been regularly continued.

One of these Work Packages pertains to the improvement of GHG and air pollutant emissions inventories sub-mitted by the 28 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 ETC/ACM assist DG CLIMA regarding the technical requirements.

To support the inventory process for the submission in 2018, in November 2017 Member States received fuel and emissions data for the years 2005 to 2016 as calculated by EUROCONTROL using a TIER 3b methodology applying the Advanced Emissions Model (AEM). This is a follow up of ERT recommendations made to perform QA exercises and to make data from EUROCONTROL available to Member States on a regular basis. In November 2017 three webinars took place to exchange information between EUROCONTROL and Member States on the data provided.

In the course of the ‘initial checks’ of MS inventories in the first months of 2018 the comparison between Tier 3b calculations from EUROCONTROL and time series of MS inventories has been conducted with most actual inventories from Member States. In case of considerable differences between Member State results and those from EUROCONTROL, the European Environment Agency and its ETC/ACM asked Member States via the EMRT about possible reasons. In addition the European Environment Agency provided MS with a comparison between EUROCONTROL data and MS data on fuel consumption of civil and international aviation for the years 2015 and 2016, related CO_2 emissions and implied emission factors of CH_4 and N_2O. For more information on the results of the comparison, see chapter 3.2.

During the whole process countries have been encouraged to provide feedback to these EUROCONTROL results so that suggestions and questions could be taken into account in the next modelling exercise. Based on the experience gained during this QA/QC process, recommendations will be made to EUROCONTROL to safeguard and improve time-series calculations for use by MS. Under a new framework contract with DG CLIMA, EUROCONTROL will provide data for the year 2018 and eventually recalculate time series for the period 2005 to 2017 in case of considerable changes in the model.

As explained in the NIR 2014, comparing emissions reported by Member States with independent modelling results such as performed by EUROCONTROL is a genuine quality assurance exercise and assists in identifying areas in need for improvement of aviation emission calculations. In this sense, the EUROCONTROL results are used for identifying ways of checking and improving the accuracy of emission estimates for the EU and its Member States in accordance with the ARR of 2014.

1.5 Description of key categories

A key category analysis has been carried out according to the Tier 1 method (quantitative approach) described in the 2006 IPCC guidelines. 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.

In addition to the key category analysis at EU-28 level, every Member State provides a national key category analysis which is independent from the assessment at EU-28 level. The EU-28 key category analysis is not intended to replace the key category analysis by Member States. The key category analysis at EU-28 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-28 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-28 and Iceland, the following procedure was applied:

- Starting point for the key category identification for this report was the EEA database. Most categories where GHG emissions/removals occur were listed, at an aggregation level such as 2.B.1 and split by gas, while for the sector Energy a less aggregated level such as 1.A.1.a, split by fuel and per gas was chosen. It makes sense for the EU to rely on this less aggregated level for the KCA as also the initial checks of the MS submissions are performed at this level of detail and therefore guarantee a more profound quality checking for all EU key categories (at fuel level). Additionally the EU KCA (at detailed level) is used in order to select the categories for which more detailed information is provided in the EU NIR. Although the more detailed EU approach differs from the KCA generated in the CRF overall the results are very similar.
- A level and a trend assessment was carried out for the years 1990 and 2016 The assessment was carried out for emissions excluding LULUCF and including LULUCF.
  The key category analysis excluding LULUCF resulted in the identification of 88 key categories for the EU-28 and Iceland and cover 94 % of total EU-28 GHG emissions in 2014 (see Annex I). The key category analysis including LULUCF resulted in 104 key categories (Table 1.12).

In Chapters 3 to 7 overview tables are presented for each EU key category showing the Member States' contributions to the EU-28 key category in terms of level and trend.

Table 1.12 Key categories for the EU-28 and Iceland (Gg CO_2 equivalents)

Source category gas	kt CO_2 equ.		Trend	Level	
	1990	2016		1990	2016
1.A.1.a Public Electricity and Heat Production: Gaseous Fuels (CO_2)	107504	217931	T	L	L
1.A.1.a Public Electricity and Heat Production: Liquid Fuels (CO_2)	176297	31795	T	L	L
1.A.1.a Public Electricity and Heat Production: Other Fuels (CO_2)	10763	39291	T	L	L
1.A.1.a Public Electricity and Heat Production: Peat (CO_2)	8531	7992	0	L	L
1.A.1.a Public Electricity and Heat Production: Solid Fuels (CO_2)	1129328	715806	T	L	L
1.A.1.b Petroleum Refining: Gaseous Fuels (CO_2)	5275	23362	T	0	L
1.A.1.b Petroleum Refining: Liquid Fuels (CO_2)	112255	94632	T	L	L
1.A.1.b Petroleum Refining: Solid Fuels (CO_2)	3633	143	T	0	0
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries: Gaseous Fuels (CO_2)	17326	18059	T	L	L
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries: Solid Fuels (CO_2)	91118	31637	T	L	L
1.A.2.a Iron and Steel: Gaseous Fuels (CO_2)	30905	18053	T	L	L
1.A.2.a Iron and Steel: Liquid Fuels (CO_2)	8512	1377	T	L	0
1.A.2.a Iron and Steel: Solid Fuels (CO_2)	142975	76691	T	L	L
1.A.2.b Non-Ferrous Metals: Gaseous Fuels (CO_2)	3918	6715	T	0	L
1.A.2.b Non-Ferrous Metals: Liquid Fuels (CO_2)	4529	830	T	0	0
1.A.2.b Non-Ferrous Metals: Solid Fuels (CO_2)	8047	1165	T	0	0
1.A.2.c Chemicals: Gaseous Fuels (CO_2)	54677	35420	T	L	L
1.A.2.c Chemicals: Liquid Fuels (CO_2)	39330	17111	T	L	L
1.A.2.c Chemicals: Solid Fuels (CO_2)	14893	8869	0	L	L
1.A.2.d Pulp, Paper and Print: Gaseous Fuels (CO_2)	13199	17950	T	L	L
1.A.2.d Pulp, Paper and Print: Liquid Fuels (CO_2)	11414	1907	T	L	0
1.A.2.d Pulp, Paper and Print: Solid Fuels (CO_2)	8359	2882	T	0	0
1.A.2.e Food Processing, Beverages and Tobacco: Gaseous Fuels (CO_2)	19307	29728	T	L	L
1.A.2.e Food Processing, Beverages and Tobacco: Liquid Fuels (CO_2)	20047	4172	T	L	0
1.A.2.e Food Processing, Beverages and Tobacco: Solid Fuels (CO_2)	12486	4573	T	L	0
1.A.2.f Non-metallic minerals: Gaseous Fuels (CO_2)	27322	28503	T	L	L
1.A.2.f Non-metallic minerals: Liquid Fuels (CO_2)	44635	24475	T	L	L
1.A.2.f Non-metallic minerals: Other Fuels (CO_2)	1422	12543	T	0	L
1.A.2.f Non-metallic minerals: Solid Fuels (CO_2)	57641	16478	T	L	L
1.A.2.g Other Manufacturing Industries and Constructions: Gaseous Fuels (CO_2)	95218	87230	T	L	L
1.A.2.g Other Manufacturing Industries and Constructions: Liquid Fuels (CO_2)	113836	47730	T	L	L
1.A.2.g Other Manufacturing Industries and Constructions: Solid Fuels (CO_2)	93501	13793	T	L	L
1.A.3.a Domestic Aviation: Jet Kerosene (CO_2)	13755	15517	T	L	L
1.A.3.b Road Transportation: Diesel Oil (CO_2)	297957	623282	T	L	L
1.A.3.b Road Transportation: Diesel Oil (N_2O)	1799	7360	T	0	L
1.A.3.b Road Transportation: Gaseous Fuels (CO_2)	504	3778	T	0	0
1.A.3.b Road Transportation: Gasoline (CH_4)	5756	837	T	0	0
1.A.3.b Road Transportation: Gasoline (CO_2)	404900	231331	T	L	L
1.A.3.b Road Transportation: Liquefied Petroleum Gases (LPG) (CO_2)	7338	16108	T	0	L
1.A.3.c Railways: Liquid Fuels (CO_2)	12845	6086	T	L	L
1.A.3.d Domestic Navigation: Gas/Diesel Oil (CO_2)	17868	13682	0	L	L
1.A.3.d Domestic Navigation: Residual Fuel Oil (CO_2)	10448	4548	T	L	0
1.A.4.a Commercial/Institutional: Gaseous Fuels (CO_2)	66847	110199	T	L	L
1.A.4.a Commercial/Institutional: Liquid Fuels (CO_2)	83979	38853	T	L	L
1.A.4.a Commercial/Institutional: Other Fuels (CO_2)	777	5278	T	0	0
1.A.4.a Commercial/Institutional: Solid Fuels (CO_2)	47401	4474	T	L	0
1.A.4.b Residential: Biomass (CH_4)	9400	10718	T	L	L
1.A.4.b Residential: Gaseous Fuels (CO_2)	183941	257633	T	L	L
1.A.4.b Residential: Liquid Fuels (CO_2)	181470	100076	T	L	L
1.A.4.b Residential: Solid Fuels (CH_4)	9387	2981	T	L	0

Source category gas	kt CO_2 equ.		Trend	Level	
	1990	2016		1990	2016
1.A.4.b Residential: Solid Fuels (CO_2)	136848	38501	T	L	L
1.A.4.c Agriculture/Forestry/Fishing: Gaseous Fuels (CO_2)	12480	11231	0	L	L
1.A.4.c Agriculture/Forestry/Fishing: Liquid Fuels (CO_2)	72355	59927	T	L	L
1.A.4.c Agriculture/Forestry/Fishing: Solid Fuels (CO_2)	9751	4121	T	L	0
1.A.5.a Other Other Sectors: Solid Fuels (CO_2)	5983	9	T	0	0
1.A.5.b Other Other Sectors: Liquid Fuels (CO_2)	14025	4598	T	L	0
1.B.1.a Coal Mining and Handling: Operation (CH_4)	95180	26327	T	L	L
1.B.2.a Oil: Operation (CO_2)	9104	11456	T	L	L
1.B.2.b Natural Gas: Operation (CH_4)	51404	25141	T	L	L
1.B.2.c Venting and Flaring: Operation (CO_2)	8723	6180	0	L	L
2.A.1 Cement Production: no classification (CO_2)	102679	74699	0	L	L
2.A.2 Lime Production: no classification (CO_2)	25925	18695	0	L	L
2.A.4 Other Process Uses of Carbonates: no classification (CO_2)	11721	10332	0	L	L
2.B.1 Ammonia Production: no classification (CO_2)	33361	23935	0	L	L
2.B.10 Other chemical industry: no classification (CO_2)	5913	9956	T	0	L
2.B.2 Nitric Acid Production: no classification (N_2O)	49572	3953	T	L	0
2.B.3 Adipic Acid Production: no classification (N_2O)	57555	331	T	L	0
2.B.8 Petrochemical and Carbon Black Production: no classification (CO_2)	14953	14946	T	L	L
2.B.9 Fluorochemical Production: no classification (HFCs)	29034	475	T	L	0
2.B.9 Fluorochemical Production: no classification (Unspecified mix of HFCs and PFCs)	5567	62	T	0	0
2.C.1 Iron and Steel Production: no classification (CO_2)	95382	62641	T	L	L
2.C.3 Aluminium Production: no classification (PFCs)	21277	560	T	L	0
2.D.3 Other non energy products: no classification (CO_2)	8384	6014	0	L	0
2.F.1 Refrigeration and Air conditioning: no classification (HFCs)	4	97283	T	0	L
2.F.2 Foam Blowing Agents: no classification (HFCs)	0	2957	T	0	0
2.F.3 Fire Protection: no classification (HFCs)	0	3356	T	0	0
2.F.4 Aerosols: no classification (HFCs)	3	5494	T	0	0
3.A.1 Enteric Fermentation: Dairy Cattle (CH_4)	79592	60380	0	L	L
3.A.1 Enteric Fermentation: Mature Dairy Cattle (CH_4)	10329	7777	0	L	L
3.A.1 Enteric Fermentation: Non-Dairy Cattle (CH_4)	87595	75566	T	L	L
3.A.1 Enteric Fermentation: Other Cattle (CH_4)	20908	13098	0	L	L
3.A.2 Enteric Fermentation: Other Sheep (CH_4)	28806	20155	0	L	L
3.A.4 Enteric Fermentation: Other livestock (CH_4)	6193	6229	0	0	L
3.B.1 CH_4 Emissions: Farming (CH_4)	52893	41529	0	L	L
3.B.2 N_2O and NMVOC Emissions: Farming (N_2O)	31292	22891	0	L	L
3.D.1 Agricultural Soils: Direct N_2O Emissions From Managed Soils (N_2O)	155812	129959	T	L	L
3.D.2 Agricultural Soils: Farming (N_2O)	36847	29236	0	L	L
4.A.1 Forest Land: Land Use (CO_2)	-363025	-375593	T	L	L
4.A.2 Forest Land: Land Use (CO_2)	-41859	-48953	T	L	L
4.B.1 Cropland: Land Use (CO_2)	23832	21446	T	L	L
4.B.2 Cropland: Land Use (CO_2)	49775	42693	T	L	L
4.C.1 Grassland: Land Use (CO_2)	48139	33566	0	L	L
4.C.2 Grassland: Land Use (CO_2)	-18260	-24195	0	L	L
4.D.1 Wetlands: Land Use (CO_2)	12622	13392	T	L	L
4.E.2 Settlements: Land Use (CO_2)	33433	50196	T	L	L
4.G Harvested Wood Products: Wood product (CO_2)	-31306	-38235	0	L	L
5.A.1 Managed Waste Disposal Sites: Waste (CH_4)	159159	86113	T	L	L
5.A.2 Unmanaged Waste Disposal Sites: Waste (CH_4)	25724	12962	T	L	L
5.B.1 Waste Composting: Waste (CH_4)	357	2972	T	0	0
5.B.1 Waste Composting: Waste (N_2O)	326	2814	T	0	0
5.D.1 Wastewater Treatment and Discharge: Domestic Wastewater (CH_4)	22192	10529	T	L	L

Source category gas	kt CO_2 equ.		Trend	Level	
	1990	2016		1990	2016
5.D.1 Wastewater Treatment and Discharge: Domestic Wastewater (N_2O)	8273	7085	0	0	L
5.D.2 Wastewater Treatment and Discharge: Industrial Wastewater (CH_4)	12085	9258	0	L	L

Note: EU totals for 2015 in sector Energy and IPPU may not include data for Sweden due to confidential reporting.

1.6 General uncertainty evaluation

The EU-28 uncertainty analysis was made on basis of the Tier 1 uncertainty estimates, which were submitted from the Member States under Article 7(1)(p) of Regulation (EU) 252/2013.

Uncertainties were estimated at detailed level and aggregated to six main sectors 'Energy', 'Fugitive emissions', Industrial processes and product use', '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 calculated 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 uncertainty estimates for the sectors and for total GHG emissions were calculated. This is a more sophisticated approach than required under the IPCC guidelines. The EU team adopted this approach in order to obtain a more accurate uncertainty estimates than with the "simple" approach included in the IPCC guidelines.

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

Trendn,x = En,x(t)-En,x(0) **(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 1.13 gives 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 1.13 Trend uncertainty for EU emissions 2006 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 given 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 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 independent.

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 Table 1.14, in which waste sector uncertainties are presented both with analytical method and Monte Carlo simulation: If uncertainty increases, also the difference between the two methods increases.

Table 1.14 .Comparison of trend uncertainty estimates 2005 for EU Waste Sector using the modified Tier 1 method and Monte Carlo simulation (Tier 2).

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:

$$\mathbf{Trend_{n,x} = [E_{n,x}(t)-E_{n,x}(0)]/ E_{n,x}(0)} \qquad \mathbf{(2)}$$

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 1.15 shows the main results of the Tier 1 uncertainty analysis for the EU-28 and Iceland. The lowest level uncertainty estimates are for fuel combustion activities (0.9 %), the highest estimates are for waste (51.4 %). Overall level uncertainty estimates including LULUCF of all EU-28 and Iceland GHG emissions is calculated with 5.8 % and excluding LULUCF slightly lower with 5.0 %.

With regard to trend uncertainty estimates the lowest uncertainty estimates are for fuel combustion activities (+/-0.3 percentage points), the highest estimates are for LULUCF (19.0 percentage points). Overall trend uncertainty (including LULUCF) of all EU-28 GHG and Iceland emissions is estimated to be 1.2 percentage points.

These results of the Tier 1 uncertainty analysis 2016 are very similar to the results of the previous year. The biggest change of level uncertainty can be identified in sector LULUCF. The uncertainty decrease is mainly due to updated emission factor uncertainty estimate of United Kingdom in sector 4A (CO_2). The trend uncertainty estimate changes the most in sector waste. Germany's new emission factor in sector 5D1 (N_2O) leads to increased emission trend change and higher trend uncertainty. More detailed uncertainty estimates for the source categories are provided in Chapters 3-7.

Table 1.15 Tier 1 uncertainty estimates of EU-28 and Iceland GHG emissions (in CO_2 equivalents) for the main sectors

Source category	Gas	Emissions Base Year	Emissions 2016	Emission trends Base Year-2016	Level uncertainty estimates based on MS uncertainty estimates	Trend uncertainty estimates based on MS uncertainty estimates
1.A Fuel combustion activities	all	4 189 282	3 263 413	-22.1%	0.9%	0.3%
1.B Fugitive emissions	all	199 484	86 009	-56.9%	18.4%	8.8%
2. Industrial processes	all	534 587	356 624	-33.3%	11.8%	4.8%
3. Agriculture	all	536 210	428 892	-20.0%	45.4%	2.8%
5. Waste	all	233 353	137 837	-40.9%	51.4%	14.8%
4. LULUCF	all	-221 048	-279 966	26.7%	32.6%	19.0%
Total (incl LULUCF)	**all**	**5 471 868**	**3 992 809**	**-27.0%**	**5.8%**	**1.2%**
Total (excl LULUCF)	**all**	**5 692 916**	**4 272 775**	**-24.9%**	**5.0%**	**0.9%**

Note: Due to confidential values reported by Germany and Sweden, sectoral EU emissions and total EU emissions for 2016 in the following tables might not always be identical to the actual emission reported by MS in the sector chapters

Table 1.16 gives an overview of information provided by EU-28 Member States on uncertainty estimates in their national inventory reports 2018 and presents summarised results of these estimates.

Table 1.16 Overview of uncertainty estimates available from EU-28 Member States and Iceland

Member State	Austria		Belgium	Bulgaria		Croatia		Cyprus	Czech Republic		Denmark	
Citation	NIR March 2018, pp.62-70		NIR April 2018, pp.49-52	NIR April 2018, pp.65-66		NIR May 2018, p.52		NIR May 2018, p.51	NIR April 2018, pp.44		NIR March 2018, pp.57-63	
Method used	Tier 1		Tier 1	Tier 1		Tier 1 + Tier 2		Tier 1	Tier 1		Tier 1	
Documentation in NIR (according to IPCC 2006 GL)	Yes		Yes (Annex 2)	Yes (Annex 2)		Yes (Annex 2)		Yes (Annex 2)	Yes (Annex 2)		Yes	
Years and sectors included	emissions: 2016; trends: 1990-2016; including LULUCF		emissions: 2016; trends: 1990-2016; including LULUCF	emissions: 2016; trends: 1998-2015; including LULUCF		emissions: 2016; trends: 1990-2016; including LULUCF		emissions: 2016; trends: 1990-2016; excluding LULUCF	emissions: 2016; trends: 1990-2016; including LULUCF		emissions: 2016 trends: 1990-2016*; including LULUCF	
Uncertainty (%)	Tier 1 (i .L.)	Tier 1 (e. L.)	Tier 1	Tier 1 (i .L.)	Tier 1 (e. L.)	Tier 1 (i .L.)	Tier 1 (e. L.)	Tier 1	Tier 1 (i .L.)	Tier 1 (e. L.)	Tier 1 (i .L.)	Tier 1 (e. L.)
CO_2											3.80%	4.90%
CH_4											16.3%	
N_2O											36.8%	
F-gases			32%								42.3%	
Total	23.11%	5.03%	3.73%	28.89%	14.89%	-18.9% to 41.97%	-28.22% to -18.64%	10.05%	3.79%	3.65%	5.1%	5.0%
Uncertainty in trend (%)	Tier 1 (i .L.)	Tier 1 (e. L.)	Tier 1	Tier 1 (i .L.)	Tier 1 (e. L.)	Tier 1 (i .L.)	Tier 1 (e. L.)	Tier 1	Tier 1 (i .L.)	Tier 1 (e. L.)	Tier 1 (i .L.)	Tier 1 (e. L.)
CO_2											1.5%	1.9%
CH_4											12.8%	
N_2O											9.4%	
F-gases											95.1%	
Total	2.19%	2.86%	2.28%	9.04%	2.33%	-25.31%	-23.80%	2.38%	2.30%	2.33%	1.90%	1.9%

Member State	Estonia		Finland				France		Germany	Greece		Hungary	Ireland	
Citation	NIR May 2018, p.48		NIR April 2018, pp.42-44				NIR March 2018, pp.77-79		NIR April 2018, pp.129-132	NIR April 2018, pp.68-72		NIR May 2018, pp.23-24	NIR Apr. 2018, pp.27-44	
Method used	Tier 1		Tier 1 + Tier 2				Tier 1		Tier 1 + Tier 2	Tier 1		Tier 1	Tier 1	
Documentation in NIR (according to IPCC 2006 GL)	Yes (Annex 2)		Yes (Annex 2)				Yes (Annex 6)		Yes (Annex 7)	Yes (Annex 4)		Yes (Annex 2)	Yes	
Years and sectors included	emissions: 2016; trends: 1990-2016; including LULUCF		emissions: 2016; trends: 1990-2016; including LULUCF				emissions: 2016; trends: 1990-2016; including LULUCF		emissions: 2016; trends: 1990-2016; including LULUCF	emissions: 2016; trends: 1990-2016; including LULUCF		emissions: 2016; trends: 1990-2016; excluding LULUCF	emissions: 2016; trends: 1990-2016; including LULUCF	
Uncertainty (%)	Tier 1 (i .L.)	Tier 1 (e. L.)	Tier 1 (i .L.)	Tier 1 (e. L.)	Tier 2 (i .L.)	Tier 2 (e. L.)	Tier 1 (i .L.)	Tier 1 (e. L.)	Tier 1	Tier 1 (i .L.)	Tier 1 (e. L.)	Tier 1	Tier 1 (i .L.)	Tier 1 (e. L.)
CO_2										3.0%	2.5%	2.5%	2.51%	1.27%
CH_4										35.5%	35.6%	24.0%	2.04%	2.02%
N_2O										105.8%	106.3%	145.2%	2.63%	2.76%
F-gases										281.1%	281.1%	12.8%	0.42%	0.45%
Total	10.78%	4.75%	44%	4%	-36% +43%	-3% +4%	12.3%	10.8%	4.5%	13.7%	13.2%	11.2%	4.19%	3.68%
Uncertainty in trend (%)	Tier 1 (i .L.)	Tier 1 (e. L.)	Tier 1 (i .L.)	Tier 1 (e. L.)	Tier 2 (i .L.)	Tier 2 (e. L.)	Tier 1 (i .L.)	Tier 1 (e. L.)	Tier 1	Tier 1 (i .L.)	Tier 1 (e. L.)	Tier 1	Tier 1 (i .L.)	Tier 1 (e. L.)
CO_2													10.09%	1.77%
CH_4													1.11%	0.96%
N_2O													0.85%	0.83%
F-gases													0.67%	0.67%
Total	4.07%	1.96%	34%	4%	-21% +28%	-4% +4%	2.4%	2.0%	5.1%	12.5%	12.2%	2.5%	10.21%	2.28%

Member State	Italy		Latvia		Lithuania		Luxembourg		Malta	Netherlands			Poland	
Citation	NIR May 2018, pp.46-47		NIR March 2018, pp.64-65		NIR May 2018, pp.60-61		NIR April 2018, pp.84-92		NIR May 2018, p.16	NIR May 2018, pp.53-58			NIR Feb. 2018, p.26	
Method used	Tier 1 + Tier 2		Tier 1		Tier 1		Tier 1		Tier 1	Tier 1 + Tier 2			Tier 1	
Documentation in NIR (according to IPCC 2006 GL)	Yes (Annex 1)		Yes (Annex 2)		Yes (Annex 2)		Yes (pp.87-91)		Yes (p. 256)	Yes (Annex 2)			Yes (Annex 8)	
Years and sectors included	emissions: 2016; trends: 1990-2016; including LULUCF		emissions: 2016; trends: 1990-2016; including LULUCF		emissions: 2016; trends: 1990-2016 *; including LULUCF		emissions: 2016; trends: 1990-2016; including LULUCF		emissions: 2016; trends: 1990-2016; including LULUCF	emissions: 2016; trends: 1990-2016 *; including LULUCF			emissions: 2016; trends: 1988-2016; including LULUCF	
Uncertainty (%)	Tier 1 (i .L.)	Tier 1 (e. L.)	Tier 1 (i .L.)	Tier 1 (e. L.)	Tier 1 (i .L.)	Tier 1 (e. L.)	Tier 1 (i .L.)	Tier 1 (e. L.)	Tier 1 (i .L.)	Tier 1 (i .L.)	Tier 1 (e. L.)	Tier 2 (e.L.)	Tier 1 (i .L.)	Tier 1 (e. L.)
CO_2											3%	3%	5.4%	1.8%
CH_4											17%	10%	22.9%	22.9%
N_2O											41%	27%	45.6%	48.0%
F-gases											41%	25%		
Total	4.8%	2.7%	29%	7%	49.9%	10.5%	4.68%	3.31%	5.15%	3%	3%	3%	5.8%	3.9%
Uncertainty in trend (%)	Tier 1 (i .L.)	Tier 1 (e. L.)	Tier 1 (i .L.)	Tier 1 (e. L.)	Tier 1 (i .L.)	Tier 1 (e. L.)	Tier 1 (i .L.)	Tier 1 (e. L.)	Tier 1 (i .L.)	Tier 1 (i .L.)	Tier 1 (e. L.)	Tier 2 (e.L.)	Tier 1 (i .L.)	Tier 1 (e. L.)
CO_2											1%		1.31%	1.17%
CH_4											6%		2.95%	2.95%
N_2O											7%		2.46%	2.39%
F-gases											12%			
Total	3.9%	2.1%	14%	2%	10.6%	2.2%	5.41%	3.65%	2.09%		2%		4.40%	4.00%

Member State	Portugal	Romania		Slovakia	Slovenia		Spain		Sweden		United Kingdom		Iceland	
Citation	NIR May 2018, p."1-21"	NIR May 2018, pp.119-121		NIR March 2018, p.38	NIR April 2018, pp.30-31		NIR May 2018, pp."1-43" - "1-44"		NIR March 2018, pp.69-71		NIR April 2018, p.94		NIR April 2018, p.11	
Method used	Tier 1	Tier 1		Tier 1	Tier 1		Tier 1		Tier 1		Tier 1 + Tier 2		Tier 1	
Documentation in NIR (according to IPCC 2006 GL)	Yes (Annex L)	Yes (Annex 2)		Yes (Annex 3)	Yes (Annex 6)		Yes (Annex 6)		Yes (Annex 7)		Yes (Annex 2)		Yes (Annex 2)	
Years and sectors included	emissions: 2016; trends: 1990-2016; including LULUCF **	emissions: 2016; trends: 1990-2016; including LULUCF		emissions: 2016; trends: 1990-2016; including LULUCF	emissions: 2016; trends: 1986-2016; including LULUCF		emissions: 2016; trends: 1990-2016 *; including LULUCF		emissions: 2016; trends: 1990-2016; including LULUCF		emissions: 2016; trends: 1990-2016 *; including LULUCF		emissions: 2016; trends: 1990-2016; including LULUCF	
Uncertainty (%)	Tier 1	Tier 1 (i .L.)	Tier 1 (e. L.)	Tier 1	Tier 1 (i .L.)	Tier 1 (e. L.)	Tier 1 (i .L.)	Tier 1 (e. L.)	Tier 1 (i .L.)	Tier 1 (e. L.)	Tier 1	Tier 2	Tier 1 (i .L.)	Tier 1 (e. L.)
CO_2												3.2%		
CH_4												16.3%		
N_2O												26.5%		
F-gases														
Total	6.26%	19.6%	11.9%	10.69%	12.95%	5.96%	19.9%	16.4%	77.62%	4.90%	3.5%	3.4%	46.0%	8.4%
Uncertainty in trend (%)	Tier 1	Tier 1 (i .L.)	Tier 1 (e. L.)	Tier 1	Tier 1 (i .L.)	Tier 1 (e. L.)	Tier 1 (i .L.)	Tier 1 (e. L.)	Tier 1 (i .L.)	Tier 1 (e. L.)	Tier 1	Tier 2	Tier 1 (i .L.)	Tier 1 (e. L.)
CO_2														
CH_4														
N_2O														
F-gases														
Total	4.04%	5.9%	2.1%	3.75%	11.81%	2.67%	1.4%	1.0%	16.65%	1.90%	2.4%	2.9%	21.0%	8.8%

1.7 General assessment of the completeness

1.7.1 Completeness checks 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.

In response to the Saturday paper 2010 the EU implemented an action plan in 2011 aiming at improving the completeness regarding NEs of the EU greenhouse gas inventory.

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 implemented by the EU needs to continue to be based primarily on the UNFCCC review reports. This is in particular evident with 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.
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 there are no methods available in the 2006 IPCC Guidelines. Overall, a fair and complete analysis of the use of "NE" including the situations highlighted in point 1 above was considered to be indispensable (see chapter 1.7.1).

Given the above considerations the specific steps of the action plan followed since 2011 are as follows:

1. Member States are required by the Monitoring Mechanism Regulation 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 is 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 is then immediately notified to each Member State. During February the experts of the EU inventory team consult and discuss 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. Any finding with regard to the use of the notation key "NE" or relevant blank cells is communicated to the Member States' via the EMRT by 28 February latest. According to the procedures and time scales described in Annex IX of the Implementing Regulation, the Draft EU inventory is sent to MS also by 28 February. Updated or additional inventory data submitted by MS (to remove inconsistencies or fill gaps) and complete final national inventory reports are 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, prepare the missing GHG source estimates in accordance with the gap-filling provisions in articles 13-16 of Commission Decision 2005/166/EC. 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. For transparency reasons, since 2011 the EU's inventory submission contains 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 continue to be applied. The WG1 on annual inventories continues to address issues of completeness giving them priority and the EU peer reviews and the ESD reviews focus on identifying issues that may lead to an under- or overestimation of emissions.

Since 2012 the completeness checks have been extended to the use of the notation key NO and NA. All cases where less than seven Member States reported NO or NA and all other MS reported emission estimates were checked by the sector experts and clarified with Member States, if needed. With the implementation of the new 2006 IPCC Guidelines, there is an additional check regarding 'insignificance' as described in paragraph 37 of the UNFCCC Reporting Guidelines which is also relevant for the ESD review.

Member States may only report NEs if:

1. There are no 2006 IPCC methods/EFs available.
2. Emissions are considered insignificant: below 0.05% of the NT & do not exceed 500 kt CO_2 eq. The sum of insignificant NEs shall remain below 0.1% of the NT.
   a. MS shall indicate in both the NIR and the CRF completeness table why such emissions/removals have not been estimated.
   b. MS should provide justifications for exclusion in terms of the likely level of emissions in the NIR, using approximated AD and default IPCC EFs.
3. Emissions have not been reported in a previous submission, otherwise they shall be reported in subsequent submissions.

➢ If MS report unjustified NEs (according to 1. 2. and 3. above) gap-filling rules will apply: art. 4 Delegated Act of the MMR.

For the sectors energy, industrial processes and product use, agriculture, LULUCF and waste sector-specific checks are performed by the EU sector experts using outlier tools similar to those of the UNFCCC and other QA/QC tools. The results of the consistency and completeness checks as well as the main findings of the sector specific checks are documented in the web-based EEA Emission Review Tool (EMRT). This tool is accessible for MS inventory coordinators and inventory experts. The Member States are asked to respond to findings in this tool and if needed provide revised emission estimates or additional information.

For every updated inventory submission provided by the MS by 15 March follow-up checks are performed by the sector experts and additional findings are documented in the EEA Emission Review

Tool (EMRT). In addition it is checked if issues identified in the QA/QC communication tool (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.

Since 2015 also cases where neither numeric values nor notation keys have been reported (blank cells) have been included in the checking procedure. EU experts have checked with Member States if blank cells have been caused by the new CRF reporter software or if in fact the blank cells should be replaced by notation keys or a numeric values.

1.7.2 Reporting of notation key "NE"

As the EU GHG inventory is the sum of MS inventories all categories reported as "NE" by Member States are also reflected in the EU GHG inventories. However, the EU CRF tables include only a small number of categories where the "NE" is actually visible because the "NE" of a Member State is only visible in the EU CRF in a category where all EU MS report notation keys. Table 1.17 shows that in 31 categories "NE" is visible in the CRF tables for 2016 of which one case refers to a mandatory category.

Table 1.17 Overview of the number of NE visible in the EU CRF tables for 2016

Sector	Number of NE visible in the EU CRF for the year 2016 for mandatory and non-mandatory categories	Number of NE visible in the EU CRF for the year 2016 for mandatory categories
Energy	5	0
IPPU	16	1
Agriculture	4	0
Waste	6	0

For a potential underestimate of emissions NEs in mandatory categories are relevant. Therefore the following table shows the only case where an NE is visible in the EU CRF for the year 2016 for a mandatory category. Table 1.18 shows that the NE can be considered insignificant.

Table 1.18 NE visible in the EU CRF tables for mandatory category in 2016

Sector number	Sector name	Gas	Years	Countries: Value	Explanation
2.C.1.c	Metal industry Iron and steel production Direct reduced iron	CH_4	1990-2016	SWE: NE DEU, ESP: IE all other MS: NO	For CH_4 emissions from direct reduced iron, test calculations have been made with default emission factors applied for the total amount of natural gas used at the facility. The resulting CH_4 amounts are thousand fold below the national totals of 30 kt CO_2-eq, meaning that these emissions can be considered insignificant. CH_4 is therefore reported as NE.

1.7.3 Reporting of confidential data

According to the UNFCCC reporting guidelines Parties may report specific categories with the notation key C in case of confidentiality. In 2018 only two MS made use of this option; Croatia reported CO_2, CH_4 and N_2O emission from 1D2 as confidential, while Sweden reported correct sector totals for all sectors but in the sectors Energy and IPPU on a less aggregated level the country reported 176 sub-categories as confidential. Manual changes have been performed in order to reflect this in the most appropriate way in the EU CRF tables. For further details refer to Table 1.7. Please note that the EU

GHG inventory team – on request - obtains access to confidential MS data for quality checking purposes which has been the case for Sweden in 2018.

Therefore, in the relevant sector chapters, EU trends at fuel level do not always include Sweden for confidentiality reasons and also to preserve time series consistency for the EU. Consequently, the EU CRF tables at sub-category level and data shown on the same level in the NIR are not always consistent. Note that at sector level and at national totals level the EU NIR and the EU CRF tables are fully consistent.

As the EU GHG inventory is the sum of MS inventories all categories reported as confidential by Member States are also reflected in the EU GHG inventories. However, the EU CRF tables include only very few categories where the "C" is actually visible. A "C" of a Member State is only visible in the EU CRF in a category where all EU MS report notation keys. In the 2018 CRF submission this is the case for categories 2.C.1.c and 2.C.1.e (Table 1.19).

Table 1.19 Overview of confidential data (notation key "C") visible in the EU CRF tables for 2016

2.C.1.c	Metal industry Iron and steel production Direct reduced iron	CO2	2015-2016	NO,C,IE	DEU,ESP: IE SWE: C other MS: NO	The Swedish data is confidential at micro level (e.g. company or plant level) and the company either declined to publish the data or a consent could be not be acquired.
2.C.1.e	Metal industry Iron and steel production Pellet	CO2	2015	NO,C,IE	HUN, NLD, SVK, ESP: IE SWE: C other MS: NO	

1.7.4 Data gaps, gap-filling and use of international data sources

1.7.4.1 Gap filling of emissions

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 in collaboration with the relevant 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 example were a Member States does not provide new estimates for the latest reporting 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.

For data gaps in Member States' inventory submissions, the following procedure is applied by the ETC/ACM in accordance with the implementing provisions under the MMR 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 2006 IPCC guidelines[11].

1.7.4.2 Gap filling of emissions in GHG inventory submissions 2018

Since 2011 GHG inventory estimates have been complete for all EU Member States, and therefore no gap filling has been needed.

1.7.4.3 Gap filling of activity data

In response to recommendations of the UNFCCC review team the EU elaborated and implemented a gap filling procedure for gaps in activity data (for further details on the methodology also see 4.3). Due to the large resource needs for gap filling the following rules apply:

- Only activity data for key categories will be gap-filled.
- If more than 75 % of the emissions are calculated on basis of consistent activity data.
- If the IEF has a reasonable degree of consistency (i.e. standard deviation divided by mean < 50 %).
- Only for the latest reporting year.

1.7.4.4 Gap filling of activity data in GHG inventory submissions 2018

Applying the rules mentioned above activity data of the following categories have been gap-filled in this inventory submission:

- Glass production 2A3
- Ammonia production in 2B1

1.7.4.5 Use of international activity data

According to the EU QA/QC programme, member States are responsible for the quality of the AD, EFs and other parameters used for their inventories. Therefore, using international data sources for the European Union would imply that the data reported by the countries to international data sources are considered more accurate than those used by the national inventory compilers and would lead to inconsistencies with member States' inventories, which would contradict the QA/QC programme of the European Union. International data sources are only used for the reference approach in CRF table 1A(b).

1.7.5 Geographical coverage of the European Union inventory

Table 1.20 shows the geographical coverage of the EU Member States' national inventories. Note that not all Member States have signed and ratified the UNFCCC and the Kyoto Protocol with the same geographical coverage. In addition, the EU territory of a country is not always equivalent to the territory

[11] ETC ACC technical note on gap filling procedures, December 2006.

of the Party to the UNFCCC or the Kyoto Protocol. For three Member States there are differences in geographical coverage as UNFCCC Party, Kyoto Protocol Party and/or EU Member State (DK, FR and the UK). If there are differences in geographical coverage the respective country needs to prepare several inventories.

As the EU-28 inventory is the sum of the Member States' inventories, the EU-28 inventory covers the same geographical area as the inventories of the 28 Member States for their respective EU territory. Note that Denmark, France and the United Kingdom submit GHG inventories to the UNFCCC that may differ from the GHG inventories used for the EU-28 inventory because these countries submit more than one inventory to the UNFCCC which have different geographical coverages. However, the EU's submission under the Convention is fully consistent with MS GHG emissions by sources and sinks according to the EU territory. And the EU's submission under the Kyoto Protocol is fully consistent with the joint ratification of the second commitment period of KP by the EU (see Table 1.20).

Table 1.20 Geographical coverage of the Union's GHG inventory

Member State	Geographical coverage	EU and MS Party coverage (Kyoto Protocol, second committment period)	EU-territory coverage (UNFCCC)	Party coverage (UNFCCC)	Country code
Austria	Austria	√	√	√	AUT
Belgium	Belgium consisting of Flemish Region, Walloon Region and Brussels Region	√	√	√	BEL
Bulgaria	Bulgaria	√	√	√	BGR
Croatia	Croatia	√	√	√	HRV
Cyprus	Area under the effective control of the Republic of Cyprus	√	√	√	CYP
Czech Republic	Czech Republic	√	√	√	CZE
Denmark	Denmark (excluding Greenland and the Faeroe Islands)	√	√		DNM
Estonia	Estonia	√	√	√	EST
Finland	Finland including Åland Islands	√	√	√	FIN
France	Metropolitan France, the overseas departments (Guadeloupe, Martinique, Guyana and Reunion) and the overseas communities (Saint-Barthelemy, Saint-Martin and Mayotte), excluding the French overseas communities (French Polynesia, Wallis and Futuna, Saint-Pierre and Miquelon) and overseas territories (the French Southern and Antarctic Lands) and New Caledonia.	√	√		FRK
	Metropolitan France, the overseas departments (Guadeloupe, Martinique, Guyana and Reunion), the overseas communities (French Polynesia, Saint-Barthelemy and Saint-Martin, Wallis and Futuna, Mayotte, Saint-Pierre and Miquelon) and overseas territories (the French Southern and Antarctic Lands) and New Caledonia.			√	FRA
Germany	Germany	√	√	√	DEU
Greece	Greece	√	√	√	GRC
Hungary	Hungary	√	√	√	HUN
Ireland	Ireland	√	√	√	IRE
Italy	Italy	√	√	√	ITA
Latvia	Latvia	√	√	√	LVA
Lithuania	Lithuania	√	√	√	LTU
Luxembourg	Luxembourg	√	√	√	LUX
Malta	Malta	√	√	√	MLT
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	√	√	√	NLD
Poland	Poland	√	√	√	POL
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	√	√	√	PRT
Romania	Romania	√	√	√	ROU
Slovakia	Slovakia	√	√	√	SVK
Slovenia	Slovenia	√	√	√	SVN
Spain	Spanish part of Iberian mainland, Canary Islands, Balearic Islands, Ceuta and Melilla	√	√	√	ESP
Sweden	Sweden	√	√	√	SWE
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).		√		GBE
	England, Scotland, Wales and Northern Ireland and the UK Overseas Territories and UK Crown Dependencies to whom the UK's ratification of the Kyoto Protocol has been extended and whose emissions are included for the second commitment period (the Cayman Islands, the Falkland Islands, Gibraltar, Jersey, Guernsey and the Isle of Man).	√			GBK
	England, Scotland, Wales and Northern Ireland and the UK Overseas Territories and UK Crown Dependencies for whom the UK's ratification of the UN Framework Convention on Climate Change is extended (the Cayman Islands, the Falkland Islands, Gibraltar, Bermuda, Jersey, Guernsey and the Isle of Man).			√	GBR
European	EU-28		√	√	EUA
Iceland	Iceland	√		√	
European Union and	EU-28, Iceland and the relevant UK's Overseas Territories and Crown Dependencies.	√			EUC

Notes: FRA includes emissions from Mayotte only since 2014

1.7.6 Completeness of the European Union submission

1.7.6.1 National inventory report

The EU NIR follows – as far as possible - 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 Member States tables for every CRF table. Table 1.21 provides information on what is included in the Annexes to the EU GHG inventory report and provides explanations where the EU does not follow the UNFCCC reporting guidelines.

Table 1.21 Annexes as outlined in the UNFCCC reporting guidelines and annexes included in the EU submission

Annex required in the UNFCCC reporting guidelines	Annex included in the EU submission
Annex I: Key categories	Included: Key category analyses Tier 1 including and excluding LULUCF
Annex II: Assessment of uncertainty	Included: The uncertainty assessment is included in the NIR, section 1.6
Annex III: Detailed methodological descriptions for individual source or sink categories	Included: A summary description of the methodologies used by each Member State for the EU key categories
Annex IV: National energy balance of the most recent year	Not included: 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 V: Additional information	Included: Summary Table 2 for all MS in order to make transparent the data basis of the EU inventory

1.7.6.2 Activity data in the EU CRF

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. The 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-level these different types of activity data cannot be simply added up. It should be noted that at EU-level no emissions are calculated directly on the basis of activity data reported by MS. However, all the details for the calculation of MS emissions are documented in the Member States' CRF tables, as part of their national GHG inventories.

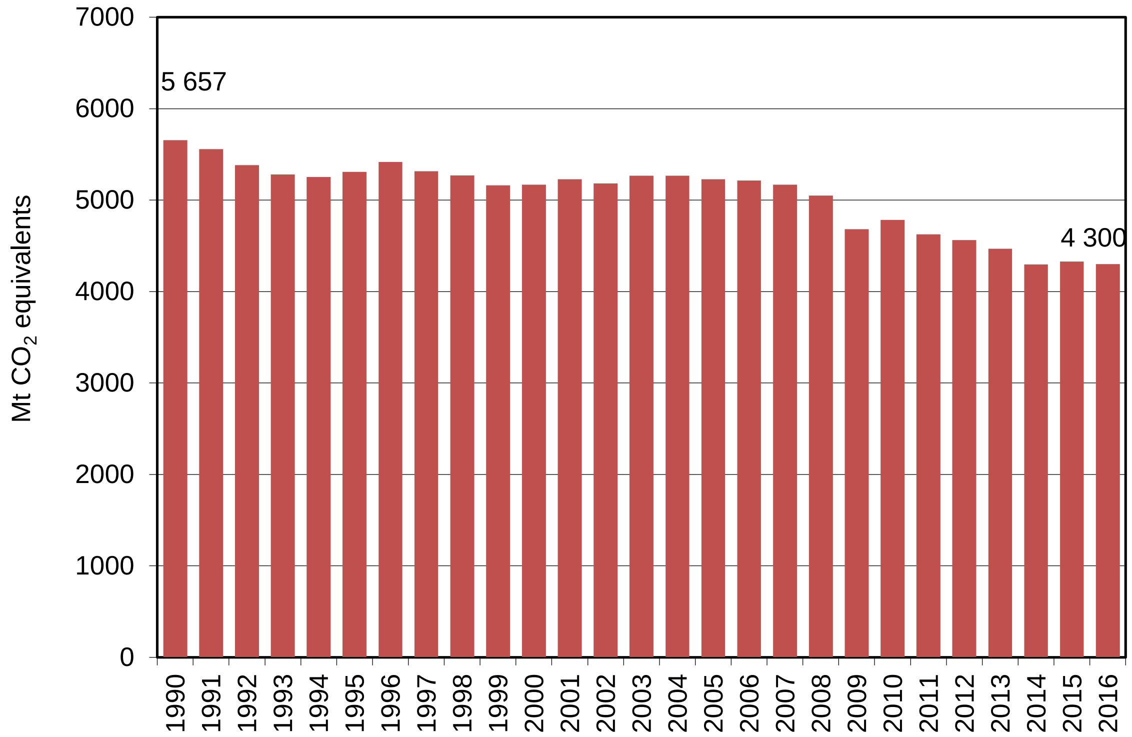
2 EU GREENHOUSE GAS EMISSION TRENDS

This chapter presents the main GHG emission trends in the EU. Aggregated results are described as regards total GHG and emission trends are briefly analysed mainly at gas level. A short overview of Member States' contributions to total EU GHG trends is given. Finally, the trends of indirect GHGs and SO_2 emissions are presented.

2.1 Aggregated greenhouse gas emissions

In 2016 total GHG emissions in the EU-28 and Iceland, without LULUCF, were 24.0 % (-1 356 million tonnes CO_2 equivalents) below 1990. Emissions decreased by 0.6 % (-27 million tonnes CO_2 equivalents) between 2015 and 2016 (Figure 2.1).

Figure 2.1 EU-28 and Iceland GHG emissions 1990–2016 (excl. LULUCF)



Notes: GHG emission data for the EU-28 and Iceland as a whole refer to domestic emissions (i.e. within its territory), include indirect CO_2 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 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 Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC).

2.1.1 Main trends by source category, 1990-2016

Total GHG emissions (excluding LULUCF) decreased by 1 356 million tonnes since 1990 (or 24.0 %) reaching their lowest level during this period in 2014 (4 298 Mt CO_2 eq.). There has been a progressive decoupling of gross domestic product (GDP) and GHG emission compared to 1990, with an increase in GDP of about 53 % alongside a decrease in emissions of 24 % over the period.

The reduction in greenhouse gas emissions over the 26-year period was due to a variety of factors, including the growing share in the use of renewables, the use of less carbon intensive fuels and improvements in energy efficiency, as well as to structural changes in the economy and the economic recession. Demand for energy to heat households has also been lower, as Europe on average has experienced milder winters since 1990, which has also helped reduce emissions.

GHG emissions decreased in the majority of sectors between 1990 and 2016, with the notable exception of transport, including international transport, and refrigeration and air conditioning. At the aggregate level, emission reductions were largest for manufacturing industries and construction, electricity and heat production, and residential combustion.

A combination of factors explains lower emissions in industrial sectors, such as improved efficiency and carbon intensity as well as structural changes in the economy, with a higher share of services and a lower share of more-energy-intensive industry in total GDP. The economic recession that began in the second half of 2008 and continued through to 2009 also had an impact on emissions from industrial sectors. Emissions from electricity and heat production decreased strongly since 1990. In addition to improved energy efficiency there has been a move towards less carbon intense fuels. Between 1990 and 2016, the use of solid and liquid fuels in thermal stations decreased strongly whereas natural gas consumption doubled, resulting in reduced CO_2 emissions per unit of fossil energy generated. Emissions in the residential sector also represented one of the largest reductions. Energy efficiency improvements from better insulation standards in buildings and a less carbon-intensive fuel mix can partly explain lower demand for space heating in the EU as a whole over the past 26 years. Since 1990, there has been a warming of the autumn/winter in Europe; although there is high regional variability. The very strong increase in the use of biomass for energy purposes has also contributed to lower GHG emissions in the EU.

In terms of the main GHGs, CO_2 was responsible for the largest reduction in emissions since 1990. Reductions in emissions from N_2O and CH_4 have been substantial, reflecting lower levels of mining activities, lower agricultural livestock, as well as lower emissions from managed waste disposal on land and from agricultural soils. A number of policies (both EU and country-specific) have also contributed to the overall GHG emission reduction, including key agricultural and environmental policies in the 1990s and climate and energy policies in the 2000s.

Almost all EU Member States reduced emissions compared to 1990 and thus contributed to the overall positive EU performance. The UK and Germany accounted for about 48% of the total net reduction in the EU of the past 26 years.

Table 2.1 shows those sources that made the largest contribution to the change in total GHG emissions in the EU plus Iceland between 1990 and 2016.

Table 2.1 Overview of EU-28 plus Iceland source categories whose emissions increased or decreased by more than 20 Million tonnes CO_2 equivalent in the period 1990-2016

Source category	Million tonnes (CO_2 equivalents)
Road Transportation (CO_2 from 1.A.3.b)	163
Refrigeration and Air conditioning (HFCs from 2.F.1)	97
Aluminium Production (PFCs from 2.C.3)	-21
Agricultural Soils: Direct N_2O Emissions From Managed Soils (N_2O from 3.D.1)	-26
Fugitive emisisons from Natural Gas (CH_4 from 1.B.2.b)	-26
Cement Production (CO_2 from 2.A.1)	-28
Fluorochemical Production (HFCs from 2.B.9)	-29
Commercial/Institutional (CO_2 from 1.A.4.a)	-40
Enteric Fermentation: Cattle (CH_4 from 3.A.1)	-44
Nitric Acid Production (N_2O from 2.B.2)	-46
Adipic Acid Production (N_2O from 2.B.3)	-57
Manufacture of Solid Fuels and Other Energy Industries (CO_2 from 1.A.1.c)	-61
Coal Mining and Handling (CH_4 from 1.B.1.a)	-69
Managed Waste Disposal Sites (CH_4 from 5.A.1)	-73
Residential: Fuels (CO_2 from 1.A.4.b)	-109
Iron and steel production (CO_2 from 1.A.2.a +2.C.1)	-120
Manufacturing industries (excl. Iron and steel) (Energy-related CO_2 from 1.A.2 excl. 1.A.2.a)	-278
Public Electricity and Heat Production (CO_2 from 1.A.1.a)	-420
Total	**-1356**

Notes: As the table only presents sectors whose emissions increased or decreased by at least 20 million tonnes CO_2-equivalent, the sum of the source categories presented does not match the total change listed at the bottom of the table.

2.1.2 Main trends by source category, 2015-2016

Total GHG emissions (excluding LULUCF) decreased in 2016 by 26.8 million tonnes, or -0.6 % compared to 2015, to reach 4 300 Mt CO_2 equivalent in 2016. This small decrease in emissions came along with an increase in GDP of 2 %. The United Kingdom and Spain accounted for the largest decreases in GHG emissions in absolute terms in the EU in 2016. Reductions in these countries were largely because of lower consumption of solid fuels in the power sector. On the other hand, there was a relatively large increase in emissions in Poland, particularly in the road transport sector.

In terms of sectors, emissions decreased in energy supply (mostly in electricity and heat production) and industry (mostly in iron and steel). The overall 0.6% net decrease in total GHG emissions was partly offset by increased fuel-use for road transportation as well as by higher heat consumption in the residential/commercial sectors due to colder winter conditions in 2016. This increase in road transportation can be attributed mainly to higher diesel consumption in passenger cars, but also in heavy- and light-duty vehicles.

In terms of fuels, there was a very strong decline in coal consumption (in the power sector) and a large increase in the consumption of natural gas (in the residential sector). Oil consumption also increased in 2016. Based on Eurostat data, the decline in nuclear electricity in 2016 was offset by a larger increase in the use of renewable energy sources.

Other positive developments in 2016 are the continued decoupling of GHG from GDP, the improved energy intensity of the economy and the better carbon intensity of the energy system compared to 2015. The improvement in energy intensity was largely driven by lower transformation losses and better energy efficiency. The improvement in carbon intensity was driven by higher consumption of renewables and of natural gas and lower consumption of solid fuels.

Table 2.2 shows the source categories making the largest contribution to the change in GHG emissions in the EU-28 between 2015 and 2016.

Table 2.2 Overview of EU-28 plus Iceland source categories whose emissions increased or decreased by more than 3 million tonnes CO_2 equivalent in the period 2015–2016

Source category	**Million tonnes (CO_2 equivalents)**
Road Transportation (CO_2 from 1.A.3.b)	19
Residential: Fuels (CO_2 from 1.A.4.b)	15
Commercial/Institutional (CO_2 from 1.A.4.a)	4
Iron and steel production (CO_2 from 1.A.2.a +2.C.1)	-8
Public Electricity and Heat Production (CO_2 from 1.A.1.a)	-49
Total	**-27**

Notes: As the table only presents sectors whose emissions have increased or decreased by at least 3 million tonnes of CO_2- equivalent, the sum of the source categories presented does not match the total change listed at the bottom of the table

Table 2.3 gives an overview on total GHG emissions by Member States, illustrating where main changes occurred.

Table 2.3 Greenhouse gas emissions in CO_2 equivalent (excl. LULUCF)

	1990 (million tonnes)	2016 (million tonnes)	2015 - 2016 (million tonnes)	Change 2015 - 2016 (%)	Change 1990-2016 (%)
Austria	78.7	79.7	0.8	1.0%	1.2%
Belgium	146.7	117.7	0.1	0.1%	-19.7%
Bulgaria	104.0	59.1	-2.7	-4.4%	-43.2%
Croatia	31.9	24.3	0.1	0.5%	-23.8%
Cyprus	5.6	8.8	0.4	5.3%	56.9%
Czech Republic	199.6	130.3	1.9	1.5%	-34.7%
Denmark	70.4	50.5	2.0	4.1%	-28.3%
Estonia	40.4	19.6	1.6	8.7%	-51.4%
Finland	71.3	58.8	3.4	6.1%	-17.6%
France	546.4	458.2	0.1	0.0%	-16.1%
Germany	1251.6	909.4	2.7	0.3%	-27.3%
Greece	103.1	91.6	-3.7	-3.9%	-11.1%
Hungary	93.8	61.5	0.5	0.7%	-34.5%
Ireland	55.5	61.5	2.1	3.6%	10.9%
Italy	518.4	427.9	-5.0	-1.2%	-17.5%
Latvia	26.5	11.3	0.0	-0.2%	-57.3%
Lithuania	48.1	20.1	-0.1	-0.5%	-58.3%
Luxembourg	12.8	10.0	-0.2	-2.4%	-21.6%
Malta	2.1	1.9	-0.3	-14.2%	-9.1%
Netherlands	221.3	195.2	0.5	0.2%	-11.8%
Poland	467.3	395.8	10.7	2.8%	-15.3%
Portugal	59.9	67.8	-1.8	-2.6%	13.1%
Romania	246.7	112.5	-3.7	-3.2%	-54.4%
Slovakia	74.0	41.0	0.1	0.3%	-44.5%
Slovenia	18.6	17.7	0.9	5.1%	-4.9%
Spain	287.7	324.7	-11.1	-3.3%	12.9%
Sweden	71.5	52.9	-0.9	-1.6%	-26.0%
United Kingdom	796.6	482.8	-25.1	-4.9%	-39.4%
EU-28	5650.4	4292.7	-26.7	-0.6%	-24.0%
Iceland	3.6	4.7	-0.1	-1.7%	28.5%
United Kingdom (KP)	799.1	485.5	-25.0	-4.9%	-39.2%
EU-28 + ISL	5656.5	4300.1	-26.8	-0.6%	-24.0%

2.2 Emission trends by gas

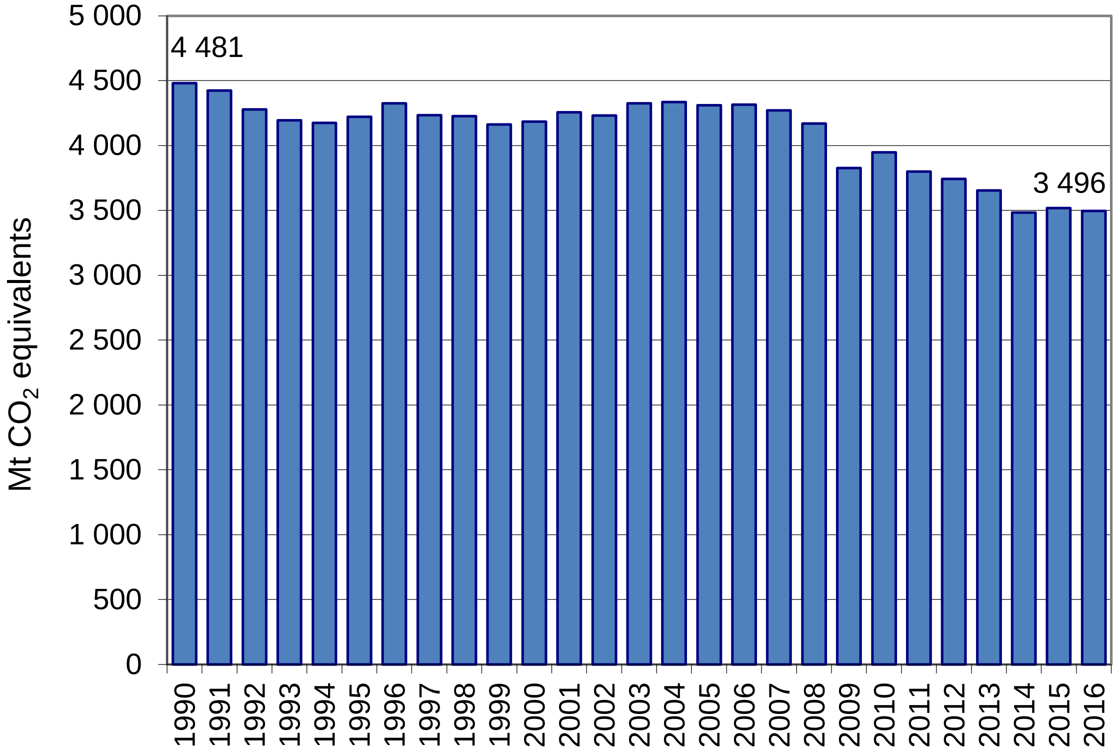
Table 2.4, Figure 2.2 and Figure 2.3 give an overview of the main trends in EU GHG emissions and removals for 1990–2016. In the EU the most important GHG is CO_2, accounting for 81 % of total EU emissions in 2016 excluding LULUCF. In 2016, EU CO_2 emissions excluding LULUCF were 3 496 Mt, which was 22 % below 1990 levels. Compared to 2015, CO_2 emissions decreased by 0.6 %.

Table 2.4 Overview of EU-28 and Iceland GHG emissions and removals from 1990 to 2016 in CO_2 equivalent

GREENHOUSE GAS EMISSIONS	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Net CO_2 emissions/removals	4 208	3 922	3 855	3 974	3 969	3 957	3 824	3 479	3 608	3 473	3 413	3 320	3 153	3 188	3 182
CO_2 emissions (without LULUCF)	4 481	4 221	4 185	4 310	4 316	4 270	4 170	3 827	3 946	3 800	3 742	3 654	3 484	3 518	3 496
CH_4	730	669	611	549	535	528	515	504	493	483	480	468	461	461	457
N_2O	397	360	318	298	287	288	278	263	253	248	246	246	249	249	248
HFCs	29	44	55	77	83	91	97	98	104	106	109	112	115	110	110
PFCs	26	17	12	7	7	6	6	4	4	4	4	4	4	4	4
Unspecified mix of HFCs and PFCs	6	6	2	1	1	1	1	1	0	0	1	1	1	1	1
SF_6	11	15	11	8	7	7	7	6	7	6	6	6	6	6	7
NF_3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total (with net CO_2 emissions/removals)	**5 407**	**5 033**	**4 864**	**4 915**	**4 890**	**4 879**	**4 727**	**4 355**	**4 469**	**4 321**	**4 259**	**4 158**	**3 988**	**4 019**	**4 009**
Total (without CO2 from LULUCF)	**5 680**	**5 332**	**5 194**	**5 250**	**5 237**	**5 192**	**5 072**	**4 703**	**4 807**	**4 649**	**4 588**	**4 491**	**4 320**	**4 349**	**4 323**
Total (without LULUCF)	**5 657**	**5 307**	**5 169**	**5 227**	**5 215**	**5 168**	**5 051**	**4 680**	**4 785**	**4 627**	**4 564**	**4 469**	**4 298**	**4 327**	**4 300**

Notes: CO_2 emissions include indirect CO_2

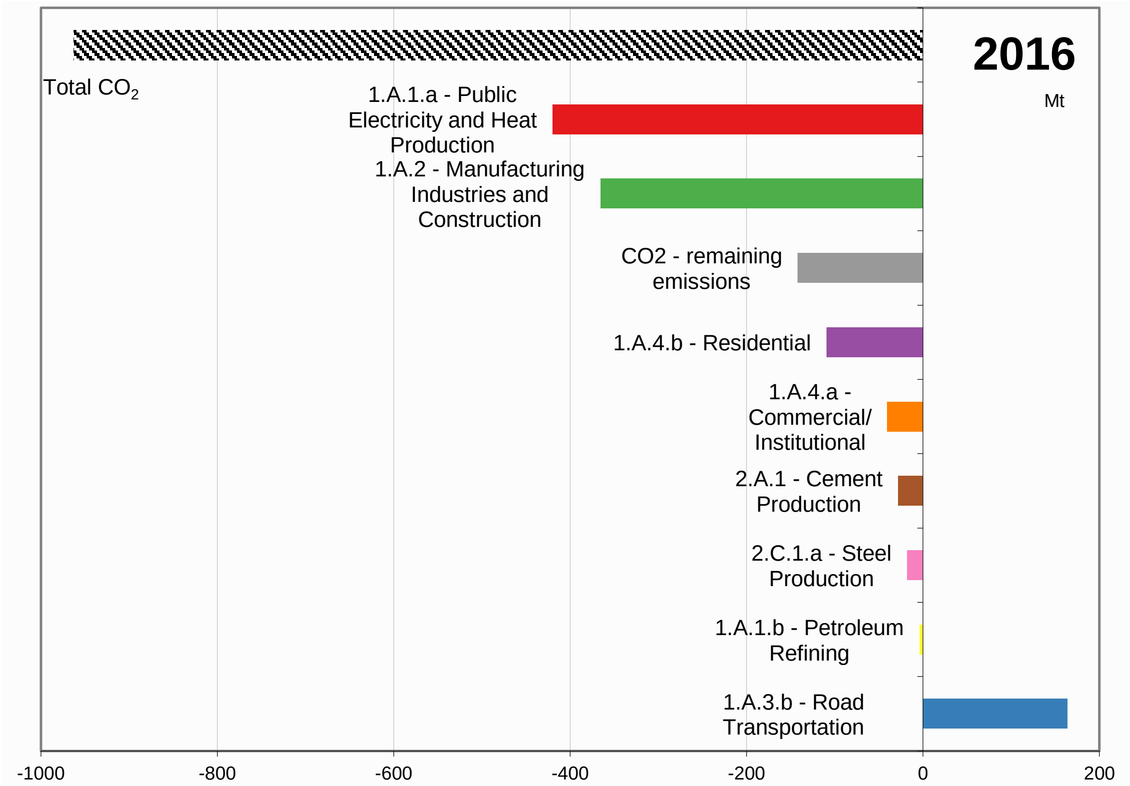
Figure 2.2 CO_2 emissions 1990 to 2016 (Mt)



Notes: CO_2 emissions include indirect CO_2

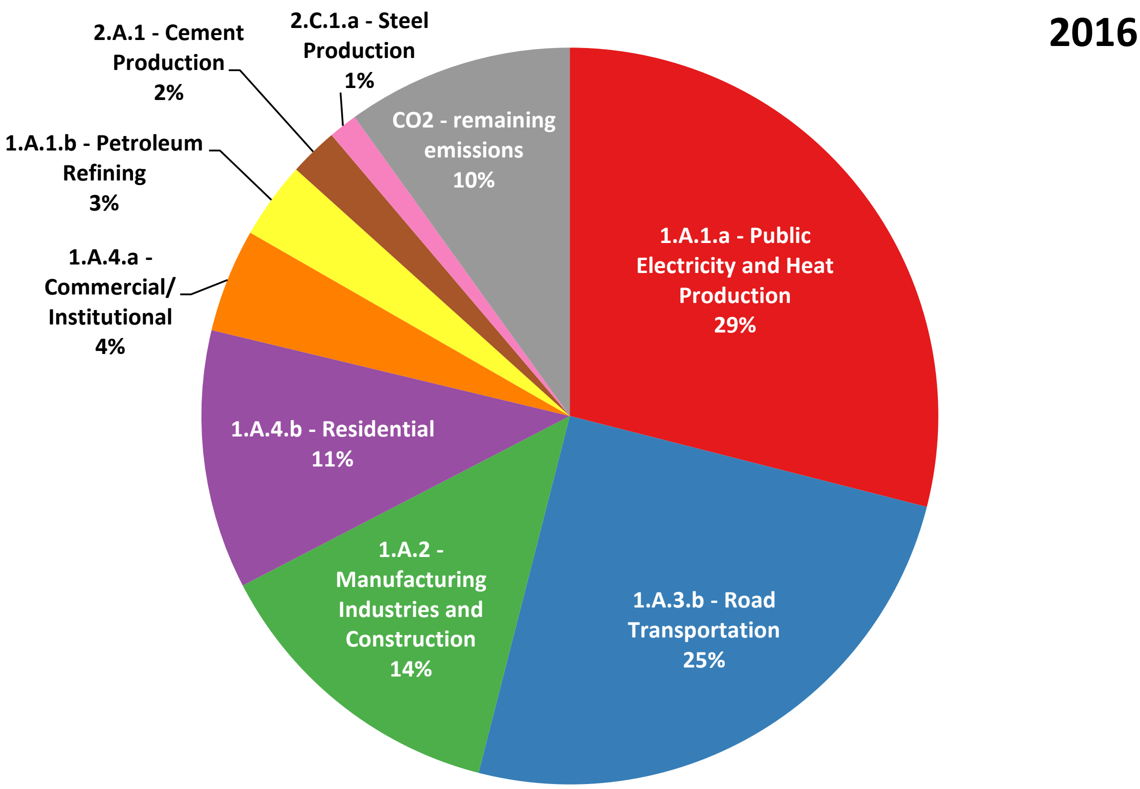
The largest key source categories for CO_2 emissions (Figure 2.3) have been reduced between 1990 and 2016 with the exception of 1.A.3.b Road transportation which accounts for 25 % of CO_2 emissions in 2016.

Figure 2.3 Absolute change of CO_2 emissions by large key source categories 1990 to 2016 in CO_2 equivalents (Mt) for EU-28 and Iceland



Note: Other is calculated by subtracting the presented categories from the sector total

Figure 2.4 CO_2 emissions: Share of key source categories and all remaining categories in 2016 for EU-28 and Iceland



Note: Other is calculated by subtracting the presented categories from the sector total

CH_4 emissions account for 11 % of total EU GHG emissions in 2016 and decreased by 37 % since 1990 to 457 Mt CO_2 equivalents in 2016 (Figure 2.5). The two largest key sources are enteric fermentation and anaerobic waste. They account for 53 % of CH_4 emissions in 2016.

Figure 2.5 CH_4 emissions 1990 to 2016 in CO_2 equivalents (Mt)

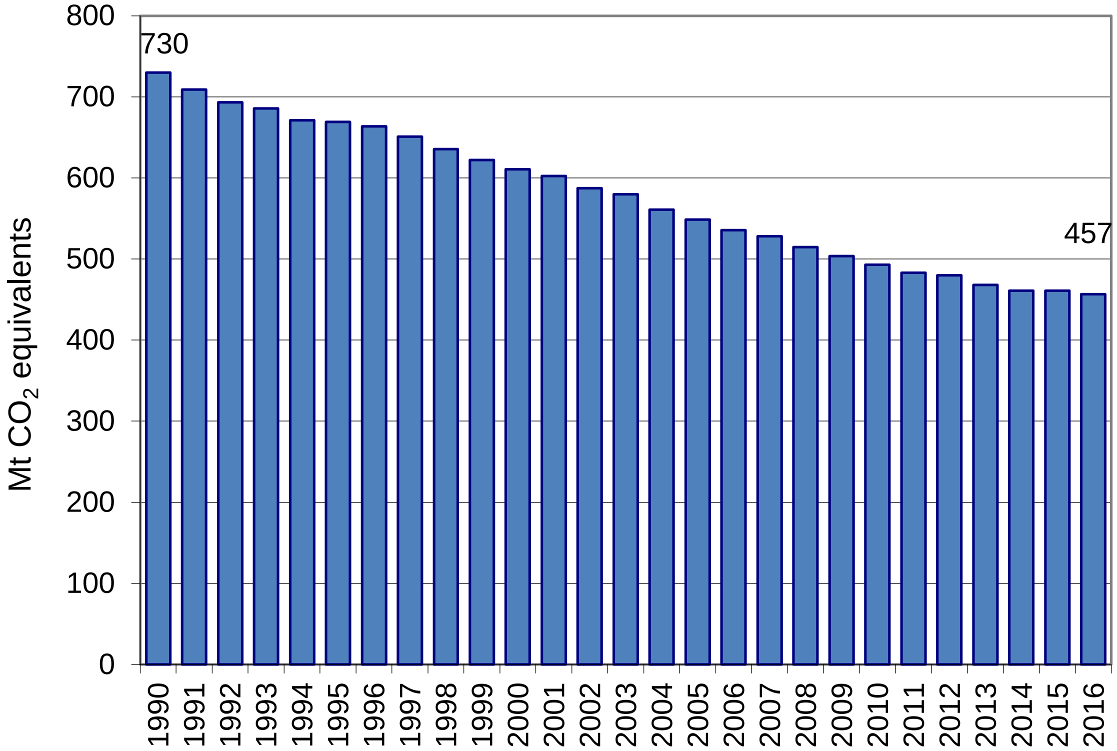
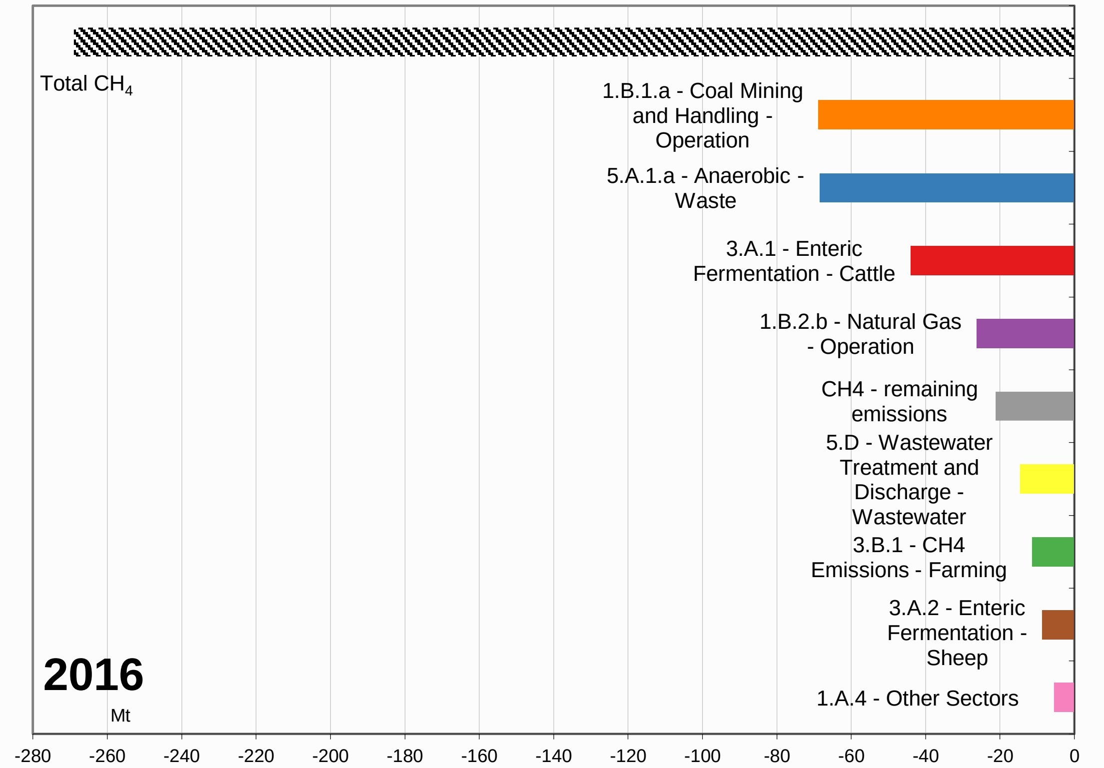


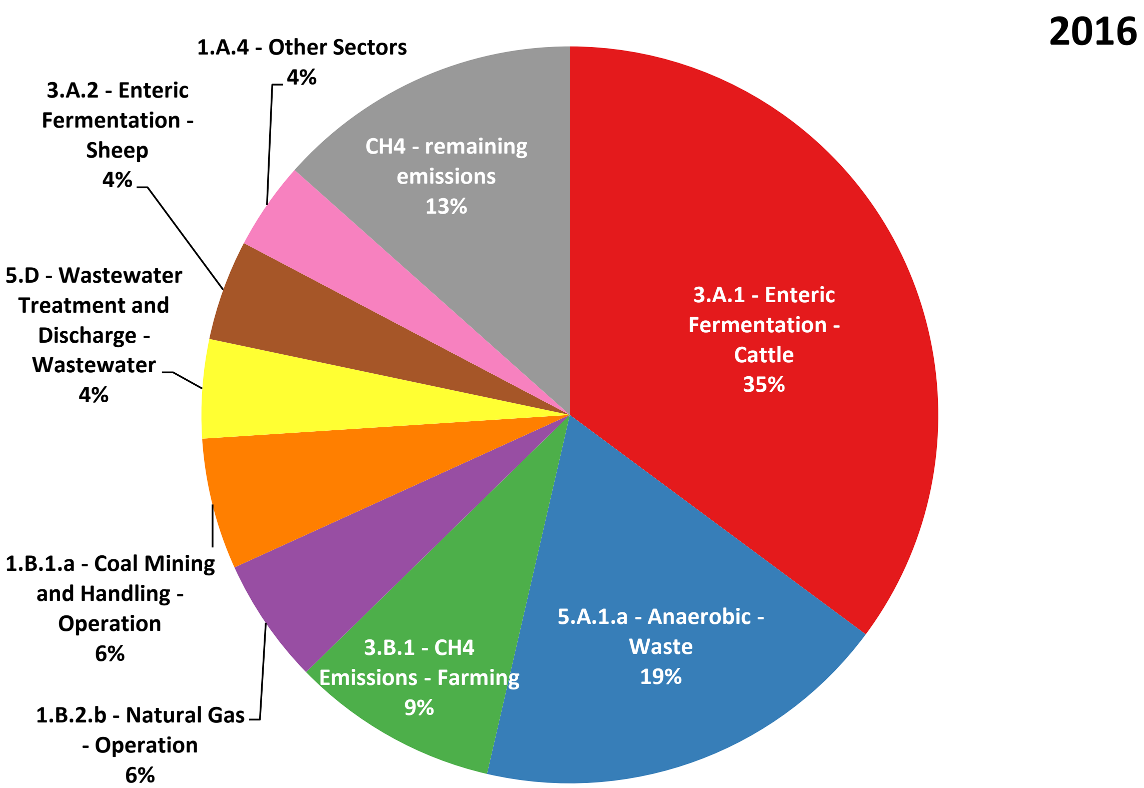
Figure 2.6 shows that the main reasons for declining CH_4 emissions were reductions in coal mining and anaerobic waste.

Figure 2.6 Absolute change of CH_4 emissions by large key source categories 1990 to 2016 in CO_2 equivalents (Mt) for EU-28 and Iceland



Note: Other is calculated by subtracting the presented categories from the sector total

Figure 2.7 CH_4 emissions: Share of key source categories and all remaining categories in 2016 for EU-28 and Iceland



Note: Other is calculated by subtracting the presented categories from the sector total

N_2O emissions are responsible for 6 % of total EU GHG emissions and decreased by 37 % to 248 Mt CO_2 equivalents in 2016 (Figure 2.8). N_2O emissions derive mainly from the agriculture sector. The two largest key sources account for about 64 % of N_2O emissions in 2016. Figure 2.9 shows that the main reason for large N_2O emission cuts were reduction in chemical industry and agricultural soils.

Figure 2.8 N_2O emissions 1990 to 2016 in CO_2 equivalents (Mt)

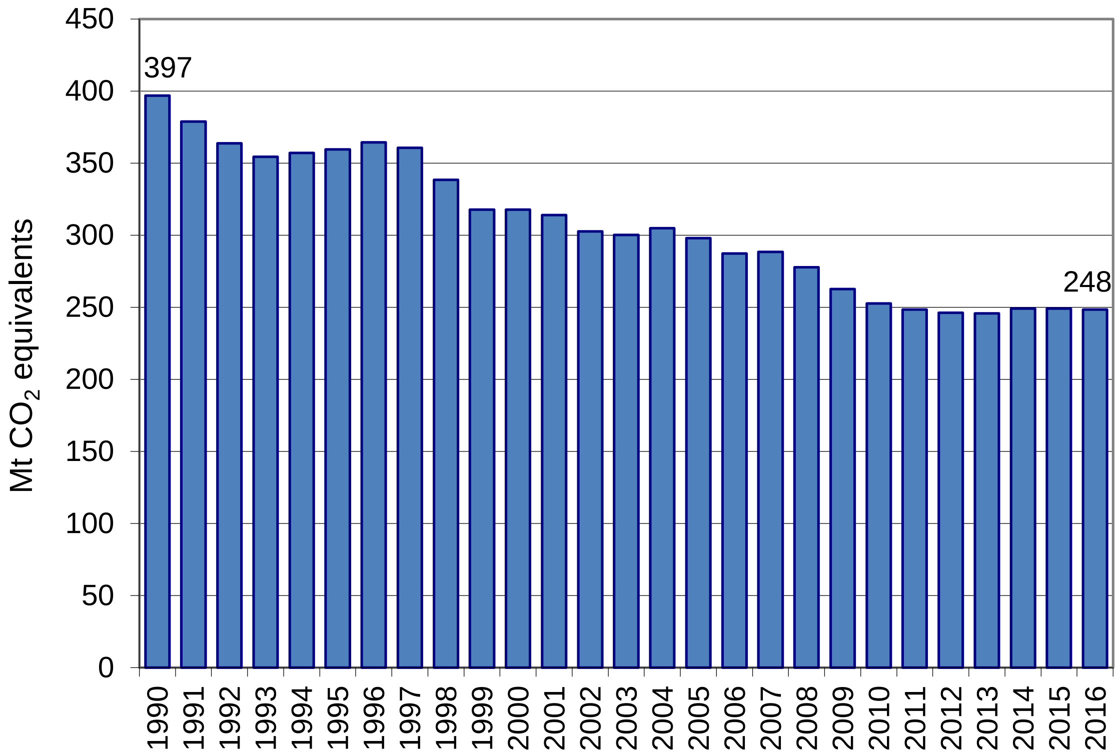
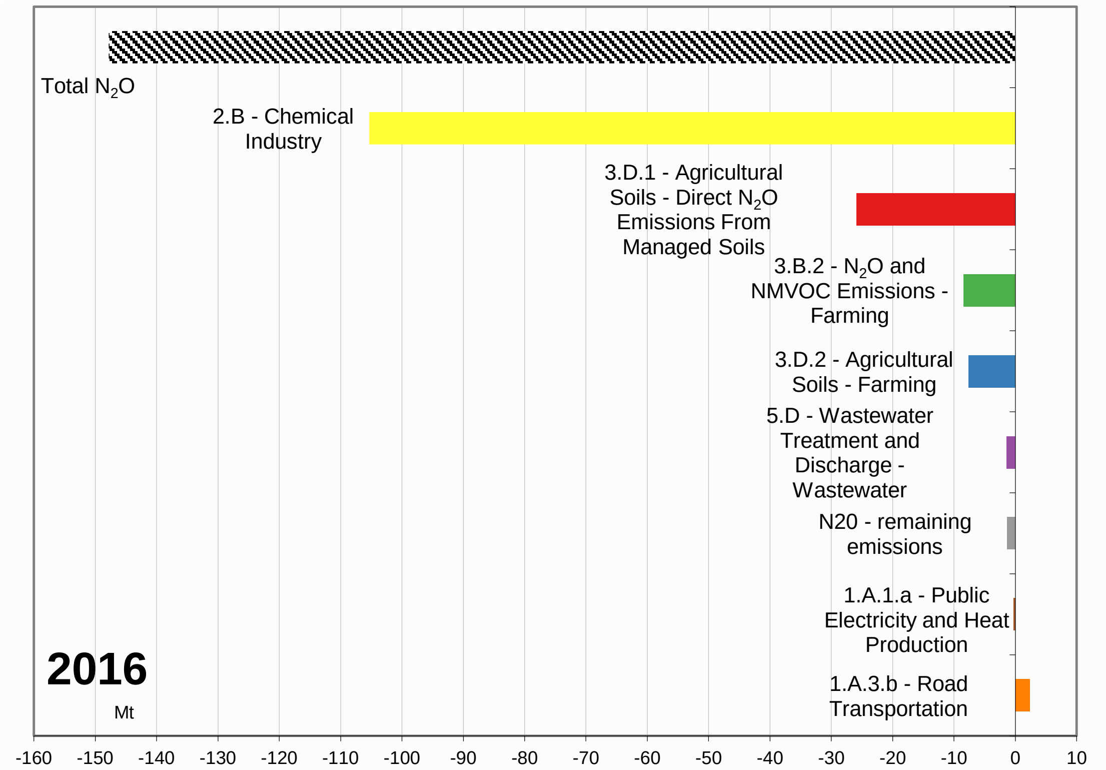
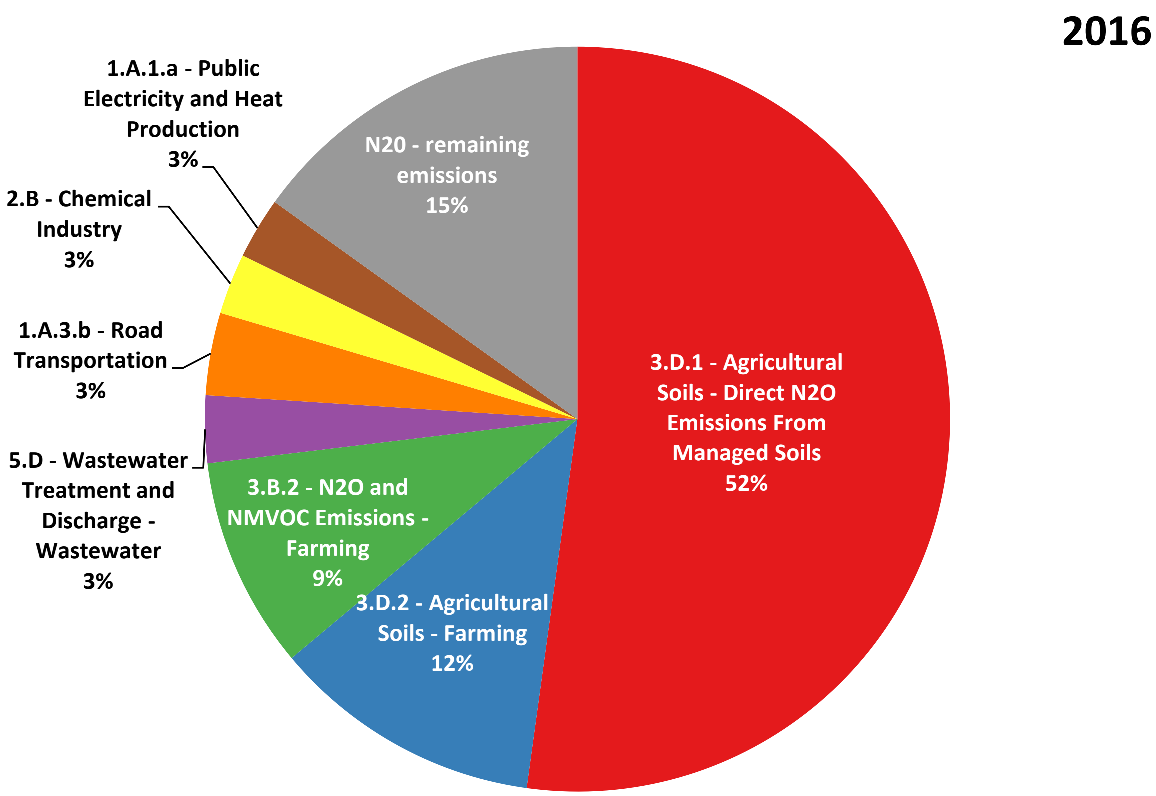


Figure 2.9 Absolute change of N_2O emissions by large key source categories 1990 to 2016 in CO_2 equivalents (Mt) for EU-28 and Iceland



Note: Other is calculated by subtracting the presented categories from the sector total

Figure 2.10 N_2O emissions: Share of key source categories and all remaining categories in 2016 for EU-28 and Iceland



Note: Other is calculated by subtracting the presented categories from the sector total

Fluorinated gas emissions account for 2.8 % of total EU GHG emissions. In 2016, emissions were 122 Mt CO_2 equivalents, which was 68 % above 1990 levels (Figure 2.11). Refrigeration and air conditioning, the largest key category, accounts for 80 % of fluorinated gas emissions in 2016. Figure 2.12 reveals that HFCs from refrigeration and air conditioning showed large increases between 1990 and 2016. 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, the sum of HFC emissions from categories not presented individually in Figure 2.12 (Other in Figure 2.12) decreased substantially.

Figure 2.11 Fluorinated gas emissions 1990 to 2016 in CO_2 equivalents (Mt)

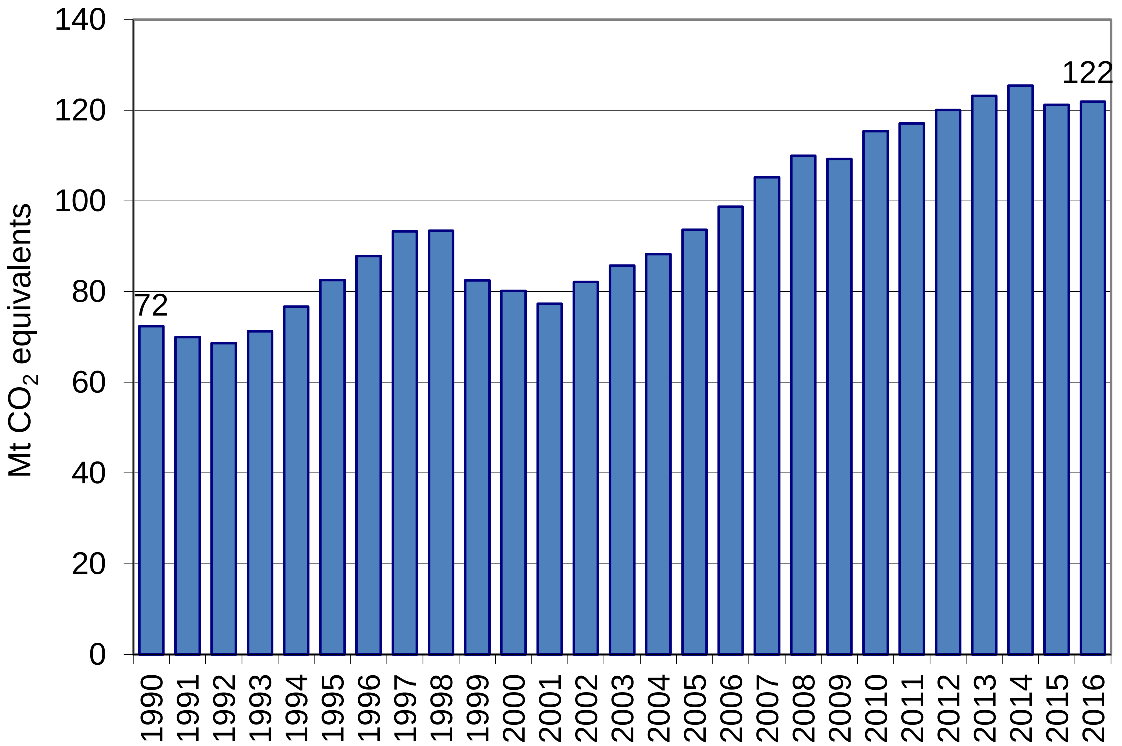
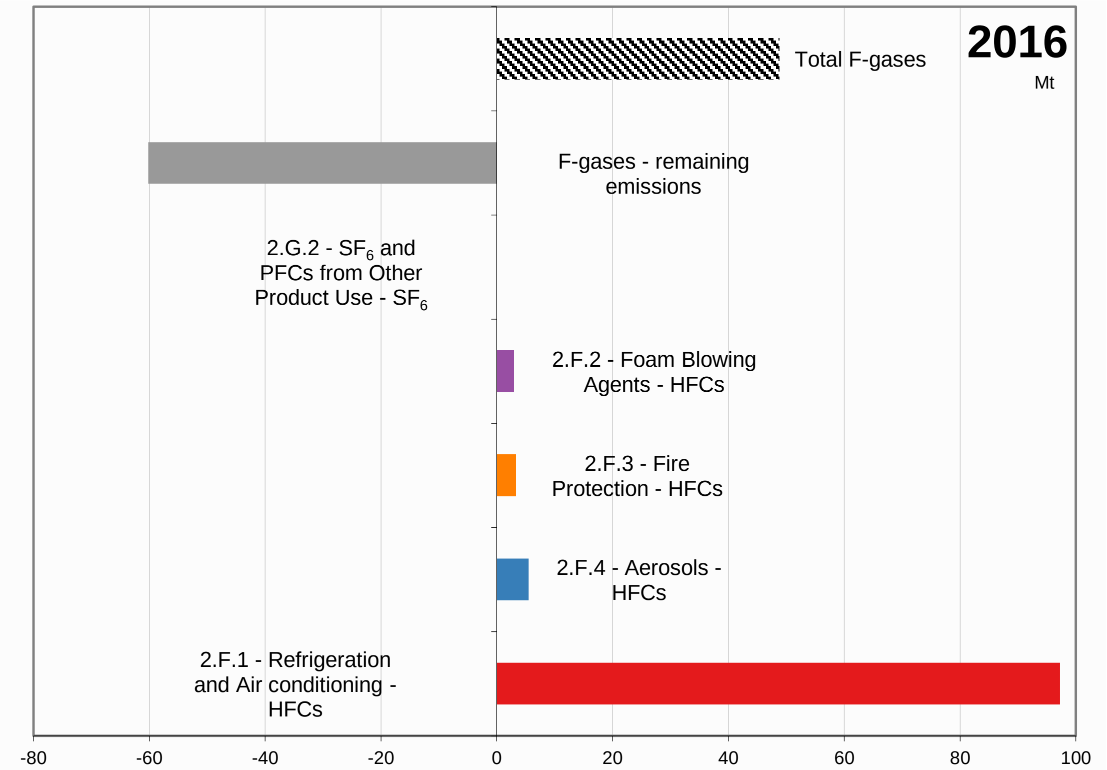
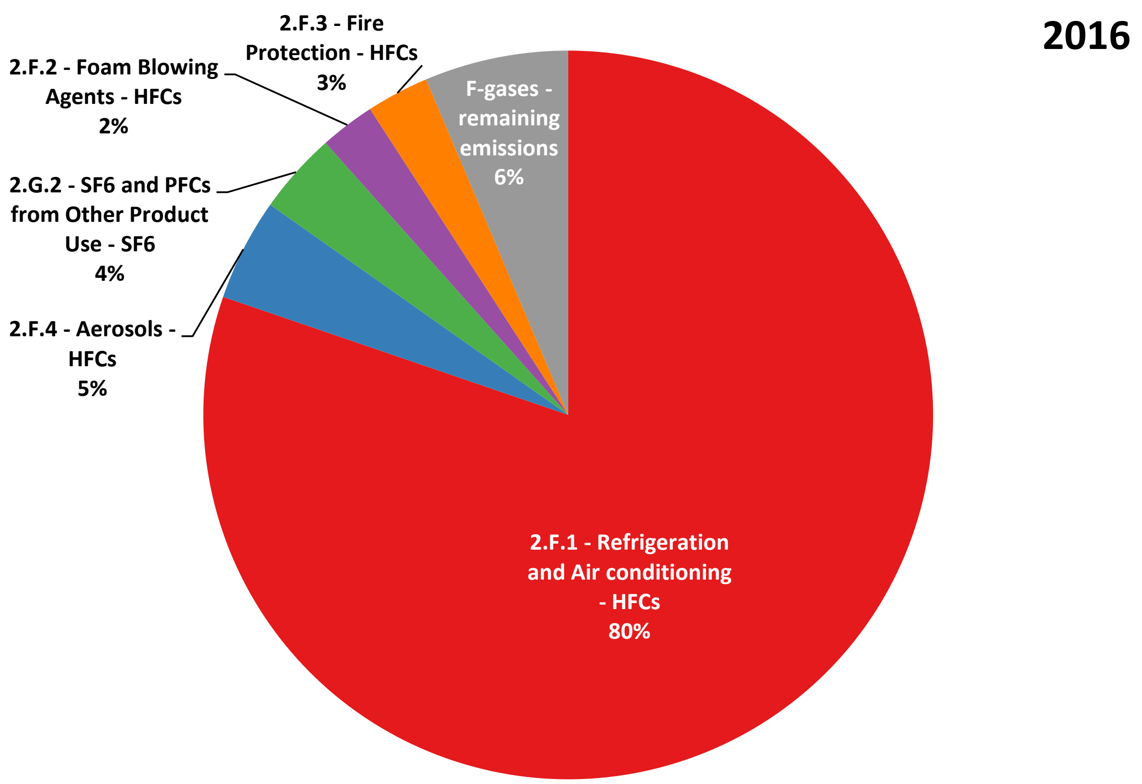


Figure 2.12 Absolute change of fluorinated gas emissions by large key source categories 1990 to 2016 in CO_2 equivalents (Mt) for EU-28 and Iceland



Note: Other is calculated by subtracting the presented categories from the sector total

Figure 2.13 Fluorinated gas: Share of key source categories and all remaining categories in 2016 for EU-28 and Iceland



Note: Other is calculated by subtracting the presented categories from the sector total

2.3 Emission trends by source

Table 2.5 gives an overview of EU-28 and Iceland GHG emissions in the main source categories for 1990–2016. The most important sector by far is energy (i.e. combustion and fugitive emissions), which accounted for 78°% of total EU emissions in 2016. The second largest sector is agriculture (10°%), followed by industrial processes (9°%). More detailed trend descriptions are included in the individual sector chapters (chapters 3-7).

More detailed trend descriptions are included in Chapters 3 to 9.

Table 2.5 Overview of EU-28 and Iceland GHG emissions (in million tonnes CO_2 equivalent) in the main source and sink categories for the period 1990 to 2016

GHG SOURCE AND SINK	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
1. Energy	4 355	4 088	4 022	4 123	4 121	4 066	3 985	3 701	3 800	3 651	3 607	3 518	3 339	3 375	3 352
2. Industrial Processes	518	499	457	467	466	478	453	379	396	392	379	378	384	379	377
3. Agriculture	543	473	459	435	431	434	431	426	421	421	419	422	429	430	431
4. Land-Use, Land-Use Change and Forestry	-250	-275	-305	-312	-325	-289	-324	-325	-317	-306	-306	-312	-310	-307	-291
5. Waste	236	244	229	200	194	188	179	173	166	161	157	150	144	141	139
6. Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
indirect CO_2 emissions	4.3	3.7	2.7	2.3	2.3	2.2	2.1	1.9	2.0	1.8	1.8	1.6	1.6	1.6	1.5
Total (with net CO_2 emissions/removals)	**5 407**	**5 033**	**4 864**	**4 915**	**4 890**	**4 879**	**4 727**	**4 355**	**4 469**	**4 321**	**4 259**	**4 158**	**3 988**	**4 019**	**4 009**
Total (without LULUCF)	**5 657**	**5 307**	**5 169**	**5 227**	**5 215**	**5 168**	**5 051**	**4 680**	**4 785**	**4 627**	**4 564**	**4 469**	**4 298**	**4 327**	**4 300**

Notes: CO_2 emissions include indirect CO_2

2.4 Emission trends by Member State

Table 2.6 gives an overview of EU countries‘ contributions to the EU GHG emissions for 1990–2016 Member States show large variations in GHG emission trends.

Table 2.6 Overview of EU-28 plus Iceland contributions to total GHG emissions, excluding LULUCF, including indirect CO_2 emissions, from 1990 to 2016 in million tonnes CO_2-equivalent

Member State	**1990**	**1995**	**2000**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Austria	79	80	80	93	90	87	87	80	85	82	80	80	76	79	80
Belgium	147	155	150	145	143	139	139	126	133	122	119	120	114	118	118
Bulgaria	104	75	60	64	64	68	67	58	61	66	61	56	59	62	59
Croatia	32	23	26	30	30	32	30	29	28	28	26	25	24	24	24
Cyprus	6	7	8	9	9	10	10	10	9	9	9	8	8	8	9
Czech Republic	200	159	150	148	149	151	146	138	141	138	134	129	127	128	130
Denmark	70	78	71	66	74	69	66	63	63	58	53	55	51	49	50
Estonia	40	20	17	19	18	22	20	17	21	21	20	22	21	18	20
Finland	71	72	70	70	81	79	71	68	76	68	62	63	59	55	59
France	546	541	551	553	541	532	525	502	512	484	485	484	454	458	458
Germany	1252	1123	1045	993	1000	973	975	908	943	920	925	942	903	907	909
Greece	103	109	126	136	132	135	132	124	118	115	112	103	99	95	92
Hungary	94	75	73	76	75	73	71	65	65	64	60	57	58	61	61
Ireland	55	59	69	70	69	68	67	62	61	57	58	58	57	59	62
Italy	518	533	554	581	570	562	548	495	504	491	472	441	425	433	428
Latvia	26	13	11	11	12	12	12	11	12	12	11	11	11	11	11
Lithuania	48	22	19	23	23	25	24	20	21	21	21	20	20	20	20
Luxembourg	13	10	10	13	13	12	12	12	12	12	12	11	11	10	10
Malta	2	3	3	3	3	3	3	3	3	3	3	3	3	2	2
Netherlands	221	231	219	214	209	208	207	201	213	199	195	194	187	195	195
Poland	467	438	390	398	412	413	405	388	406	405	398	395	382	385	396
Portugal	60	70	83	87	82	80	77	74	70	69	67	65	65	70	68
Romania	247	180	141	148	150	153	148	128	122	128	125	115	115	116	113
Slovakia	74	54	50	51	51	49	50	45	46	45	43	43	40	41	41
Slovenia	19	19	19	21	21	21	22	20	20	20	19	18	17	17	18
Spain	288	327	386	439	432	443	410	371	356	355	349	322	324	336	325
Sweden	72	74	69	67	67	65	63	58	64	60	57	55	54	54	53
United Kingdom	797	749	713	693	686	674	653	597	612	564	581	566	526	508	483
EU-28	**5650**	**5301**	**5162**	**5220**	**5208**	**5160**	**5042**	**4673**	**4777**	**4620**	**4557**	**4462**	**4291**	**4319**	**4293**
Iceland	4	3	4	4	5	5	5	5	5	5	5	5	5	5	5
United Kingdom (KP)	799	752	716	696	689	677	656	600	615	567	584	569	528	511	485
EU-28 + ISL	**5657**	**5307**	**5169**	**5227**	**5215**	**5168**	**5051**	**4680**	**4785**	**4627**	**4564**	**4469**	**4298**	**4327**	**4300**

The overall EU GHG emission trend is dominated by the two largest emitters Germany and the United Kingdom accounting for almost one third of total EU GHG emissions in 2016. These two Member States have achieved total GHG emission reductions of 656 million tonnes CO_2-equivalents compared to 1990.

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 liberalizing 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 % and 10 %, respectively. Italy's GHG emissions were 18 % below 1990 levels in 2016. Italian GHG emissions increased since 1990 primarily from road transport, electricity and heat production and petrol refining. However, Italian emissions decreased significantly since 2006 with a significant drop in 2009, which was mainly due to the economic crisis and reductions in industrial output. Since 2010 emissions were decreasing continuously until 2014. France's emissions were 16 % below 1990 levels in 2016. In France, large reductions were achieved in N_2O emissions from the chemical industry, but CO_2 emissions from road transport and HFC emissions from electronics industry and product uses as substitutes of ODS increased considerably between 1990 and 2016.

Poland is the fifth largest emitter in the EU-28, accounting for 9 % of total EU GHG emissions. Poland's GHG emissions were 15 % below 1990 levels in 2016. The main factors for decreasing emissions in Poland — as with other 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.

Spain, the sixth largest emitter in the EU-28, increased emissions by 13 % between 1990 and 2016. This was largely due to emission increases from road transport, electricity and heat production, and households and services

2.5 Emission trends for indirect greenhouse gases and sulphur dioxide

Emissions of CO, NO_x, NMVOC and SO_2 have to be reported to the UNFCCC Secretariat because they influence climate change indirectly: CO, NO_x 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 SO_2 emissions in the EU between 1990 and 2016. All emissions were reduced significantly from 1990 levels: the largest reduction was achieved in SO_2 (-89 %) followed by, CO (-66 %), NMVOC (-58 %). and NO_x (-57 %),

Table 2.7 Overview of EU-28 and Iceland indirect GHG and SO_2 emissions for 1990–2016(kt)

	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
NO_x	17 960	15 430	13 398	12 286	11 950	11 635	10 747	9 872	9 683	9 293	8 974	8 562	8 217	8 060	7 781
CO	63 317	51 556	40 089	31 629	30 326	30 406	28 524	25 980	26 603	24 216	24 384	23 198	21 481	21 650	21 417
NMVOC	16 981	13 818	11 445	9 607	9 387	9 031	8 658	8 096	8 102	7 703	7 562	7 390	7 131	7 142	7 105
SO_2	24 605	15 789	9 585	7 373	7 144	6 786	5 409	4 599	4 345	4 213	3 944	3 533	3 271	3 175	2 730

Table 2.8 shows the NO_x emissions of the EU-28 Member States and Iceland between 1990 and 2016. The largest emitters, Germany, France, the United Kingdom, Spain, and Italy made up 60 % of total EU NO_x emissions in 2016. All EU-28 Member States but Malta reduced their NO_x emissions between 1990 and 2016.

Table 2.9 shows the CO emissions of the EU-28 Member States and Iceland between 1990 and 2016. The largest emitters, France, Germany, Poland, Romania and Spain that made up 57 % of the total CO emissions in 2016, reduced their emissions from 1990 levels substantially. But also all other EU-28 Member States reduced emissions.

Table 2.10 shows the NMVOC emissions of the EU-28 Member States and Iceland between 1990 and 2016. The largest emitters France, Germany, Italy and the United Kingdom that made up 53 % of the total NMVOC emissions in 2016, reduced their emissions from 1990 levels, together with most other EU-28 Member States and Iceland.

Table 2.11 shows the SO_2 emissions of the EU-28 Member States and Iceland between 1990 and 2016. The largest emitters, Poland, Bulgaria and Germany that made up 47 % of the total SO_2 emissions in 2016, reduced their emissions from 1990 levels substantially, together with all other EU-28 Member States.

Table 2.8 Overview of Member States' contributions to EU-28 and Iceland NO_x emissions for 1990–2016 (kt)

Party	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Austria	219	200	214	238	225	214	199	183	183	174	169	170	160	157	152
Belgium	410	380	342	317	303	294	267	240	245	227	214	211	200	200	191
Bulgaria	269	170	144	159	157	160	153	134	138	148	137	121	129	137	128
Croatia	87	69	75	84	83	85	81	75	67	63	58	57	53	54	52
Cyprus	16	18	21	21	21	21	19	19	18	21	21	16	17	15	14
Czech Republic	737	418	292	281	276	273	254	235	225	212	199	185	177	171	164
Denmark	302	290	226	204	204	190	174	155	149	140	129	124	115	114	114
Estonia	96	50	44	41	40	45	42	38	45	44	41	38	40	39	39
Finland	299	252	229	198	215	204	186	169	178	163	154	149	141	130	129
France	2075	1905	1746	1551	1464	1403	1305	1220	1206	1141	1107	1090	1003	971	936
Germany	2892	2171	1931	1578	1568	1499	1428	1331	1357	1341	1304	1302	1263	1239	1217
Greece	315	320	352	404	406	406	387	374	318	295	244	242	236	233	230
Hungary	234	182	182	174	167	163	157	146	142	133	125	122	122	124	116
Ireland	168	168	174	168	163	158	145	121	115	103	106	107	106	109	110
Italy	2072	1947	1495	1286	1216	1165	1080	996	979	940	882	823	808	786	764
Latvia	88	49	40	42	42	42	39	37	39	36	36	36	36	36	34
Lithuania	128	62	53	57	61	60	59	52	55	52	55	53	52	53	53
Luxembourg	40	34	40	54	48	42	38	33	33	33	31	27	25	21	19
Malta	7	9	10	8	8	9	9	8	8	8	9	9	9	8	7
Netherlands	586	485	398	347	336	322	315	291	286	270	259	249	234	233	224
Poland	1052	1035	846	859	877	878	842	831	858	841	810	774	726	705	726
Portugal	258	288	288	278	254	245	225	215	200	183	169	166	163	165	158
Romania	485	390	376	321	321	346	303	274	248	253	275	237	226	225	215
Slovakia	215	155	113	112	104	104	104	94	94	86	84	81	80	75	66
Slovenia	72	72	60	56	56	54	59	51	49	48	47	45	40	36	37
Spain	1472	1525	1505	1508	1463	1452	1244	1112	1037	1019	980	855	861	872	836
Sweden	281	251	217	185	181	174	166	155	158	151	143	141	140	135	131
United Kingdom	3046	2489	1944	1719	1657	1589	1431	1248	1220	1135	1157	1098	1024	988	888
EU-28	**17920**	**15387**	**13357**	**12249**	**11914**	**11595**	**10710**	**9836**	**9649**	**9261**	**8942**	**8530**	**8186**	**8029**	**7752**
Iceland	31	34	32	29	29	32	30	30	28	26	26	25	25	26	24
United Kingdom (KP)	3055	2498	1952	1726	1664	1596	1438	1254	1225	1140	1162	1104	1030	992	893
EU-28 + Iceland	**17960**	**15430**	**13398**	**12286**	**11950**	**11635**	**10747**	**9872**	**9683**	**9293**	**8974**	**8562**	**8217**	**8060**	**7781**

Table 2.9 Overview of Member States' contributions to EU-28 and Iceland CO emissions for 1990–2016 (kt)

Party	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Austria	1190	928	740	670	657	619	600	570	582	568	571	590	543	566	563
Belgium	1389	1111	931	756	701	654	656	429	499	395	345	523	322	375	367
Bulgaria	831	558	285	221	224	196	186	161	167	165	158	142	137	137	134
Croatia	536	435	441	419	391	376	324	316	300	272	255	232	202	216	202
Cyprus	43	38	30	26	24	24	22	19	18	17	15	14	14	14	14
Czech Republic	1028	892	948	833	857	864	805	802	823	805	804	821	798	803	805
Denmark	717	639	463	416	403	408	386	354	344	305	287	273	249	253	243
Estonia	239	179	163	132	126	150	133	127	128	112	115	110	113	111	121
Finland	709	616	548	469	459	442	420	399	411	375	372	358	352	335	340
France	10670	9232	6677	5316	4719	4548	4326	3848	4223	3522	3207	3255	2732	2683	2743
Germany	12520	6460	4808	3733	3637	3520	3412	2967	3332	3245	2873	2845	2739	2845	2858
Greece	1156	990	947	774	795	726	673	621	559	503	531	440	444	417	375
Hungary	1388	947	820	678	583	540	481	524	528	537	553	546	468	454	447
Ireland	346	289	246	216	199	186	177	156	142	131	124	116	109	105	99
Italy	7209	7256	4854	3448	3296	3367	3497	3112	3076	2436	2671	2502	2268	2377	2309
Latvia	443	332	249	219	209	194	177	184	148	154	161	144	135	114	110
Lithuania	452	279	183	173	185	189	180	173	155	170	165	158	150	145	144
Luxembourg	463	210	41	37	35	39	33	29	28	26	27	26	25	21	21
Malta	20	20	14	11	10	10	11	9	8	8	7	7	7	6	6
Netherlands	1216	879	806	718	720	711	709	662	666	642	621	599	584	585	580
Poland	3588	4367	3252	3059	3220	2977	2986	2909	3069	2784	2798	2664	2419	2370	2506
Portugal	724	784	662	509	479	456	414	394	396	369	358	339	323	331	318
Romania	2369	2331	3644	2500	2453	3497	2465	2380	2168	2102	2909	2095	2052	2156	2023
Slovakia	505	405	376	380	340	323	312	268	278	261	256	248	255	248	240
Slovenia	306	278	182	150	140	132	127	130	131	127	124	123	105	107	110
Spain	4813	4086	2963	2206	2072	2054	1920	1756	1825	1777	1712	1667	1676	1662	1674
Sweden	1078	940	680	560	529	528	514	502	492	480	456	451	438	428	430
United Kingdom	7287	6002	4072	2935	2794	2590	2453	2053	1982	1806	1788	1787	1701	1663	1506
EU-28	**63235**	**51484**	**40026**	**31566**	**30255**	**30320**	**28401**	**25855**	**26479**	**24095**	**24262**	**23073**	**21359**	**21526**	**21291**
Iceland	58	52	49	51	60	76	114	118	117	115	116	119	117	120	122
United Kingdom (KP)	7311	6022	4087	2948	2805	2600	2462	2060	1989	1813	1794	1792	1706	1667	1510
EU-28 + Iceland	**63317**	**51556**	**40089**	**31629**	**30326**	**30406**	**28524**	**25980**	**26603**	**24216**	**24384**	**23198**	**21481**	**21650**	**21417**

Table 2.10 Overview of Member States' contributions to EU-28 and Iceland NMVOC emissions for 1990–2016 (kt)

Party	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Austria	302	218	175	159	154	149	146	142	143	139	139	140	135	137	137
Belgium	330	278	217	176	170	161	154	142	142	130	127	124	117	114	114
Bulgaria	162	130	97	89	88	85	83	78	77	76	77	73	73	81	75
Croatia	165	112	99	114	114	109	107	93	88	83	77	73	67	68	69
Cyprus	15	15	15	17	16	17	15	14	15	10	10	9	9	9	9
Czech Republic	301	207	258	267	267	260	252	247	242	230	225	223	216	216	213
Denmark	201	198	161	134	131	129	124	119	117	111	108	109	101	103	101
Estonia	49	33	30	27	27	28	27	23	23	23	23	23	24	25	27
Finland	243	209	183	157	152	148	135	127	131	119	117	111	109	103	104
France	2811	2423	1997	1531	1421	1289	1206	1130	1124	1069	1036	1024	988	980	970
Germany	3401	2038	1609	1323	1335	1270	1212	1115	1230	1145	1119	1105	1029	1039	1052
Greece	260	244	247	230	227	220	199	187	178	167	166	158	156	157	147
Hungary	319	223	204	168	155	150	144	146	144	147	147	149	140	142	140
Ireland	145	138	123	122	122	122	117	115	111	108	110	112	108	108	110
Italy	1996	2028	1590	1338	1300	1283	1257	1180	1117	1027	1019	992	926	918	904
Latvia	83	62	53	52	50	50	45	44	42	42	43	43	43	42	40
Lithuania	101	71	59	62	62	62	58	55	56	53	53	49	50	50	50
Luxembourg	22	18	15	15	13	12	14	12	11	11	12	12	12	12	12
Malta	2	2	2	2	2	2	2	1	2	2	3	3	3	3	3
Netherlands	483	343	249	186	177	178	172	162	172	166	162	156	152	149	141
Poland	495	667	596	606	647	618	633	617	636	616	611	603	591	591	609
Portugal	222	219	224	193	187	183	173	160	163	155	153	152	156	157	153
Romania	353	203	256	275	279	278	302	268	266	254	262	247	243	239	239
Slovakia	169	150	121	107	104	99	102	96	90	88	80	71	66	69	64
Slovenia	64	62	52	43	43	41	40	38	37	35	33	32	30	30	31
Spain	1053	985	980	829	802	789	727	667	655	627	602	582	581	597	608
Sweden	354	263	224	212	208	202	191	185	184	177	167	163	161	162	159
United Kingdom	2860	2261	1599	1166	1124	1087	1012	924	900	887	875	847	839	834	818
EU-28	**16962**	**13801**	**11434**	**9598**	**9378**	**9021**	**8650**	**8089**	**8095**	**7696**	**7555**	**7383**	**7125**	**7135**	**7098**
Iceland	14	13	9	8	8	9	8	8	7	7	7	7	7	7	7
United Kingdom (KP)	2865	2266	1601	1166	1124	1088	1013	923	899	886	875	847	839	834	817
EU-28 + Iceland	**16981**	**13818**	**11445**	**9607**	**9387**	**9031**	**8658**	**8096**	**8102**	**7703**	**7562**	**7390**	**7131**	**7142**	**7105**

Table 2.11 Overview of Member States' contributions to EU-28 and Iceland SO_2 emissions for 1990–2016 (Gg)

Party	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Austria	74	47	32	26	26	23	20	15	16	15	15	15	15	15	14
Belgium	365	258	172	142	133	124	96	74	60	53	47	44	41	41	42
Bulgaria	480	377	334	373	376	426	422	383	411	493	429	369	393	428	379
Croatia	135	65	51	59	55	60	54	56	35	29	25	17	14	16	15
Cyprus	31	39	48	38	31	29	22	18	22	21	16	14	17	13	16
Czech Republic	1871	1090	233	208	207	212	170	169	164	167	160	145	133	128	116
Denmark	178	146	32	26	30	27	21	15	15	14	12	13	10	10	10
Estonia	222	103	80	64	57	79	60	45	73	64	30	26	31	24	28
Finland	250	105	81	69	84	83	68	60	67	60	51	48	43	42	40
France	1301	986	652	484	456	445	380	318	296	268	261	230	192	180	159
Germany	5456	1746	646	473	474	458	455	398	411	401	382	374	359	364	356
Greece	518	528	575	601	558	538	465	415	233	171	143	130	114	112	108
Hungary	822	607	427	41	39	36	35	30	31	34	32	31	28	23	23
Ireland	183	161	140	72	61	55	45	32	26	25	23	23	17	15	14
Italy	1784	1323	756	410	388	345	290	237	218	196	178	147	132	124	116
Latvia	100	49	18	9	8	8	7	6	4	4	4	4	4	4	3
Lithuania	196	79	38	28	31	30	26	23	23	26	21	20	18	18	15
Luxembourg	15	9	3	2	3	2	2	2	2	1	1	1	2	1	1
Malta	10	11	10	12	12	13	12	8	8	8	9	4	3	2	1
Netherlands	188	125	70	61	61	58	49	36	33	33	33	29	28	29	27
Poland	2649	2138	1404	1164	1228	1166	939	803	866	828	794	759	715	702	582
Portugal	324	330	265	193	169	160	111	76	68	62	57	51	46	47	47
Romania	802	697	494	599	637	521	528	459	361	339	277	240	193	155	107
Slovakia	418	266	126	89	88	71	70	64	70	69	59	54	46	68	27
Slovenia	201	124	94	40	17	16	15	12	11	13	12	14	10	6	5
Spain	2131	1830	1432	1239	1107	1078	413	313	267	302	301	238	260	278	230
Sweden	104	69	43	36	35	31	28	27	29	26	25	22	20	18	19
United Kingdom	3763	2450	1285	772	727	631	529	432	449	414	459	396	321	253	178
EU-28	**24571**	**15757**	**9540**	**7329**	**7100**	**6724**	**5331**	**4526**	**4268**	**4137**	**3857**	**3460**	**3205**	**3115**	**2678**
Iceland	24	22	39	42	42	61	77	72	76	75	86	72	66	59	51
United Kingdom (KP)	3773	2460	1291	774	729	633	530	433	450	415	460	397	322	253	179
EU-28 + Iceland	**24605**	**15789**	**9585**	**7373**	**7144**	**6786**	**5409**	**4599**	**4345**	**4213**	**3944**	**3533**	**3271**	**3175**	**2730**

3 ENERGY (CRF SECTOR 1)

This chapter starts with an overview on emission trends in CRF Sector 1 Energy. For each EU-28 + ISL key category as well as other important subsector specific categories overview tables are presented including the Member States' contributions to the category in terms of level and trend. This chapter includes also, the reference approach, and international bunkers.

3.1 Overview of sector

CRF Sector 1 Energy comprises of the three sectors Fuel combustion activities (1.A), Fugitive emissions from fuels (1.B) and CO_2 Transport and storage (1.C). The energy sector contributes 78% to total GHG emissions and is the largest emitting sector in the EU-28 + ISL. Total GHG emissions from this sector decreased by 23% from 4355 Mt in 1990 to 3352 Mt in 2016 (Figure 3.1). In 2016, emissions decreased by -1% compared to 2015.

The most important energy-related gas is CO_2 that makes up 75% of the total EU-28 + ISL greenhouse gas emissions in 2016. CH_4 of the energy sector is responsible for 2% and N_2O for 1% of the total GHG emissions.

Figure 3.1 CRF Sector 1 Energy: EU-28 + ISL GHG emissions in CO_2 equivalents (Mt) for 1990–2016

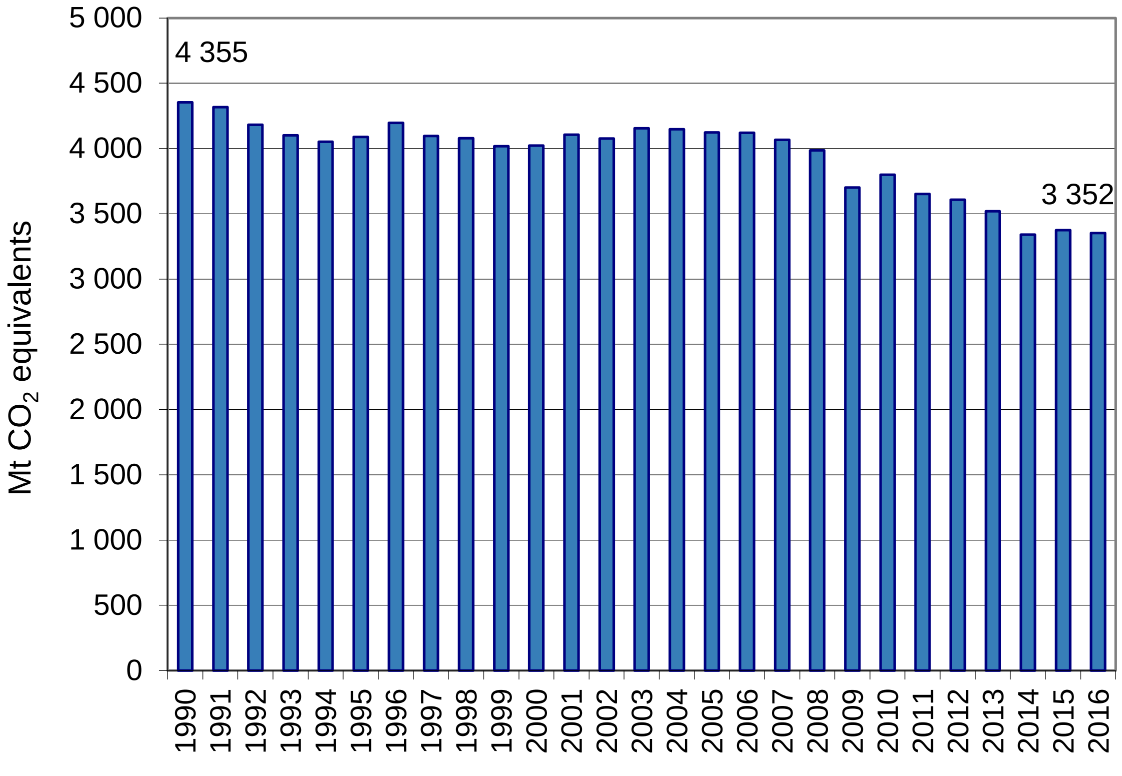
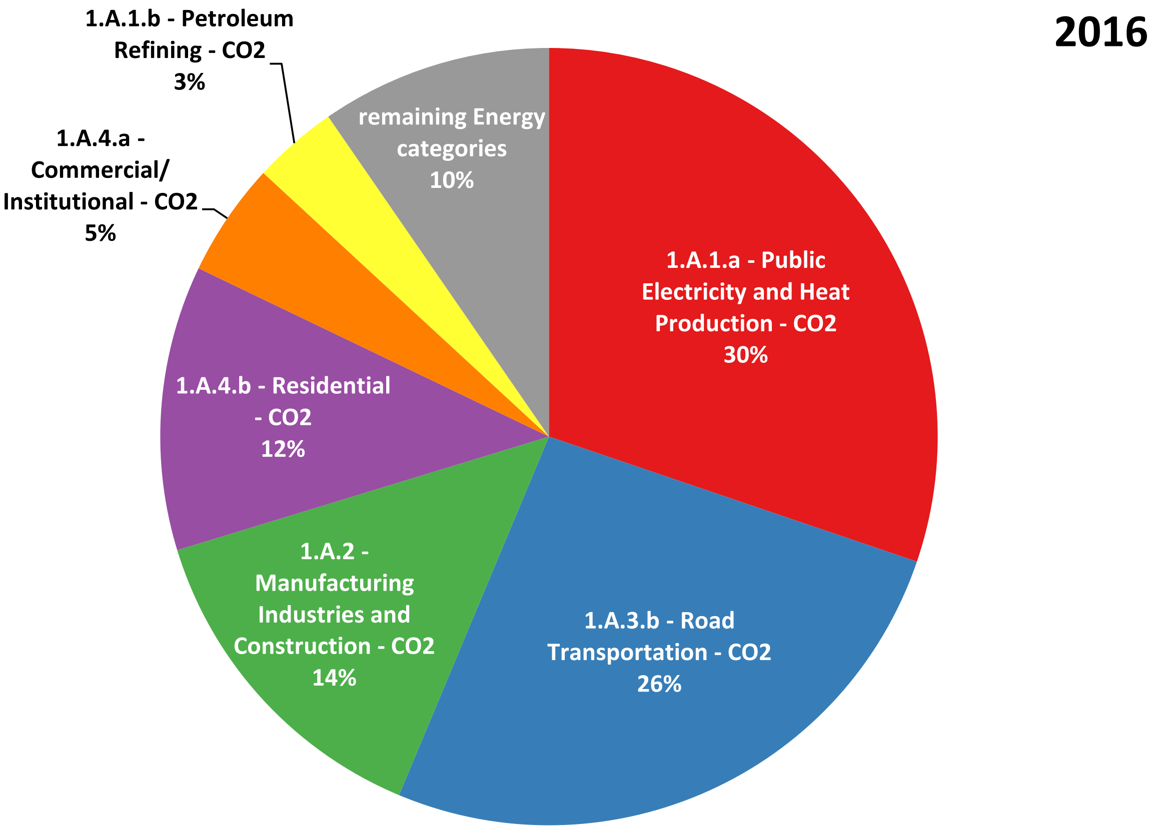


Figure 3.2 shows the share of the largest key categories in the sector Energy in 2016. The first chart illustrates that the three largest key categories account for 70.3% and the largest six for 90.4% of emissions in the whole sector 1. The two largest categories of the energy sector alone are responsible for 44 % of the total EU-28 + ISL emissions in 2016.

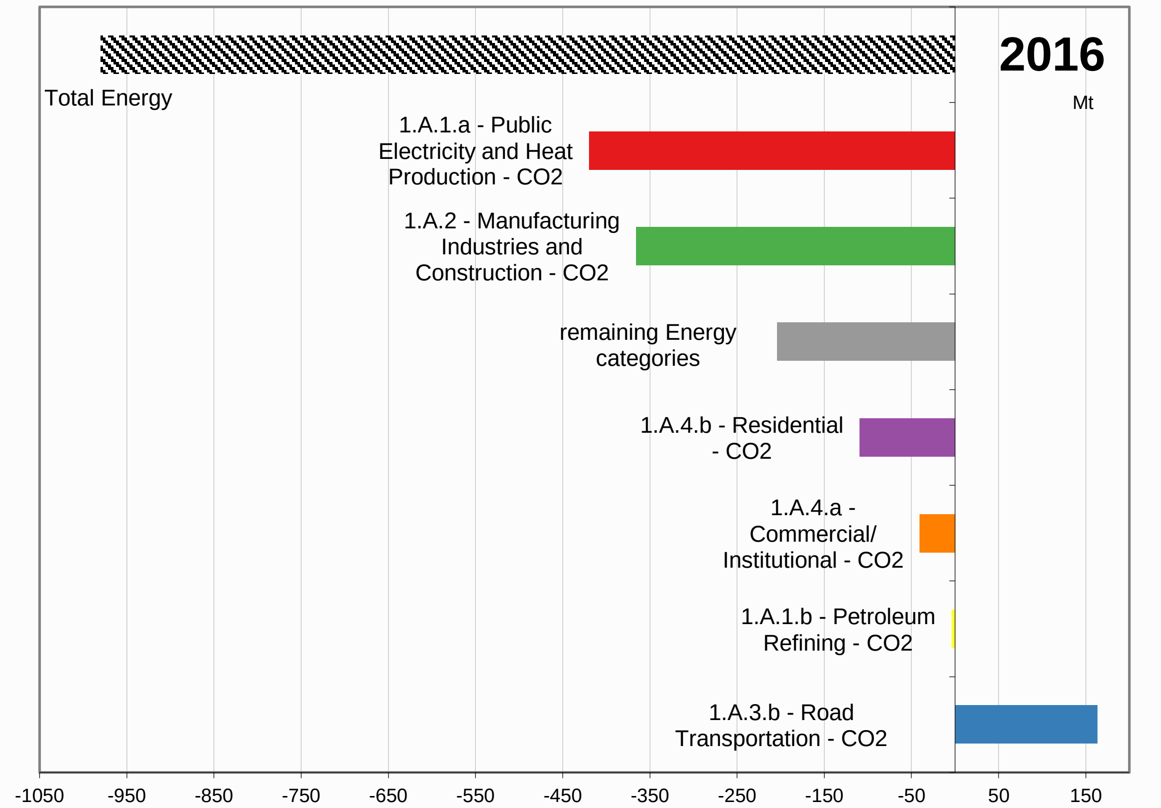
Figure 3.2 CRF Sector 1 Energy: Share of largest key source categories in 2016



Note: Remaining Energy categories is calculated by subtracting the presented categories (1.A.1.a, 1.A.1.b, 1.A.2, 1.A.3.b, 1.A.4.a and 1.A.4.b.) from the sector total

Furthermore, Figure 3.3 (on the next page) shows the absolute change of GHG emissions of these large key categories for the years 1990-2016. CO_2 emissions from Road Transportation had the highest increase in absolute terms of all energy-related emissions, while CO_2 emissions from 1.A.1.a Public Electricity and Heat Production as well as 1.A.2 Manufacturing Industries decreased substantially between 1990 and 2016. The decreases in Public Electricity and Heat Production and Manufacturing Industries as well as the increases in Road Transportation occurred in almost all Member States. The decline of Fugitive Emissions from Fuels (CH_4) and decreasing CO_2 emissions from 1.A.1.c Manufacture of Solid Fuels and Other Energy Industries are the main reasons for the large absolute emission reductions from “remaining Energy categories” in Figure 3.3.

Figure 3.3 CRF Sector 1 Energy: Absolute change of GHG emissions in CO_2 equivalents (Mt) by large key categories for 1990-2016



Note: Remaining Energy categories is calculated by subtracting the presented categories (1.A.1.a, 1.A.1.b, 1.A.2, 1.A.3.b, 1.A.4.a and 1.A.4.b.) from the sector total

The key categories in the energy 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: Peat (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-Ferrous Metals: Gaseous Fuels (CO_2)
- 1.A.2.b Non-Ferrous Metals: Liquid Fuels (CO_2)
- 1.A.2.b Non-Ferrous 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: 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.d Pulp, Paper and Print: Solid 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 Non-metallic minerals: Gaseous Fuels (CO_2)
- 1.A.2.f Non-metallic minerals: Liquid Fuels (CO_2)
- 1.A.2.f Non-metallic minerals: Other Fuels (CO_2)
- 1.A.2.f Non-metallic minerals: Solid Fuels (CO_2)
- 1.A.2.g Other Manufacturing Industries and Constructions: Gaseous Fuels (CO_2)
- 1.A.2.g Other Manufacturing Industries and Constructions: Liquid Fuels (CO_2)
- 1.A.2.g Other Manufacturing Industries and Constructions: Solid Fuels (CO_2)

- 1.A.3.a Domestic 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: Gaseous Fuels (CO_2)
- 1.A.3.b Road Transportation: Gasoline (CH_4)
- 1.A.3.b Road Transportation: Gasoline (CO_2)
- 1.A.3.b Road Transportation: Liquefied Petroleum Gases (LPG) (CO_2)
- 1.A.3.c Railways: Liquid Fuels (CO_2)
- 1.A.3.d Domestic Navigation: Gas/Diesel Oil (CO_2)
- 1.A.3.d Domestic Navigation: Residual Fuel 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: Other Fuels (CO_2)
- 1.A.4.a Commercial/Institutional: Solid Fuels (CO_2)
- 1.A.4.b Residential: Biomass (CH_4)
- 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 (CH_4)
- 1.A.4.b Residential: Solid Fuels (CO_2)
- 1.A.4.c Agriculture/Forestry/Fishing: Gaseous Fuels (CO_2)
- 1.A.4.c Agriculture/Forestry/Fishing: Liquid Fuels (CO_2)
- 1.A.4.c Agriculture/Forestry/Fishing: Solid Fuels (CO_2)

- 1.A.5.a Other Other Sectors: Solid Fuels (CO_2)
- 1.A.5.b Other Other Sectors: Liquid Fuels (CO_2)

- 1.B.1.a Coal Mining and Handling: Operation (CH_4)
- 1.B.2.a Oil: Operation (CO_2)
- 1.B.2.b Natural Gas: Operation (CH_4)
- 1.B.2.c Venting and Flaring: Operation (CO_2)

3.2 Source categories

3.2.1 Energy Industries (CRF Source Category 1.A.1)

Energy Industries (CRF 1.A.1) comprises emissions from fuels combusted by the fuel extraction or energy-producing industries and is subdivided in three categories: Public electricity and heat production (CRF 1.A.1.a), Petroleum-refining (CRF 1.A.1.b), and Manufacture of solid fuels and other energy industries (CRF 1.A.1.c). Each category is described in its own chapter.

Table 3.1 shows the ten key categories of sector 1.A.1, including information on whether the reasons for this categorization lie in their emission trend and/or level. Furthermore, it entails information on the share of higher tier methods used by the Member States. In sector 1.A.1.a Germany, Poland, the United Kingdom and Italy have mainly been influencing this share of higher tier methods because of their weight of emissions. The same applies for Italy, Germany, the United Kingdom and Spain in sector 1.A.1.b and the United Kingdom, Germany, Italy and the Czech Republic in sector 1.A.1.c.

Table 3.1: Key source categories for level and trend analyses and share of MS emissions using higher tier methods in sector 1.A.1 (Table excerpt)

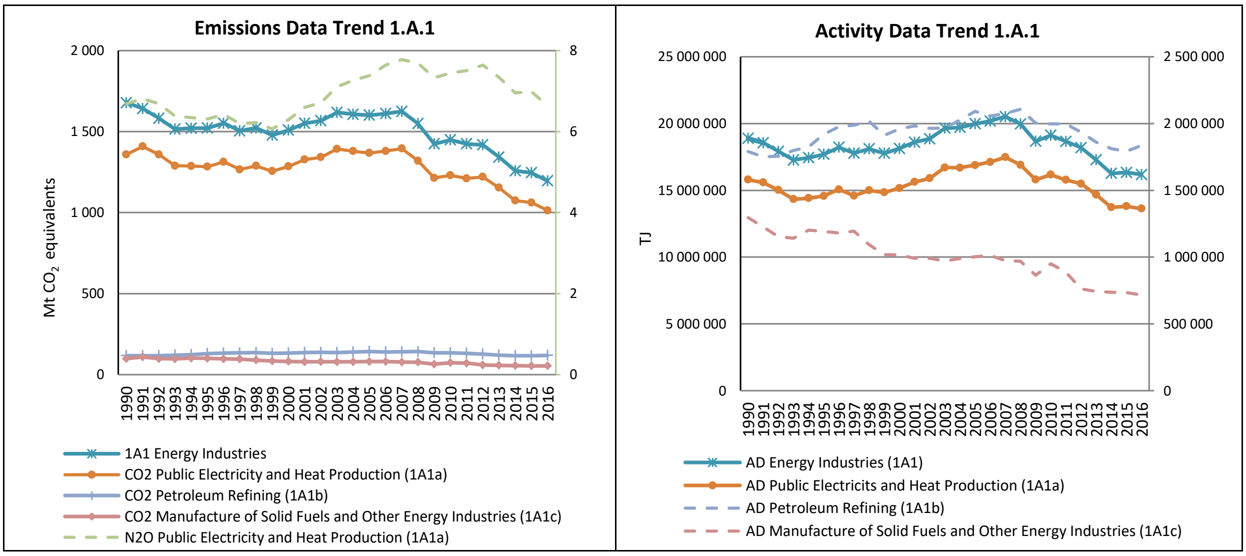
Source category gas	kt CO_2 equ.		Trend	Level		share of higher Tier
	1990	2016		1990	2016	
1.A.1.a Public Electricity and Heat Production: Gaseous Fuels (CO_2)	107 504	217 931	T	L	L	93.8%
1.A.1.a Public Electricity and Heat Production: Liquid Fuels (CO_2)	176 297	31 795	T	L	L	94.7%
1.A.1.a Public Electricity and Heat Production: Other Fuels (CO_2)	10 763	39 291	T	L	L	97.3%
1.A.1.a Public Electricity and Heat Production: Peat (CO_2)	8 531	7 992	0	L	L	96.7%
1.A.1.a Public Electricity and Heat Production: Solid Fuels (CO_2)	1 129 328	715 806	T	L	L	95.8%
1.A.1.b Petroleum Refining: Gaseous Fuels (CO_2)	5 275	23 362	T	0	L	98.3%
1.A.1.b Petroleum Refining: Liquid Fuels (CO_2)	112 255	94 632	T	L	L	93.3 %
1.A.1.b Petroleum Refining: Solid Fuels (CO_2)	3 633	143	T	0	0	94.6%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries: Gaseous Fuels (CO_2)	17 326	18 059	T	L	L	86.9%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries: Solid Fuels (CO_2)	91 118	31 637	T	L	L	96.9%

Figure 3.4 shows the trends in emissions in Energy Industries for the EU-28 + ISL between 1990 and 2016, which was mainly dominated by CO_2 emissions from public electricity and heat production. Carbon dioxide from 1.A.1.a currently represents about 85% of greenhouse gas emissions in 1.A.1 (i.e. including methane and nitrous oxide).

Total greenhouse gas emissions from 1.A.1 decreased by 29%, between 1990 and 2016. This was mainly due to a decrease of CO_2 emission from Public Electricity and Heat Production (-346 Mt CO_2) followed by -45 Mt CO_2 of the manufacturing of solid fuels. Carbon dioxide emissions from petroleum refining increased by 2 Mt in the period 1990-2016.

The decrease in fuel consumption since 2006 can be explained by the continuing effects of the economic downturn, the increased use of renewables, but also by enhanced energy efficiency in the newer EU Member States as well as mild winters.

Figure 3.4 1.A.1 Energy Industries: Total GHG, CO_2 and N_2O emission trends and Activity Data



Note: Data displayed as dashed line refers to the secondary axis.

Table 3.2 breaks down the information by Member State. Between 1990 and 2016, greenhouse gas emissions from energy industries increased in six Member States and fell in twenty-three. The highest absolute increase was accounted for by the Netherlands with 14 Mt CO_2 respectively 27%. The United Kingdom, Germany and Poland, account for the largest part of reductions (-294 Mt CO_2). The change in the EU-28 + ISL was a net decrease of about 483 Mt CO_2 equivalent. The table shows the emissions of CO_2, N_2O and CH_4 separately. The latter two greenhouse gases only contribute a very small part (combined approximately 1%) of the total emissions in energy industries.

In terms of absolute contributions to EU-28 + ISL greenhouse gas emissions from energy industries, this sector is clearly dominated by Germany, Poland, the United Kingdom and Italy. The first two combined are responsible for 41%, all four countries represent 59% and the top six Member States account for 71% of the EU's greenhouse gas emissions from energy industries.

Table 3.2 1.A.1 Energy industries: Member States' contributions to CO_2, N_2O and CH_4 emissions

Member State	GHG emissions in 1990 (kt CO2 equivalents)	GHG emissions in 2016 (kt CO2 equivalents)	CO2 emissions in 1990 (kt)	CO2 emissions in 2016 (kt)	N2O emissions in 1990 (kt CO2 equivalents)	N2O emissions in 2016 (kt CO2 equivalents)	CH4 emissions in 1990 (kt CO2 equivalents)	CH4 emissions in 2016 (kt CO2 equivalents)
Austria	14 076	10 578	14 025	10 449	42	103	8	26
Belgium	30 059	19 982	29 859	19 792	180	160	20	29
Bulgaria	38 677	27 128	38 530	27 015	133	104	14	9
Croatia	7 094	4 917	7 071	4 889	17	23	5	5
Cyprus	1 767	3 311	1 761	3 300	4	8	2	3
Czech Republic	56 916	54 449	56 654	54 163	245	253	17	33
Denmark	26 251	14 048	26 150	13 862	86	88	16	98
Estonia	29 281	13 826	29 256	13 748	18	36	8	42
Finland	18 969	19 122	18 843	18 830	116	264	10	28
France	66 392	45 204	66 008	44 873	318	293	66	38
Germany	427 353	332 158	423 906	326 539	3 167	2 577	280	3 041
Greece	43 253	37 021	43 094	36 910	145	98	14	13
Hungary	20 865	13 577	20 789	13 490	67	62	9	25
Ireland	11 223	12 515	11 145	12 368	71	140	7	8
Italy	137 158	104 358	136 447	103 785	485	441	227	132
Latvia	6 265	1 856	6 249	1 823	11	20	5	13
Lithuania	13 553	2 956	13 522	2 898	21	35	10	22
Luxembourg	36	252	33	247	1	3	1	2
Malta	1 367	581	1 361	580	5	1	1	1
Netherlands	53 368	67 686	53 148	67 273	148	308	72	105
Poland	236 171	163 208	235 067	162 353	1 022	751	82	104
Portugal	16 383	17 406	16 328	17 256	49	135	6	15
Romania	70 944	25 810	70 723	25 706	183	91	38	13
Slovakia	18 956	7 549	18 882	7 499	65	36	9	14
Slovenia	6 375	4 935	6 348	4 910	25	23	2	3
Spain	78 904	71 128	78 563	70 566	289	456	51	107
Sweden	9 951	9 200	9 815	8 921	120	232	17	47
United Kingdom	236 298	110 449	234 736	109 316	1 365	779	197	354
EU-28	**1 677 907**	**1 195 211**	**1 668 315**	**1 183 359**	**8 399**	**7 521**	**1 193**	**4 331**
Iceland	14	2	14	2	0	0	0	0
United Kingdom (KP)	236 990	111 116	235 424	109 979	1 367	781	198	355
EU-28 + ISL	**1 678 612**	**1 195 879**	**1 669 017**	**1 184 024**	**8 401**	**7 523**	**1 194**	**4 332**

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

Public heat and electricity production is the main source of emissions from energy industries. Furthermore, it is the largest source category in the EU-28 + ISL greenhouse gas inventory. 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, which are used. Some countries rely more on coal than on gas. At the EU-28 + ISL level, 45% of the fuel used in energy industries comes from solid fuels. Its contribution has been declining in favour of the in comparison relatively cleaner natural gas, whose share amounted to 28% in 2016 and biomass which has been constantly increasing with a share of 11% in 2016.

As can be seen in Figure 3.5 Germany, Poland, the United Kingdom and Italy contribute 59.4% of the total CO_2 emissions in sector 1.A.1 Energy industries in the year 2016. 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.

Figure 3.5 1.A.1 Energy Industries, all fuels: Emission trend and share for CO_2

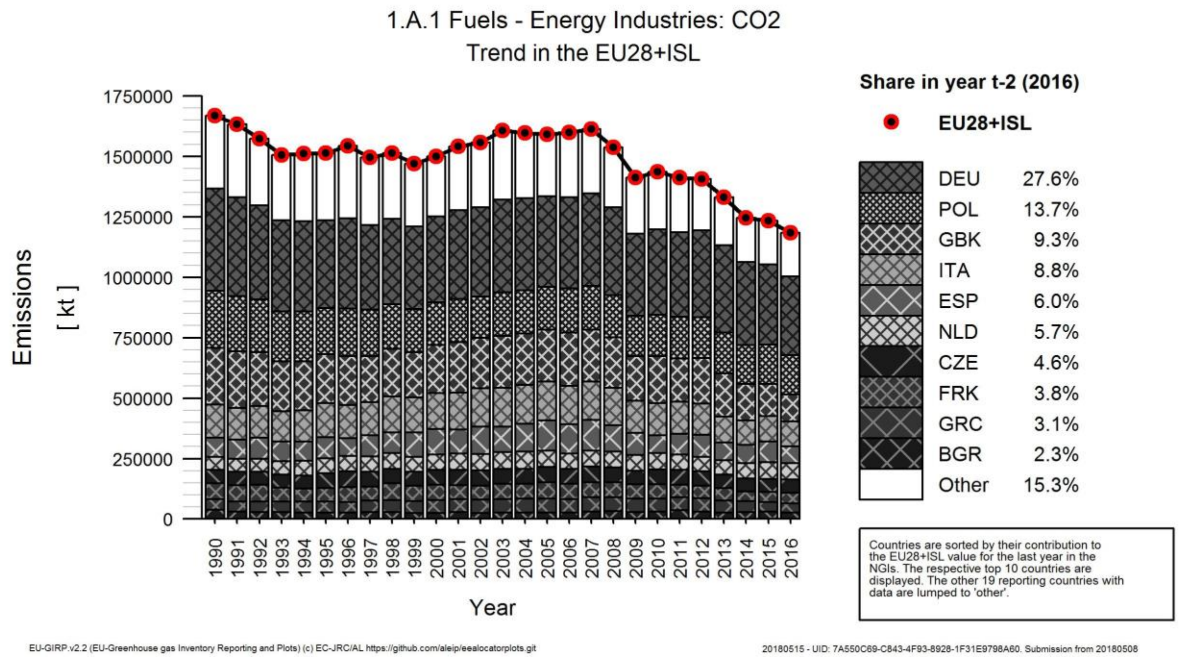


Table 3.3 provides information on the Member States' contribution to EU-28 + ISL recalculations in CO_2 from 1.A.1 Energy Industries for 1990 and 2015 as well as the main explanations for the largest recalculations in absolute terms.

Table 3.3 1.A.1 Energy Industries: Contribution of MS to EU-28 + ISL recalculations in CO_2 for 1990 and 2015 (difference between latest submission and previous submission in kt of CO_2 and percent)

	1990		2015		Main explanations
	kt CO_2	%	kt CO_2	%	
Austria	234	1.7	-173	-1.6	Revised energy balance
Belgium	1	0.0	-24	-0.1	Brussels: correction of the energy consumption in combined heat-power systems
Bulgaria	-	-	-	-	NA
Croatia	-	-	-	-	NA
Cyprus	-	-	-	-	NA
Czech Republic	-	-	49	0.1	Updated activity data
Denmark	0	0.0	63	0.5	The CO_2 emission factors for fossil waste and gas oil have been recalculated. This was initiated due to on a review recommendation. The revised emission factors are based on plant specific EU ETS data.
Estonia	-	-	6	0.0	Minor emission data fixes under solid fuels.
Finland	-	-	1 539	9.6	Allocation of plants from 1A2 to 1A1a and from 1A1b to 1A1a due to ownership change.

	1990		2015		Main explanations
	kt CO_2	%	kt CO_2	%	
France	-53	-0.1	-289	-0.7	1.A.1.c: Coal Transformation: Change in activity (coal consumption) and change in consumption of coal, change in data source.
Germany	-	-	1 347	0.4	Recalculations with the now final energy balance 2015. Revision of the calculation model for waste incineration; from 2004 (1.A) Revision of EF CO_2 for refinery-, natural- & liquid gas and hard coal products in 1A
Greece	-	-	-	-	NA
Hungary	178	0.9	-73	-0.5	Revised energy statistics (esp. natural gas consumption in oil and gas extraction), reanalysis of waste incineration based on plant-specific information, removal of some double counted emissions from 1A1c
Ireland	-	-	41	0.4	Ireland has included for the first time in this submission emissions from a natural gas refinery opened in late 2015.
Italy	-1 698	-1.2	-121	-0.1	Update of activity data
Latvia	-	-	-	-	NA
Lithuania	-	-	-	-	NA
Luxembourg	-	-	-1	-0.1	Energy balance revised
Malta	-297	-17.9	2	0.2	Activity data for the source category 'Energy Industries' was obtained from Enemalta's annual reports for the time-period 1990-2005 and the EU ETS Reports for 2010-2016. Corrections have been made to the emission factors for the former period following the recommendations of the UNFCCC review.
Netherlands	292	0.6	1 489	2.2	Reallocation of process emissions from 1.B.1
Poland	-28	-0.0	-125	-0.1	AD update and change of CO_2 EF for natural gas
Portugal	-	-	12	0.1	MSW incineration (with energy recovery)/CRF 1.A.1.a: revision of the composition (textil fraction) of the waste incinerated based on data from one incineration unit. 1.A.1.c: correction introduced in the activity data for that particular year in the national official energy statistics produced by the national focal point (MINETAD) on its latest (2017) annual questionnaire of gas.
Romania	-	-	-915	-3.1	Country specific CO_2 EFs for the corresponding fuels from 2015 EU ETS reports were used for all energy combustion categories. Net calorific values determined from the 2015 EU-ETS reports were used for the specific fuels in all energy combustion categories. Because the activity data from Energy Balance provided from National Institute of Statistics were updated for 1995-2015 period from the 1.A.1 Energy Industry sub-sector, the CO_2, CH_4 and N_2O emissions values for the 1995-2015 period were updated.
Slovakia	-173	-0.9	-15	-0.2	Recalculation due to reallocation of the industrial waste incineration with energy use (previously reported in the 1.A.1.aiii - other solid fuels)
Slovenia	-	-	-	-	NA
Spain	-1	-0.0	-8	-0.0	Upgrade of CO_2 EF for natural gas from a default values to a country-specific values following recommendation E.14 from the draft review report FCCC/ARR/2017/ESP Incorporation of natural gas and gas oil consumption from solar thermal plants (source of information: ETS; years: 2009-2016). Update of base information on fuel consumption for small power plant (mainly biomass power plants) for period 2013-2015. This updated has been possible thanks to new information provided by the national focal point on energy. Until last edition of the Inventory, information for years 2013-2015 had been surrogated from 2012 data Incorporation of new data into the existing source "incineration with energy recovery" from a plant not previously accounted for. The review of EU ETS emissions reflected the omitting of some portion of the source emissions.

	1990		2015		Main explanations
	kt CO_2	%	kt CO_2	%	
					Updated activity data for years 2010 to 2015 regarding off-gas consumption in some refineries. The review of EU ETS emissions from refineries reflected differences in the approach when reporting consumption of off-gas to the Inventory and to EU ETS. Off-gas reported to the Inventory was actually a mixture of off-was and natural gas.
Sweden	-0	-0.0	16	0.2	Updating of EF for combustion in industry sector, reallocation of emissions between IPPU and stationary combustion.
United Kingdom	-1	-0.0	301	0.2	DUKES revisions; Addition of non-biodegradable waste used for heat added to activity data for 1.A.1.a
EU28	-1 545	-0.1	3 119	0.3	
Iceland	0	0.0	-0	-0.0	NA
United Kingdom (KP)	-399	-0.2	-251	-0.2	DUKES revisions; Addition of non-biodegradable waste used for heat added to activity data for 1.A.1.a
EU28+ISL	-1 943	-0.1	2 568	0.2	

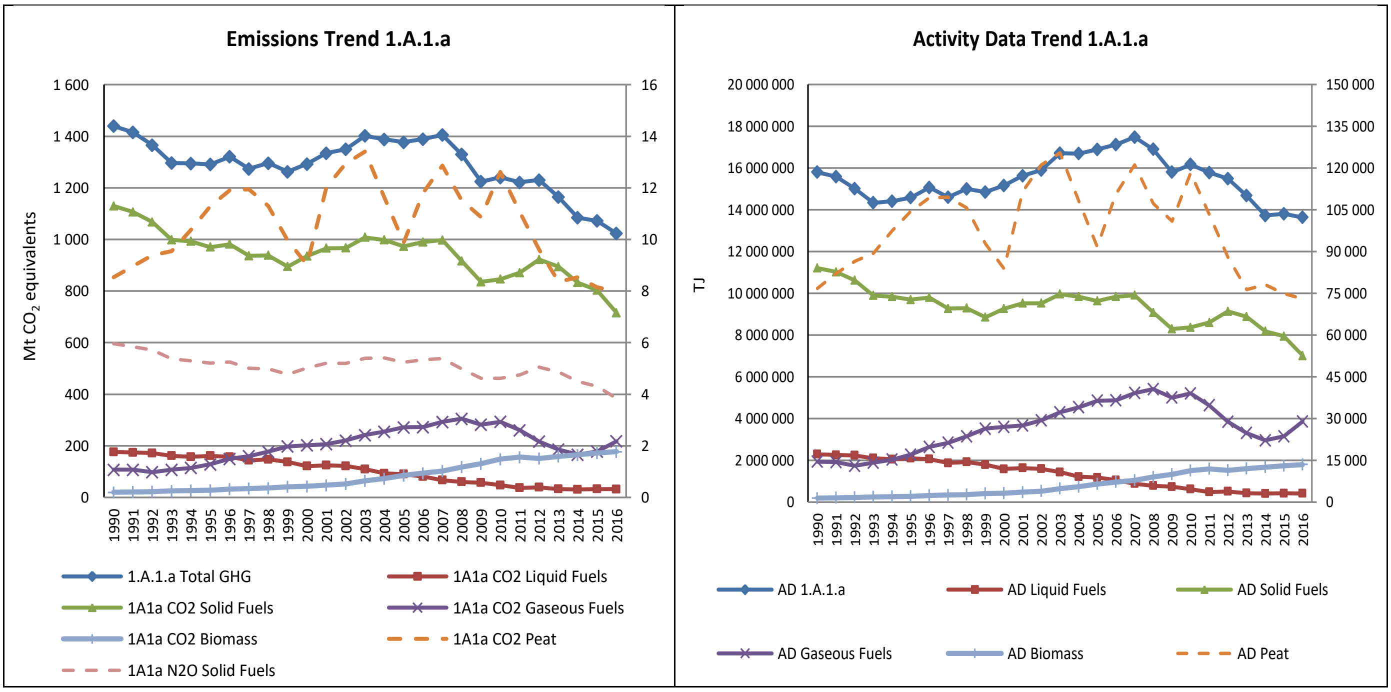
3.2.1.1 Public Electricity and Heat Production (1.A.1.a) (EU-28 + ISL)

According to the 2006 IPCC guidelines, emissions from public electricity and heat production (CRF 1.A.1.a) 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 1.A.1.a. autoproducers may be in public or private ownership.

CO_2 emissions from electricity and heat production is the largest key category in the EU-28 + ISL accounting for 24% of total greenhouse gas emissions in 2016 and for 86% of greenhouse gas emissions of the Energy Industries Sector. Between 1990 and 2016, CO_2 emissions from electricity and heat production decreased by 29% in the EU-28 + ISL.

Figure 3.6 shows the trends in emissions originating from the production of public electricity and heat by fuel in the EU-28 + ISL between 1990 and 2016 as well as the underlying activity data[12].

Figure 3.6 1.A.1.a Public Electricity and Heat Production: Total, CO_2 and N_2O emission and activity data trends



Note: Data displayed as dashed line refers to the secondary axis.

Fuel used for public electricity and heat production decreased by 14% in the EU-28 + ISL between 1990 and 2016. Solid fuels still represent 51% of the fuel used in public conventional thermal power plants, although its combustion has been declining by 37% between 1990 and 2016. Gaseous fuels have increased very rapidly, by a factor of almost 3 between 1990 and 2010, declined until 2014 and

[12] 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.

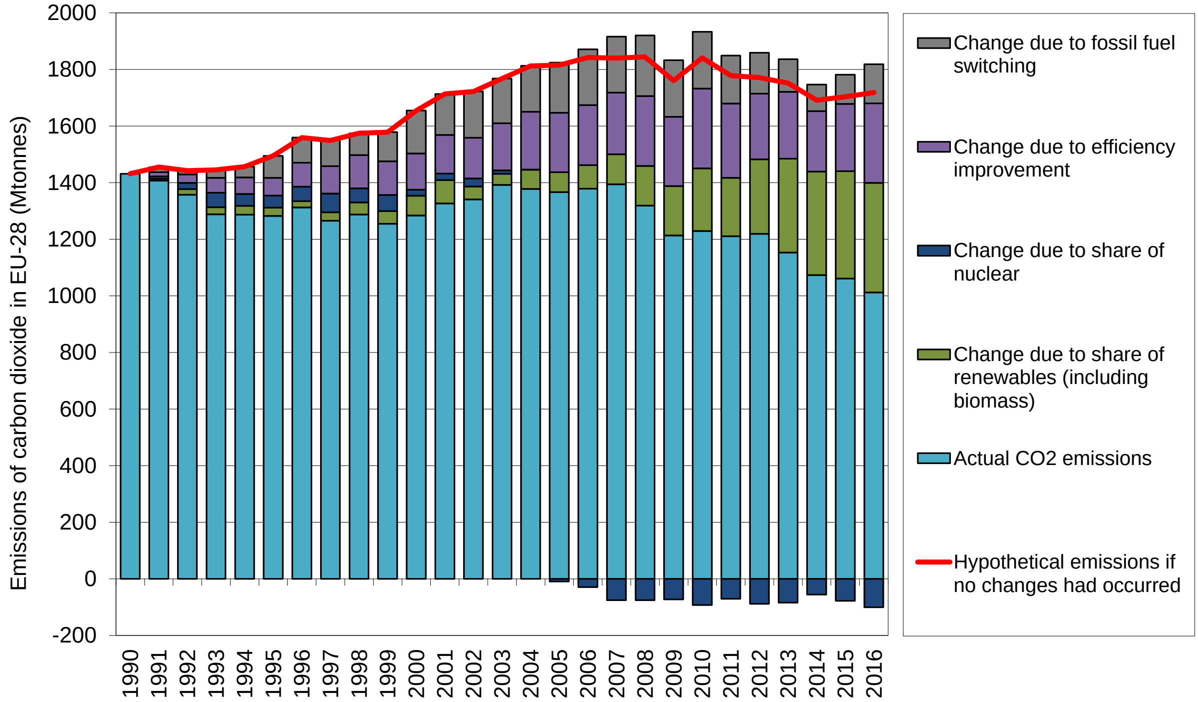
now see a new increased use in the last two years. In 2016 its share amounts to 28% of all the fuel used for the production of heat and electricity in the EU-28 + ISL. Liquid fuels still account for some 3%, but its use has declined gradually during the past 20 years. The use of biomass has increased even more rapidly than the use of gas, but its share in the fuel mix is relatively small, at around 13%.

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-28 between 1990 and 2016. The main explanatory factors at the EU-28 level during the past 26 years have been the increased share of renewable energy, improvements in energy efficiency and (fossil) fuel switching from coal to gas. This trend from coal to gas has reversed in recent years up until 2014, as a result of comparably high gas prices and lower coal prices. Since 2015, natural gas demand picked up again in the EU-28 + ISL, inter alia due to lower gas prices, higher coal prices, coal plant retirements, while world-wide coal demand dropped for a second year in a row in 2016[13][14].

[13] IEA (2017): Market Report Series: Gas 2017. Analysis and Forecasts to 2022. Executive Summary. Available at: https://webstore.iea.org/download/summary/183?fileName=English-Gas-2017-ES.pdf (last accessed: 17.05.2018)

[14] IEA (2017): Market Report Series: Coal 2017. Analysis and Forecasts to 2022. Executive Summary. Available at: https://webstore.iea.org/download/summary/143?fileName=English-Coal-2017-ES.pdf (last accessed: 17.05.2018)

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-28 between 1990 and 2016



Note: The chart shows 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 red line represents the hypothetical development of emissions that would have occurred due to increasing public heat and electricity production between 1990 and 2016, 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 is 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 light blue 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 decreased by 29% during 1990-2016 (light blue bar), but emissions would have risen by 19%, if the shares of input fuels used to produce electricity and heat as well as the efficiency remained constant and an increase due to the change in electricity consumption (20%), which was in line with the additional amount of electricity and heat produced took place. The relationship between the increase in electricity generation and the actual reduction in emissions during 1990-2016 can be explained by the following factors:

- An improvement in the thermal efficiency of electricity and heat production; during 1990-2016, there was a 17% 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 12% reduction in the CO_2 emissions per unit of fossil-fuel input during 1990-2016.

- The higher combined share of renewable energy (increasing share) and the share of nuclear (more or less constant share) for electricity and heat production in 2016 compared to 1990[15]. During 1990-2016, the share of electricity from fossil fuels in total electricity production decreased by 20%.

These three factors interact with each other in a multiplicative way: Actual CO_2 emissions change = 1.20 (increase in electricity and heat production) X 0.83 (efficiency improvement) X 0.88 (fossil fuel switching) X 0.80 (lower nuclear-renewable share) = 0.71. The combined effect was a decrease of 29% in CO_2 emissions in 2016 compared to the 1990 level.Returning to the 2018 inventory, Table 3.4 shows emissions arising from the production of public heat and electricity by Member State. Carbon dioxide emissions amount to 99% of greenhouse gas emissions from public electricity and heat production. These emissions increased in six Countries and fell in 23 compared to 1990. Of the six countries where emissions were higher in 2016 than in 1990, almost 80% of the increase was accounted for by the Netherlands alone. Of the countries, where emissions fell, 64% of the total reduction was accounted for by the United Kingdom (28%), Poland (17%), Romania (10%) and Germany (9%). The change in the EU-28 + ISL between 1990 and 2016 was a net decrease of 419 Mt CO_2 respectively of 29%.

[15] 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. The reason for negative values of nuclear power is that - from 2004 onwards - the share of nuclear power in total electricity generation was below the share of 1990. During the period 1991-2003 the share of nuclear power was above the value of 1990 (29%) reaching a peak of 32% in 1997. Therefore during this period nuclear power contributed to lower GHG emissions compared to 1990. In the figure this is reflected in the (positive) *dark blue* bars. The positive value indicates that nuclear power had a positive effect with regard to GHG emission reductions between 1990 and 2003. From 2004 onwards the picture changed: the share of nuclear power was below the value of 1990 reaching 25% in 2016. In the figure this is reflected in the (negative) *dark blue* bars. The negative value indicates that nuclear power had a negative effect with regard to GHG emission reductions between 2004 and 2016. This is also reflected by the red line in the figure: the red line assumes that the share of nuclear power stays at 29% over the whole time series. Therefore from 2004 onwards the red line is below the bars.

Table 3.4 1.A.1.a Public Electricity and Heat Production: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016	
	1990	2015	2016		kt CO2	%	kt CO2	%
Austria	11 121	7 545	7 393	0.7%	-3 728	-34%	-152	-2%
Belgium	23 537	16 262	15 016	1.5%	-8 521	-36%	-1 246	-8%
Bulgaria	37 306	28 834	25 423	2.5%	-11 883	-32%	-3 411	-12%
Croatia	3 752	3 149	3 389	0.3%	-362	-10%	241	8%
Cyprus	1 676	3 023	3 300	0.3%	1 624	97%	277	9%
Czech Republic	54 645	46 670	47 393	4.7%	-7 252	-13%	724	2%
Denmark	24 697	10 317	11 666	1.2%	-13 031	-53%	1 349	13%
Estonia	29 170	10 990	12 445	1.2%	-16 725	-57%	1 455	13%
Finland	16 453	14 943	16 832	1.7%	379	2%	1 889	13%
France	49 334	31 147	34 777	3.4%	-14 557	-30%	3 630	12%
Germany	338 451	302 801	297 658	29.4%	-40 793	-12%	-5 143	-2%
Greece	40 617	35 493	31 311	3.1%	-9 305	-23%	-4 182	-12%
Hungary	17 896	11 997	11 743	1.2%	-6 154	-34%	-254	-2%
Ireland	10 876	11 200	11 930	1.2%	1 054	10%	730	7%
Italy	106 797	78 641	75 980	7.5%	-30 818	-29%	-2 661	-3%
Latvia	6 103	1 690	1 774	0.2%	-4 329	-71%	85	5%
Lithuania	12 003	1 649	1 403	0.1%	-10 600	-88%	-246	-15%
Luxembourg	33	452	247	0.0%	214	642%	-205	-45%
Malta	1 361	890	580	0.1%	-782	-57%	-310	-35%
Netherlands	40 027	56 024	54 881	5.4%	14 854	37%	-1 143	-2%
Poland	228 038	153 652	153 719	15.2%	-74 319	-33%	67	0%
Portugal	14 355	15 881	14 867	1.5%	512	4%	-1 014	-6%
Romania	66 280	25 732	22 743	2.2%	-43 537	-66%	-2 989	-12%
Slovakia	14 690	4 832	4 712	0.5%	-9 978	-68%	-120	-2%
Slovenia	6 096	4 531	4 903	0.5%	-1 192	-20%	372	8%
Spain	65 570	73 459	58 246	5.8%	-7 324	-11%	-15 213	-21%
Sweden	7 737	6 125	6 505	0.6%	-1 231	-16%	380	6%
United Kingdom	203 098	103 486	81 312	8.0%	-121 785	-60%	-22 174	-21%
EU-28	**1 431 720**	**1 061 416**	**1 012 150**	**100%**	**-419 570**	**-29%**	**-49 266**	**-5%**
Iceland	14	4	2	0.0%	-12	-84%	-1	-39%
United Kingdom (KP)	203 786	104 147	81 976	8.1%	-121 811	-60%	-22 171	-21%
EU-28 + ISL	**1 432 422**	**1 062 080**	**1 012 816**	**100%**	**-419 607**	**-29%**	**-49 265**	**-5%**

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

N_2O emissions currently represent 0.6% of greenhouse gas emissions from public electricity and heat production. Between 1990 and 2016, emissions decreased by 4% (Table 3.5). The largest decline in emissions from this source category was reported by the United Kingdom (-622 kt CO_2eq) and Poland (-266 kt CO_2eq). The biggest increase occurred in the Netherlands (155 kt CO_2eq).

Table 3.5 1.A.1.a Public Electricity and Heat Production: Member States' contributions to N_2O emissions

Member State	N2O Emissions in kt CO2 equiv.			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016	
	1990	2015	2016		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	39	103	98	1.5%	58	148%	-5	-5%
Belgium	53	94	92	1.4%	39	74%	-3	-3%
Bulgaria	132	117	103	1.5%	-29	-22%	-14	-12%
Croatia	13	18	21	0.3%	8	61%	3	19%
Cyprus	4	7	7	0.1%	4	92%	1	9%
Czech Republic	242	230	232	3.5%	-10	-4%	2	1%
Denmark	79	74	80	1.2%	2	2%	6	9%
Estonia	18	32	35	0.5%	17	97%	3	10%
Finland	100	228	243	3.7%	143	143%	15	7%
France	289	255	286	4.3%	-3	-1%	32	12%
Germany	2 407	2 400	2 370	35.7%	-38	-2%	-30	-1%
Greece	142	116	93	1.4%	-49	-34%	-23	-20%
Hungary	63	64	61	0.9%	-2	-3%	-3	-5%
Ireland	71	122	139	2.1%	68	96%	17	14%
Italy	304	312	282	4.3%	-21	-7%	-29	-9%
Latvia	11	16	20	0.3%	9	83%	4	26%
Lithuania	19	32	34	0.5%	15	81%	2	5%
Luxembourg	1	3	3	0.0%	2	127%	0	4%
Malta	5	2	1	0.0%	-3	-72%	-1	-35%
Netherlands	133	294	288	4.3%	155	117%	-6	-2%
Poland	1 006	762	740	11.1%	-266	-26%	-22	-3%
Portugal	46	131	134	2.0%	88	193%	2	2%
Romania	179	108	88	1.3%	-90	-50%	-19	-18%
Slovakia	59	36	33	0.5%	-26	-44%	-2	-6%
Slovenia	25	21	23	0.3%	-2	-8%	2	7%
Spain	274	519	443	6.7%	169	62%	-76	-15%
Sweden	118	240	231	3.5%	113	96%	-9	-4%
United Kingdom	1 076	647	454	6.8%	-622	-58%	-193	-30%
EU-28	**6 906**	**6 984**	**6 636**	**100%**	**-270**	**-4%**	**-348**	**-5%**
Iceland	0	0	0	0.0%	0	-84%	0	-39%
United Kingdom (KP)	1 078	649	456	6.9%	-621	-58%	-193	-30%
EU-28 + ISL	**6 908**	**6 986**	**6 638**	**100%**	**-270**	**-4%**	**-348**	**-5%**

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

Finally, CH_4 emissions currently represent 0.4% of greenhouse gas emissions from public electricity and heat production. Between 1990 and 2016, emissions increased by 466%. The biggest increase was reported by Germany (2677 kt CO_2eq), which is also responsible for 73.4% of the emissions EU-28 + ISL in 2016.

Table 3.6 1.A.1.a Public Electricity and Heat Production: Member States' contributions to CH_4 emissions

Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016	
	1990	2015	2016		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	6	23	22	0.6%	16	272%	0	-1%
Belgium	11	25	25	0.6%	13	117%	-1	-2%
Bulgaria	13	8	8	0.2%	-5	-36%	0	1%
Croatia	3	3	5	0.1%	1	35%	1	43%
Cyprus	2	3	3	0.1%	2	92%	0	9%
Czech Republic	16	31	31	0.8%	16	102%	1	3%
Denmark	15	84	97	2.5%	82	551%	13	15%
Estonia	8	15	41	1.0%	33	442%	26	175%
Finland	9	23	27	0.7%	18	200%	3	14%
France	14	23	33	0.8%	19	141%	10	44%
Germany	172	2 624	2 849	73.4%	2 677	1555%	226	9%
Greece	13	11	11	0.3%	-2	-16%	0	-4%
Hungary	7	25	24	0.6%	17	226%	-1	-4%
Ireland	6	6	7	0.2%	1	13%	1	14%
Italy	93	105	107	2.8%	14	15%	2	2%
Latvia	5	10	13	0.3%	8	170%	3	25%
Lithuania	9	20	21	0.5%	12	138%	1	5%
Luxembourg	1	2	2	0.1%	1	129%	0	3%
Malta	1	1	1	0.0%	0	-38%	0	-35%
Netherlands	42	67	71	1.8%	29	69%	4	6%
Poland	75	112	98	2.5%	23	31%	-14	-12%
Portugal	4	14	14	0.4%	10	244%	0	1%
Romania	36	12	11	0.3%	-24	-68%	-1	-6%
Slovakia	6	14	13	0.3%	7	106%	-1	-7%
Slovenia	2	3	3	0.1%	1	51%	0	4%
Spain	21	73	60	1.5%	39	189%	-13	-18%
Sweden	16	42	46	1.2%	30	190%	4	9%
United Kingdom	81	228	241	6.2%	160	197%	13	6%
EU-28	**685**	**3 606**	**3 883**	**100%**	**3 197**	**466%**	**276**	**8%**
Iceland	0	0	0	0.0%	0	-84%	0	-39%
United Kingdom (KP)	82	229	242	6.2%	160	195%	13	6%
EU-28 + ISL	**686**	**3 608**	**3 884**	**100%**	**3 197**	**466%**	**276**	**8%**

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

1.A.1.a 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 3% of all greenhouse gas emissions from 1.A.1.a. Within the EU-28 + ISL, emissions fell by 82% respectively by 144 Mt CO_2 between 1990 and 2016 (Table 3.7).

Table 3.7 1.A.1.a Public Electricity and Heat Production, Liquid Fuels: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016		Method	EF information
	1990	2015	2016		kt CO2	%	kt CO2	%		
Austria	1 228	253	346	1.1%	-881	-72%	94	37%	T2	CS
Belgium	663	72	61	0.2%	-601	-91%	-11	-15%	T1,T3	D,PS
Bulgaria	3 245	664	837	2.7%	-2 408	-74%	173	26%	T1,T2	CS,D
Croatia	2 142	175	27	0.1%	-2 116	-99%	-148	-85%	T1	D
Cyprus	1 676	3 023	3 300	10.5%	1 624	97%	277	9%	CS	CS
Czech Republic	1 234	130	113	0.4%	-1 121	-91%	-17	-13%	T1,T2	CS,D
Denmark	953	158	162	0.5%	-791	-83%	4	2%	T1,T2,T3	CS,D,PS
Estonia	4 897	260	244	0.8%	-4 653	-95%	-17	-6%	T2	CS
Finland	1 234	492	820	2.6%	-414	-34%	328	67%	T3	CS,PS,D
France	8 228	4 089	4 074	13.0%	-4 154	-50%	-15	0%	T2,T3	CS,PS
Germany	8 637	1 704	1 453	4.6%	-7 184	-83%	-251	-15%	CS	CS
Greece	5 416	3 663	3 643	11.6%	-1 773	-33%	-20	-1%	T2	CS,PS
Hungary	1 456	66	46	0.1%	-1 410	-97%	-20	-31%	T1,T2	D,CS
Ireland	1 087	250	206	0.7%	-881	-81%	-44	-18%	T1,T3	CS,D,PS
Italy	63 101	2 495	1 377	4.4%	-61 724	-98%	-1 118	-45%	T3	CS
Latvia	3 079	2	2	0.0%	-3 077	-100%	0	8%	T2	CS
Lithuania	6 021	181	131	0.4%	-5 890	-98%	-50	-28%	T1,T2,T3	CS,PS,D
Luxembourg	NO	2	3	0.0%	3	∞	1	64%	T1,T2	D,CS
Malta	742	890	580	1.9%	-163	-22%	-310	-35%	T1, T2	CS, D
Netherlands	233	755	729	2.3%	495	212%	-26	-3%	CS,T2	CS,D
Poland	5 160	455	448	1.4%	-4 712	-91%	-6	-1%	T1	D
Portugal	6 434	707	740	2.4%	-5 694	-88%	33	5%	T1	D
Romania	20 356	987	722	2.3%	-19 635	-96%	-265	-27%	T1,T2	CS,D
Slovakia	1 033	17	28	0.1%	-1 006	-97%	11	63%	T2,T3	CS
Slovenia	272	22	21	0.1%	-251	-92%	-1	-5%	T1	D
Spain	6 087	9 311	9 715	31.0%	3 628	60%	404	4%	T2	CS,PS
Sweden	1 277	C	481	-	-796	-62%	481	∞	T2	CS
United Kingdom	19 716	1 085	1 034	3.3%	-18 682	-95%	-51	-5%	T1,T2	CS,D
EU-28	**174 330**	**31 903**	**30 859**	**99%**	**-143 470**	**-82%**	**-1 044**	**-3%**	**-**	**-**
Iceland	14	4	2	0.0%	-12	-84%	-1	-39%	T1	D
United Kingdom (KP)	20 393	1 559	1 486	4.7%	-18 906	-93%	-73	-5%	T1,T2	CS,D
EU-28 + ISL	**175 020**	**32 381**	**31 314**	**100%**	**-143 706**	**-82%**	**-1 067**	**-3%**	**-**	**-**

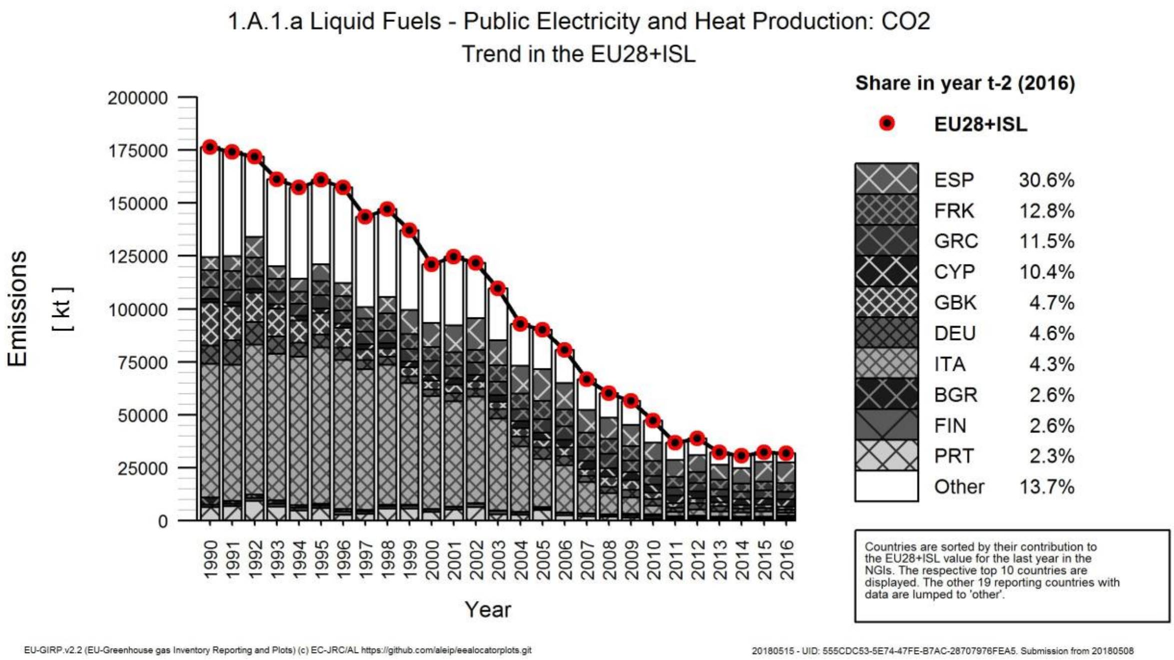
Abbreviations are explained in the Chapter 'Units and abbreviations'.

Note: EU trends in this table do not include Sweden for confidentiality reasons and to preserve time series consistency for the EU. This also explains the differences between the numbers in this table and the CRF.

Table 3.7 also shows that 94.7 % of EU-28 + ISL emissions are calculated using higher tier methods. Many Member States are using country specific information from the EU ETS and apply default emission factors for emissions that are not covered by the EU ETS. Similarly countries may use country specific emission factors for the most common fuels (for example hard coal and lignite) and use default emission factors for fuels of minor importance (for example brown coal briquettes). Therefore countries might use apparently contradicting information such as "T1, T2" for Methods used and "CS, D" for Emission Factors applied. In such cases we assumed, that 90 % of emissions are calculated using a higher tier method and 10 % of emissions are calculated using the tier 1 method. When countries have reported country specific methods and emission factors it has been assumed, that a higher tier method has been used.

Figure 3.8 shows the contribution to the emission trend for liquid fuels by the main Member States. In 2016 Spain, France, Greece and Cyprus are responsible for about 66% of emissions in this category. The strongest decrease in emissions took place in Italy because less oil is used as a fuel in the power sector. In 1990 Italy was responsible for 36.1% of the emissions in this category and now in 2016 only for 4.4%.

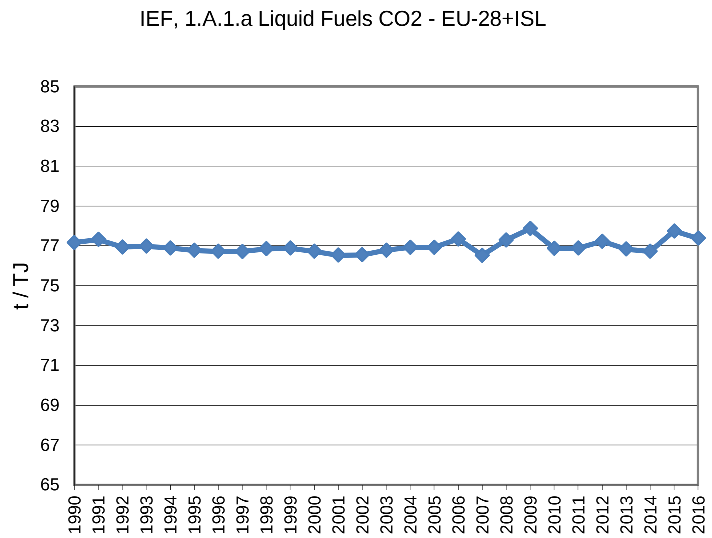
Figure 3.8 1.A.1.a Public Electricity and Heat Production, Liquid Fuels: Emission trend and share for CO_2

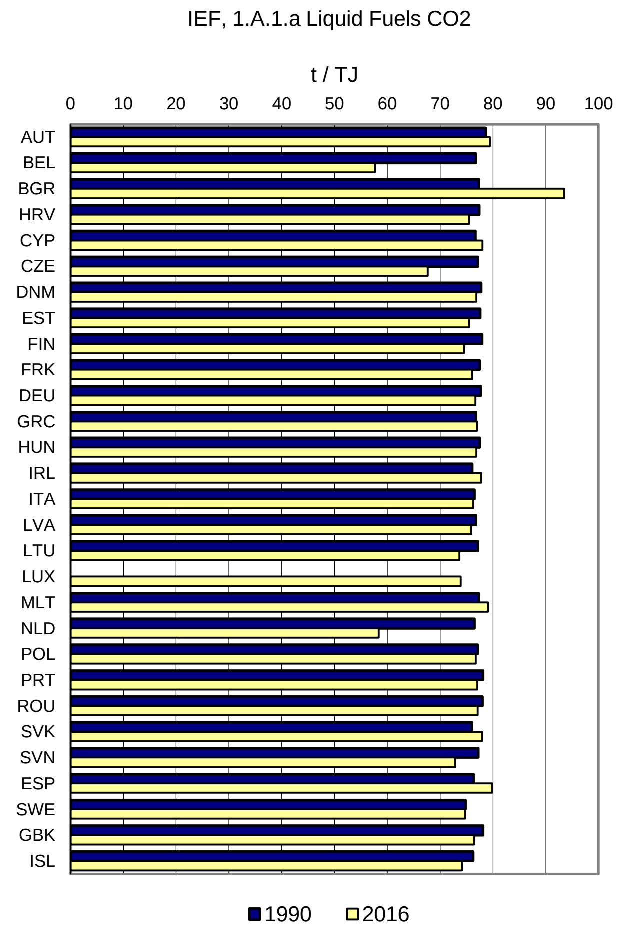


Note: This figure does include Sweden. This also explains the differences between the countries' share of emissions in this figure and the table on MS contributions.

Figure 3.9 (on the next page) shows the implied emission factors for CO_2 emissions from liquid fuels used in public electricity and heat production. The IEFs in most countries range between 76 and 79 t/TJ in 1990 as well as in 2016. Bulgaria has the highest IEF in 2016, which is explained by the relatively large share of petroleum coke used in main activity producer CHP plants. The country-specific CO_2 EF for petroleum coke varies in the range of 92-95 t/TJ, which is significantly higher than the average EF of liquid fuels. The IEF of Belgium is the lowest among the Member States in the year 2016. The low IEF and its fluctuation in the past years are caused by the varying mix of liquid fuels including gasoil and heavy fuel oil (with higher IEF) and on the other hand refinery gas (with lower IEF). The implied emission factor of the Netherlands is similarly low in 2016, it is caused by the high share of waste gas use in the liquid fuel mix, which has a comparatively low IEF (53.0 t/TJ).

Figure 3.9 1.A.1.a Public Electricity and Heat Production, Liquid Fuels: Implied Emission Factors for CO_2





1.A.1.a Electricity and Heat Production - Solid Fuels (CO_2)

CO_2 emissions from the combustion of solid fuels represented about 70% of all greenhouse gas emissions from public electricity and heat production. Within the EU-28 + ISL, emissions fell by 37% between 1990 and 2016 (Table 3.8). A reason for the recent decline is that coal is being phased out of the fuel mix especially in the United Kingdom as well as in Germany. Over the past 26 years United Kingdom, Germany and Poland account for 66.8 % of the decline in the EU-28 + ISL.

Table 3.8 1.A.1.a Public Electricity and Heat Production, Solid Fuels: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016		Method	EF information
	1990	2015	2016		kt CO2	%	kt CO2	%		
Austria	6 247	2 335	1 587	0.2%	-4 660	-75%	-749	-32%	T3	PS
Belgium	19 434	6 306	5 249	0.7%	-14 186	-73%	-1 057	-17%	T3	PS
Bulgaria	27 766	26 314	22 762	3.2%	-5 004	-18%	-3 552	-13%	T1,T2	CS,D
Croatia	603	2 064	2 299	0.3%	1 695	281%	234	11%	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czech Republic	52 368	44 102	44 262	6.2%	-8 107	-15%	159	0%	T1,T2	CS,D
Denmark	22 225	6 771	7 923	1.1%	-14 303	-64%	1 151	17%	T1,T2,T3	CS,D,PS
Estonia	22 109	9 873	11 307	1.6%	-10 802	-49%	1 434	15%	T2,T3	CS,PS
Finland	9 281	6 979	8 616	1.2%	-664	-7%	1 637	23%	T3	CS,PS,D
France	37 571	14 156	12 937	1.8%	-24 635	-66%	-1 219	-9%	T2,T3	CS,PS
Germany	307 246	261 626	249 803	35.0%	-57 443	-19%	-11 823	-5%	CS	CS
Greece	35 201	28 755	22 430	3.1%	-12 771	-36%	-6 324	-22%	T1,T2	D,PS
Hungary	12 266	8 003	7 305	1.0%	-4 961	-40%	-698	-9%	T1,T2,T3	D,CS,PS
Ireland	4 845	4 359	4 282	0.6%	-563	-12%	-77	-2%	T1,T3	CS,D,PS
Italy	27 755	38 219	31 326	4.4%	3 571	13%	-6 893	-18%	T3	CS
Latvia	218	10	16	0.0%	-202	-93%	6	57%	T2	CS
Lithuania	174	8	8	0.0%	-166	-95%	-1	-7%	T1,T2,T3	CS,PS,D
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	619	NO	NO	-	-619	-100%	-	-	NA	NA
Netherlands	25 862	37 303	34 007	4.8%	8 145	31%	-3 296	-9%	CS,T2	CS,D
Poland	220 928	149 661	148 920	20.9%	-72 007	-33%	-741	0%	T1,T2	D,CS
Portugal	7 921	12 229	10 498	1.5%	2 577	33%	-1 731	-14%	T3	PS
Romania	25 123	19 679	17 034	2.4%	-8 089	-32%	-2 645	-13%	T1,T2	CS,D
Slovakia	11 542	3 421	3 275	0.5%	-8 268	-72%	-146	-4%	T2,T3	CS
Slovenia	5 712	4 303	4 667	0.7%	-1 045	-18%	364	8%	T3	PS
Spain	58 931	51 225	35 744	5.0%	-23 187	-39%	-15 481	-30%	T2	PS
Sweden	4 231	C	2 492	-	-1 739	-41%	2 492	∞	T2	CS
United Kingdom	183 150	65 403	27 061	3.8%	-156 089	-85%	-38 342	-59%	T2	CS
EU-28	**1 125 097**	**803 106**	**713 314**	**100%**	**-411 783**	**-37%**	**-89 792**	**-11%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	183 150	65 403	27 061	3.8%	-156 089	-85%	-38 342	-59%	T2	CS
EU-28 + ISL	**1 125 097**	**803 106**	**713 314**	**100%**	**-411 783**	**-37%**	**-89 792**	**-11%**	**-**	**-**

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

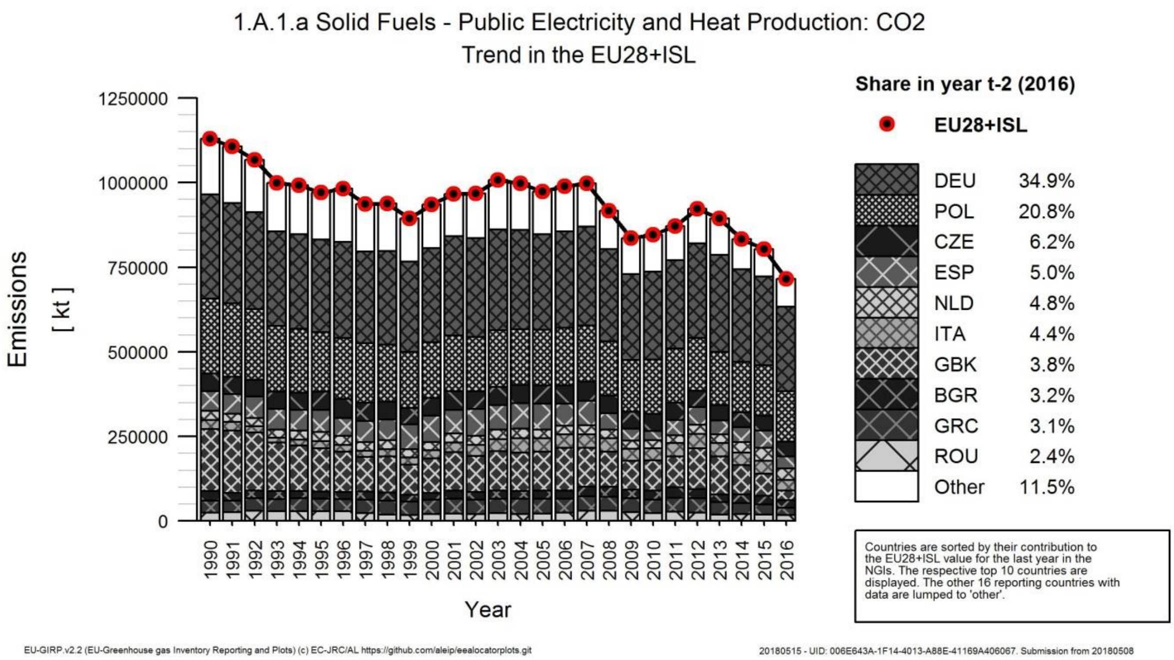
Note: EU trends in this table do not include Sweden for confidentiality reasons and to preserve time series consistency for the EU. This also explains the differences between the numbers in this table and the CRF.

Table 3.8 also shows that 95.8 % of EU-28 + ISL emissions are calculated using higher tier methods. Many Member States are using country specific information from the EU ETS and apply default emission factors for emissions that are not covered by the EU ETS. Similarly countries may use country specific emission factors for the most common fuels (for example hard coal and lignite) and use default emission factors for fuels of minor importance (for example brown coal briquettes). Therefore countries might use apparently contradicting information such as "T1, T2" for Methods used and "CS, D" for Emission Factors applied. In such cases we assumed, that 90 % of emissions are calculated using a higher tier method and 10 % of emissions are calculated using the tier 1 method.

When countries have reported country specific methods and emission factors it has been assumed, that a higher tier method has been used.

Figure 3.10 shows the trend of emissions for solid fuels for main contributing Member States. In 2016 Germany has the largest share of emissions from solid fuels in the EU-28 + ISL (34.9%), followed by Poland (20.8%) and then by a clear margin the Czech Republic (6.2%).

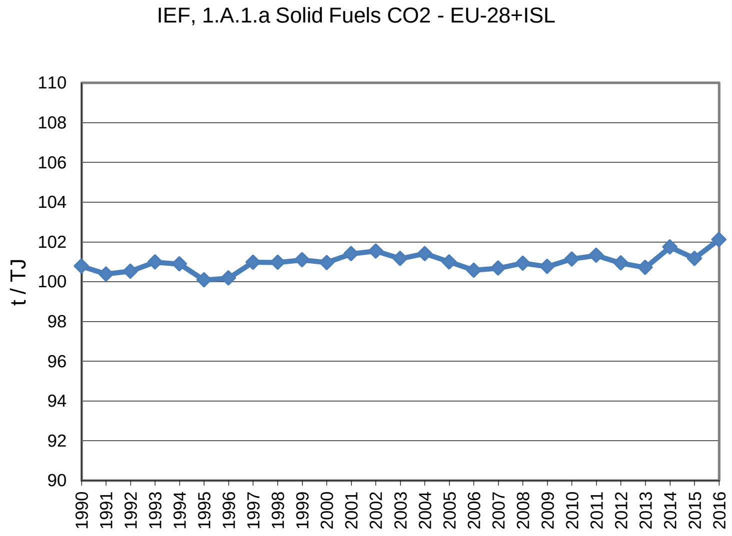
Figure 3.10 1.A.1.a Public Electricity and Heat Production, Solid Fuels: Emission trend and share for CO_2

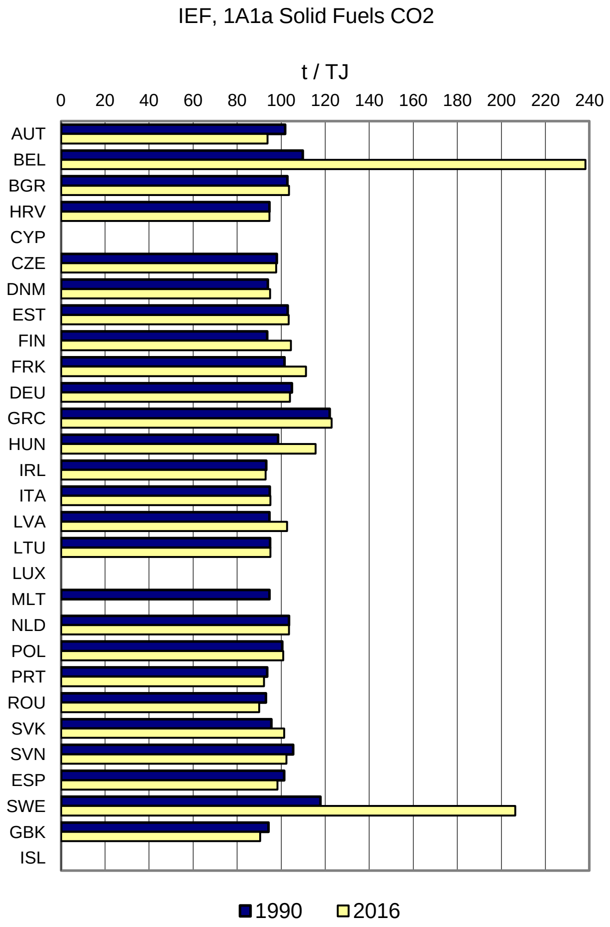


Note: This figure does include Sweden. This also explains the differences between the countries' share of emissions in this figure and the table on MS contributions.

Figure 3.11 (on the next page) shows the relevant implied emission factors for solid fuels. The EU-28 + ISL implied emission factor has remained fairly stable at around 101 t/TJ and is 102 t/TJ in 2016. The comparatively high IEF of Greece is due to the large importance of domestic lignite use for electricity production. The Greek IEF is based on verified EU-ETS reports, ranging from 33.74 to 35.37 tC/TJ. These values lie out of the range suggested by the 2006 IPCC Guidelines. However, given that the net calorific value of the Greek lignite is one of lowest a high value for the carbon content is expected. In Belgium and Sweden, the emission factors increased sharply since the late 1990s due to the use of blast furnace gas which has a much higher carbon content. A significant increase of the Belgian IEF between 2015 and 2016 can be observed. The reason for this strong increase lies in the large decrease of the consumption of coals in 2016 (2,9 PJ in 2016 compared to 19,7 PJ in 2015) and at the same time an increase in energy consumption of blast furnace gas, from 17,6 PJ in 2015 to 19,1 PJ in 2016.

Figure 3.11 1.A.1.a Public Electricity and Heat Production, Solid Fuels: Implied Emission Factors for CO_2





1.A.1.a Electricity and Heat Production - Gaseous Fuels (CO_2)

CO_2 emissions from the combustion of gaseous fuels accounted for 21% of all greenhouse gas emissions from public electricity and heat generation in 2016. Emissions increased by 103% in the EU-28 + ISL between 1990 and 2016 (Table 3.9) The United Kingdom and Italy together were responsible for 55.7% of the increase in the last 26 years.

Table 3.9 1.A.1.a Electricity and heat production, Gaseous Fuels: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016		Method	EF informa-tion
	1990	2015	2016		kt CO2	%	kt CO2	%		
Austria	3 294	3 621	3 997	1.8%	702	21%	376	10%	T2	CS
Belgium	2 766	7 826	7 619	3.5%	4 853	175%	-207	-3%	T1,T3	D,PS
Bulgaria	6 295	1 857	1 824	0.8%	-4 471	-71%	-33	-2%	T1,T2	CS,D
Croatia	1 006	910	1 064	0.5%	58	6%	154	17%	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czech Republic	1 019	2 210	2 769	1.3%	1 750	172%	559	25%	T1,T2	CS,D
Denmark	980	1 756	1 942	0.9%	962	98%	186	11%	T1,T2,T3	CS,D,PS
Estonia	1 977	583	614	0.3%	-1 363	-69%	31	5%	T2	CS
Finland	1 989	2 186	2 090	1.0%	102	5%	-96	-4%	T3	CS
France	977	7 117	11 879	5.5%	10 902	1116%	4 762	67%	T2,T3	CS,PS
Germany	18 447	24 511	31 442	14.5%	12 995	70%	6 931	28%	CS	CS
Greece	IE,NO	3 076	5 238	2.4%	5 238	∞	2 162	70%	T1,T2	D,PS
Hungary	4 148	3 709	4 157	1.9%	9	0%	448	12%	T1,T2	D,CS
Ireland	1 881	3 869	4 852	2.2%	2 971	158%	982	25%	T1,T3	CS,D,PS
Italy	15 798	37 715	43 068	19.8%	27 270	173%	5 353	14%	T3	CS
Latvia	2 658	1 678	1 757	0.8%	-901	-34%	79	5%	T2	CS
Lithuania	5 797	1 338	988	0.5%	-4 809	-83%	-351	-26%	T1,T2	CS,D
Luxembourg	NO	371	152	0.1%	152	∞	-219	-59%	T2	CS
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	13 330	15 105	17 179	7.9%	3 849	29%	2 074	14%	CS,T2	CS,D
Poland	1 197	3 358	3 921	1.8%	2 724	228%	563	17%	T1	D
Portugal	NO	2 521	3 153	1.5%	3 153	∞	632	25%	T3,T2	PS,D
Romania	20 801	5 067	4 988	2.3%	-15 813	-76%	-79	-2%	T1,T2	CS,D
Slovakia	2 089	1 372	1 387	0.6%	-702	-34%	14	1%	T2,T3	CS
Slovenia	112	194	202	0.1%	90	80%	8	4%	T2	CS
Spain	441	11 441	11 132	5.1%	10 690	2423%	-310	-3%	T2	CS,PS
Sweden	486	C	674	-	188	39%	674	∞	T2	CS
United Kingdom	16	34 015	49 669	22.9%	49 653	311151%	15 653	46%	T1,T2	CS,D
EU-28	**107 019**	**177 408**	**217 080**	**100%**	**110 061**	**103%**	**39 672**	**22%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	16	34 169	49 847	22.9%	49 831	312267%	15 678	46%	T1,T2	CS,D
EU-28 + ISL	**107 019**	**177 561**	**217 258**	**100%**	**110 239**	**103%**	**39 697**	**22%**	**-**	**-**

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

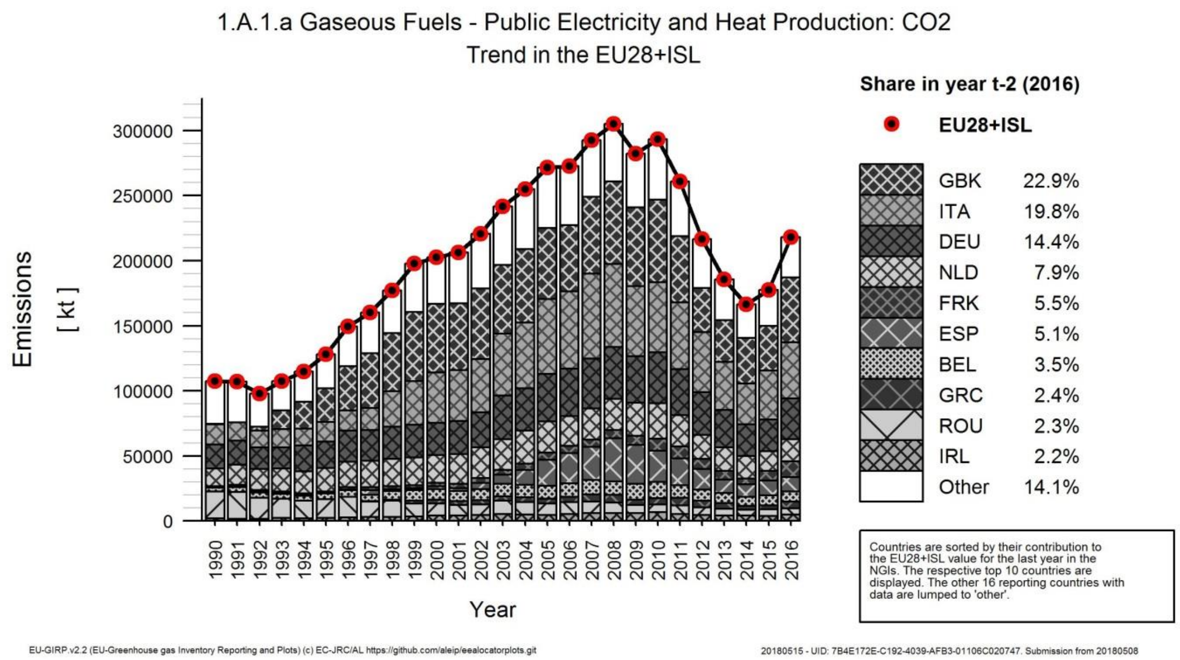
Note: EU trends in this table do not include Sweden for confidentiality reasons and to preserve time series consistency for the EU. This also explains the differences between the numbers in this table and the CRF.

Table 3.9 also shows that 93.8 % of EU-28 + ISL emissions are calculated using higher tier methods. Many Member States are using country specific information from the EU ETS and apply default emission factors for emissions that are not covered by the EU ETS. Similarly countries may use country specific emission factors for the most common fuels (for example hard coal and lignite) and use default emission factors for fuels of minor importance (for example brown coal briquettes). Therefore countries might use apparently contradicting information such as "T1, T2" for Methods used and "CS, D" for Emission Factors applied. In such cases we assumed, that 90 % of emissions are calculated using a higher tier method and 10 % of emissions are calculated using the tier 1 method.

When countries have reported country specific methods and emission factors it has been assumed, that a higher tier method has been used.

In six EU-28 Member States the consumption of gaseous fuels was lower in 2016 than in 1990.Malta and Cyprus are not utilising gaseous fuels for public electricity and heat production. In the other 20 countries, gas consumption has increased of the last 26 years. From 1990 until 2008 the use of gaseous fuels saw a steep increasing trend, followed by strong decreasing trend from 2009 until 2014, which was mainly attributed to the increased prices for natural gas. After this steep decrease the emissions of gaseous fuels increased again by 31% in 2016 compared to 2014. Figure 3.12 shows the trend of emissions from gaseous fuels by the main contributing Member States which are the United Kingdom (22.9%), Italy (19.8%) and Germany (14.4%). One of the reasons for the recent increase is that coal is in the process of being phased out of the fuel mix and replaced by gaseous fuels in many countries, but especially in the United Kingdom as well in Germany. Since 2015, natural gas demand picked up again in the EU-28 + ISL, inter alia due to lower gas prices, higher coal prices, coal plant retirements, while world-wide coal demand dropped for a second year in a row in 2016[16][17].

Figure 3.12 1.A.1.a Public Electricity and Heat Production, Gaseous Fuels: Emission trend and share for CO_2



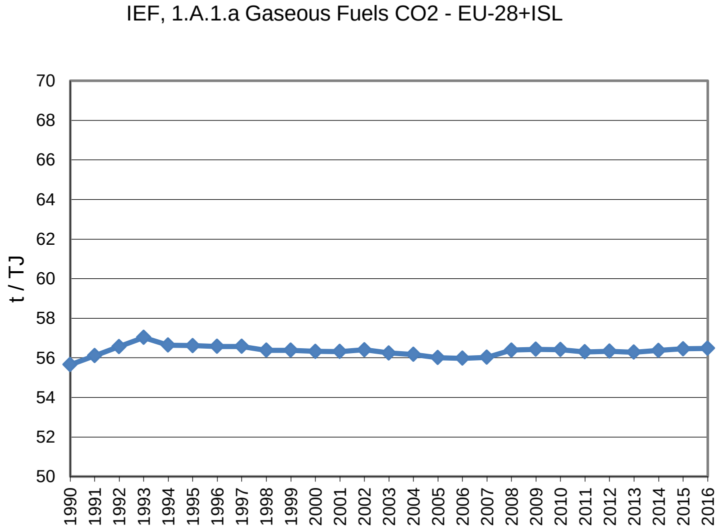
Note: This figure does include Sweden. This also explains the differences between the countries' share of emissions in this figure and the table on MS contributions.

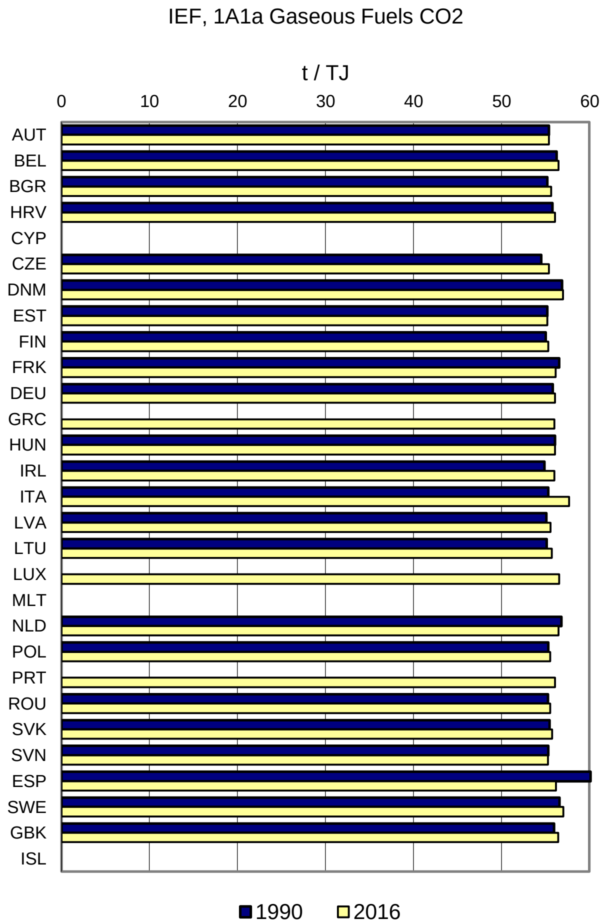
[16] IEA (2017): Market Report Series: Gas 2017. Analysis and Forecasts to 2022. Executive Summary. Available at: https://webstore.iea.org/download/summary/183?fileName=English-Gas-2017-ES.pdf (last accessed: 17.05.2018)

[17] IEA (2017): Market Report Series: Coal 2017. Analysis and Forecasts to 2022. Executive Summary. Available at: https://webstore.iea.org/download/summary/143?fileName=English-Coal-2017-ES.pdf (last accessed: 17.05.2018)

Figure 3.13 shows the implied emission factors from gaseous fuels for CO_2. The EU-28 + ISL implied emission factor has remained fairly stable (56.5 t/TJ in 2016) which is very close to the default emission factor of natural gas (56.1 t/TJ). The slight increase in the EU-28 + ISL factor observed in the early 1990s can be explained by the higher UK's gas share in the EU-28 + ISL and by an 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.

Figure 3.13 1.A.1.a Public Electricity and Heat Production, Gaseous Fuels: Implied Emission Factors for CO_2





1.A.1.a Electricity and Heat Production - Other Fuels (CO_2)

In 2016, the share of CO_2 emissions from other fuels amounts to 3.8% of total greenhouse gas emissions from public electricity and heat generation. Other fuels cover mainly the fossil part of municipal solid waste incineration where there is energy recovery, including plastics (Table 3.10). Emissions increased by 265% at EU-28 + ISL level between 1990 and 2016 and increased in all countries except for Poland, Latvia and Slovakia. Germany alone is responsible for 37.6% of the increase in the whole EU-28 + ISL over the last 26 years.

Table 3.10 1.A.1.a Public Electricity and Heat Production, Other Fuels: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016		Method	EF informa-tion
	1990	2015	2016		kt CO2	%	kt CO2	%		
Austria	352	1 336	1 464	3.7%	1 112	316%	127	10%	T2	CS
Belgium	674	2 057	2 087	5.3%	1 413	210%	30	1%	T3	PS
Bulgaria	NO	NO	NO	-	-	-	-	-	NA	NA
Croatia	NO	NO	NO	-	-	-	-	-	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czech Republic	24	228	250	0.6%	226	938%	22	10%	T1,T2	CS,D
Denmark	539	1 632	1 639	4.2%	1 101	204%	8	0%	T1,T2,T3	CS,D,PS
Estonia	NO	145	147	0.4%	147	∞	2	1%	T3	PS
Finland	1	420	507	1.3%	506	50560%	87	21%	T3	CS
France	2 558	5 785	5 887	15.0%	3 329	130%	102	2%	T2,T3	CS,PS
Germany	4 121	14 961	14 960	38.1%	10 840	263%	0	0%	CS	CS
Greece	NO	NO	NO	-	-	-	-	-	NA	NA
Hungary	26	219	235	0.6%	209	790%	17	8%	T1,T2,T3	D,CS,PS
Ireland	NO	87	86	0.2%	86	∞	-1	-1%	T1,T3	CS,D,PS
Italy	143	211	209	0.5%	66	46%	-2	-1%	T3	CS
Latvia	3	NO	NO	-	-3	-100%	-	-	T2	CS
Lithuania	NO	114	266	0.7%	266	∞	151	132%	T1,T2	CS,D
Luxembourg	33	80	92	0.2%	59	177%	12	15%	T2	CS
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	601	2 861	2 967	7.6%	2 365	393%	106	4%	CS,T2	CS,D
Poland	753	178	429	1.1%	-323	-43%	252	141%	T1	D
Portugal	NO	424	476	1.2%	476	∞	52	12%	T2	CS
Romania	NO	NO	NO	-	-	-	-	-	T1,T2	CS,D
Slovakia	25	22	23	0.1%	-2	-9%	1	6%	T2,T3	CS
Slovenia	NO	13	14	0.0%	14	∞	1	10%	T1	D
Spain	110	1 482	1 655	4.2%	1 545	1403%	173	12%	T2	CS/PS
Sweden	570	2 384	2 316	5.9%	1 745	306%	-68	-3%	T2	CS
United Kingdom	216	2 983	3 549	9.0%	3 333	1545%	566	19%	T1,T2	CS,D
EU-28	**10 751**	**37 621**	**39 258**	**100%**	**28 508**	**265%**	**1 637**	**4%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	T1	D
United Kingdom (KP)	228	3 016	3 582	9.1%	3 354	1471%	566	19%	T1,T2	CS,D
EU-28 + ISL	**10 763**	**37 654**	**39 291**	**100%**	**28 529**	**265%**	**1 637**	**4%**	**-**	**-**

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

Table 3.10 also shows that 97.3 % of EU-28 + ISL emissions are calculated using higher tier methods. Many Member States are using country specific information from the EU ETS and apply default emission factors for emissions that are not covered by the EU ETS. Similarly countries may use country specific emission factors for the most common fuels (for example hard coal and lignite) and use default emission factors for fuels of minor importance (for example brown coal briquettes). Therefore countries might use apparently contradicting information such as "T1, T2" for Methods used and "CS, D" for Emission Factors applied. In such cases we assumed, that 90 % of emissions are calculated using a higher tier method and 10 % of emissions are calculated using the tier 1 method.

When countries have reported country specific methods and emission factors it has been assumed, that a higher tier method has been used.

Figure 3.14 illustrates clearly the strong increase of emissions caused by other fuels over the past 26 years. The largest emitters of other fuels in 2016 were Germany (38%) and France (15%) and the United Kingdom (9%). Together these three Member States accounted for 62.2% of the total EU-28 + ISL emissions in this category.

Figure 3.14 1.A.1.a Public Electricity and Heat Production, Other Fuels: Emission trend and share for CO_2

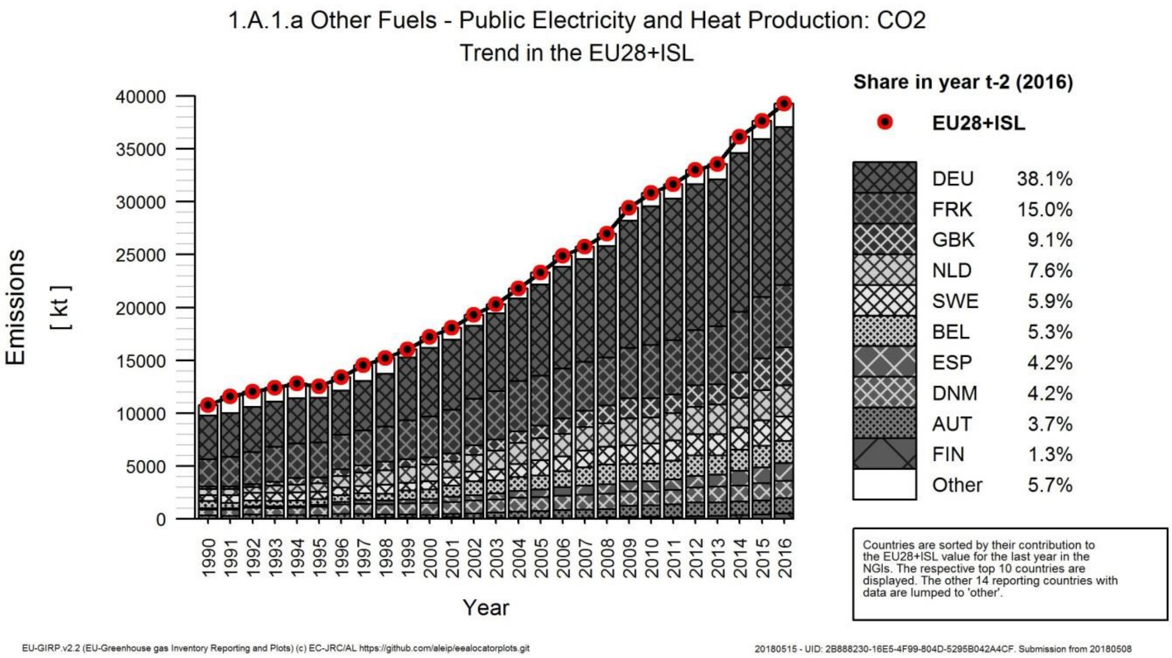
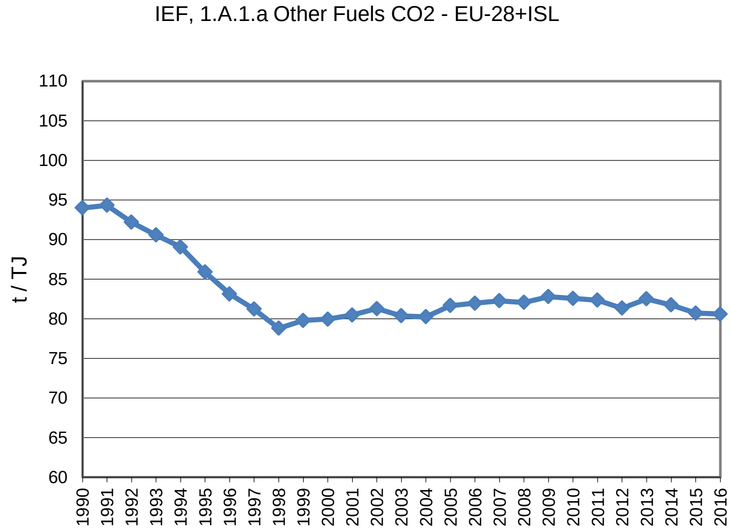
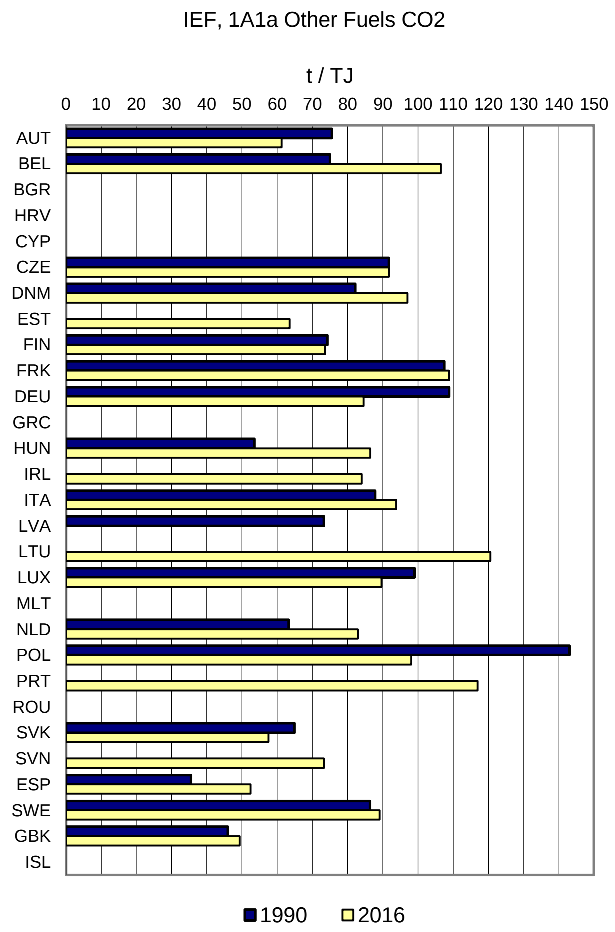


Figure 3.15 (on the next page) shows the implied emission factors of the category other fuels from CO_2. The EU-28 + ISL implied emission factor has gradually fallen until 1998, then levelled out at around 80 t/TJ, and in 2016 it amounts to 80.6 t/TJ. In Germany, the IEF declined continuously between 1990 and 2016 (from 109 to 84.5 t/TJ). 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. There is a large diversity in waste composition across countries leading to the differences in Member States' IEFs.

Figure 3.15 1.A.1.a Public Electricity and Heat Production, Other Fuels: Implied Emission Factors for CO_2





1.A.1.a Electricity and Heat Production - Peat (CO_2)

CO_2 emissions from the combustion of peat represented 0.8% of all greenhouse gas emissions from public electricity and heat production. Peat in its raw state is a fossil sedimentary deposit of vegetal origin with high water content. Only 5 Member States report emissions from peat combustion. Within the EU-28 + ISL, emissions declined by 6% respectively 0.5Mt CO_2 between 1990 and 2016 (Table 3.11).

Table 3.11 1.A.1.a Public Electricity and Heat Production, Peat: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016		Method	EF informa-tion
	1990	2015	2016		kt CO2	%	kt CO2	%		
Austria	NO	NO	NO	-	-	-	-	-	NA	NA
Belgium	NO	NO	NO	-	-	-	-	-	NA	NA
Bulgaria	NO	NO	NO	-	-	-	-	-	NA	NA
Croatia	NO	NO	NO	-	-	-	-	-	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czech Republic	NO	NO	NO	-	-	-	-	-	NA	NA
Denmark	NO	NO	NO	-	-	-	-	-	NA	NA
Estonia	187	129	134	1.7%	-53	-28%	5	4%	T1,T2	D,CS
Finland	3 950	4 866	4 799	60.0%	849	22%	-67	-1%	T3	CS
France	NO	NO	NO	-	-	-	-	-	NA	NA
Germany	NA	NA	NA	-	-	-	-	-	NA	NA
Greece	NO	NO	NO	-	-	-	-	-	NA	NA
Hungary	NO	NO	NO	-	-	-	-	-	NA	NA
Ireland	3 065	2 636	2 505	31.3%	-560	-18%	-131	-5%	T1,T3	CS,D,PS
Italy	NO	NO	NO	-	-	-	-	-	NA	NA
Latvia	146	NO	NO	-	-146	-100%	-	-	T2	CS
Lithuania	11	7	11	0.1%	-1	-5%	4	51%	T1,T2	CS,D
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	-	-	-	-	-	-	-	-	NA	NA
Poland	NO	NO	NO	-	-	-	-	-	NA	NA
Portugal	NO	NO	NO	-	-	-	-	-	NA	NA
Romania	NO	NO	NO	-	-	-	-	-	NA	NA
Slovakia	NO	NO	NO	-	-	-	-	-	NA	NA
Slovenia	NO	NO	NO	-	-	-	-	-	NA	NA
Spain	NO	NO	NO	-	-	-	-	-	NA	NA
Sweden	1 173	512	544	6.8%	-629	-54%	32	6%	T2	CS
United Kingdom	NO	NO	NO	-	-	-	-	-	NA	NA
EU-28	**8 531**	**8 149**	**7 992**	**100%**	**-539**	**-6%**	**-157**	**-2%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	NO	NO	NO	-	-	-	-	-	NA	NA
EU-28 + ISL	**8 531**	**8 149**	**7 992**	**100%**	**-539**	**-6%**	**-157**	**-2%**	**-**	**-**

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

Note: Peat is not used as a fuel in the Netherlands. Nevertheless, the Netherlands did not report Peat as notation key NO in their submission, but instead did not report on this category at all.

Table 3.11 also shows that 96.7 % of EU-28 + ISL emissions are calculated using higher tier methods. Many Member States are using country specific information from the EU ETS and apply default emission factors for emissions that are not covered by the EU ETS. Similarly countries may use country specific emission factors for the most common fuels (for example hard coal and lignite) and use default emission factors for fuels of minor importance (for example brown coal briquettes). Therefore countries might use apparently contradicting information such as "T1, T2" for Methods used and "CS, D" for Emission Factors applied. In such cases we assumed, that 90 % of emissions are calculated using a higher tier method and 10 % of emissions are calculated using the tier 1 method.

When countries have reported country specific methods and emission factors it has been assumed, that a higher tier method has been used.

Figure 3.16 illustrates the trend of peat emissions throughout the last 26 years, which is predominately influenced by the emission fluctuation over the years by Finland. In 2016, the two largest emitters, Finland and Ireland, are responsible for 91.3% of the total emissions in this category.

Figure 3.16 1.A.1.a Public Electricity and Heat Production, Peat: Emission trend and share for CO_2

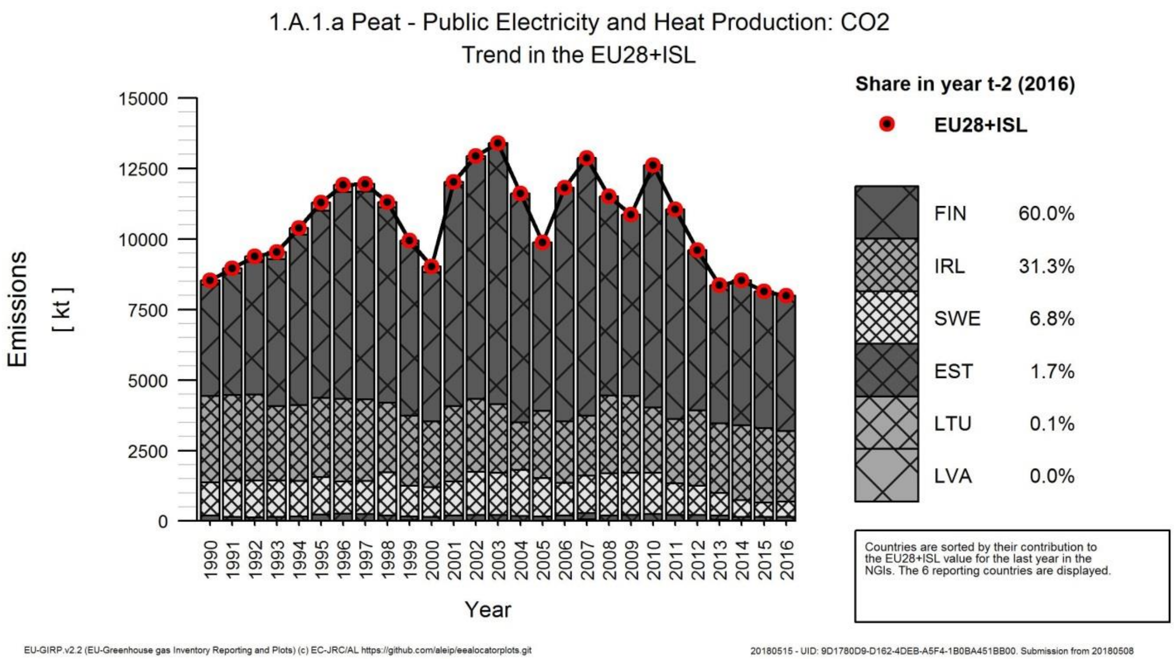
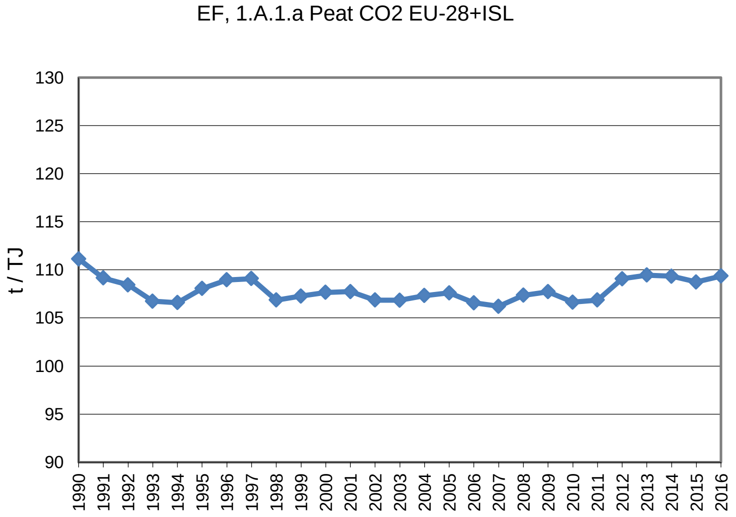
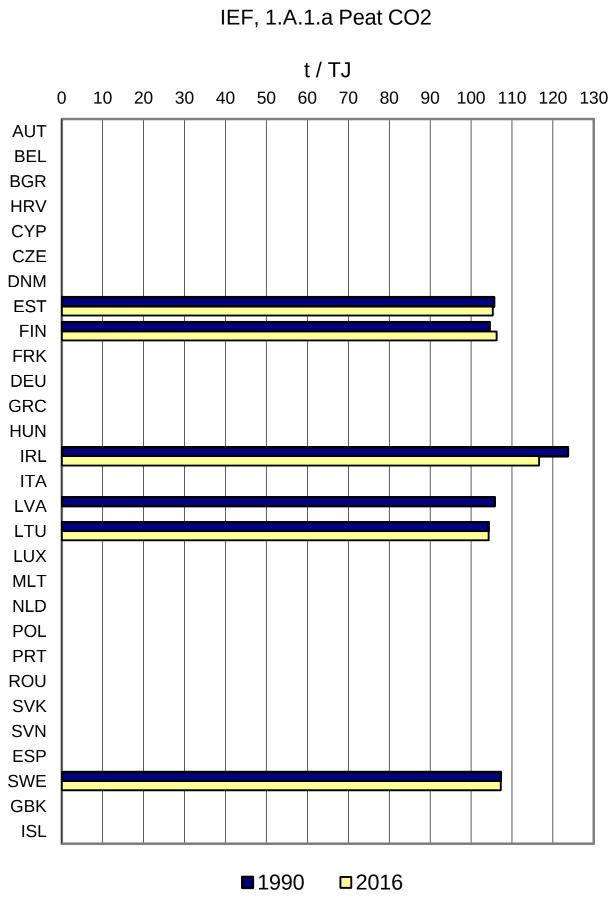


Figure 3.17 shows the implied emission factors of peat from CO_2. The EU-28 + ISL implied emission factor amounts to 109.3 t/TJ in 2016 and has been quite stable over the last 26 years. It is mainly influenced by the IEF of the two largest emitters (Finland, and Ireland). The default emission factor for peat is 106 t/TJ according to the 2006 IPCC guidelines. Only Ireland has an IEF continuously above the default value. The reason for this is the use of the plant specific emission factor (117,273 t/TJ).for three milled peat power plants in use.

Figure 3.17 1.A.1.a Public Electricity and Heat Production, Peat: Implied Emission Factors for CO_2





3.2.1.2 Petroleum Refining (1.A.1.b) (EU-28 + ISL)

According to the 2006 IPCC guidelines, Petroleum Refining (CRF 1.A.1.b) 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 1.B.2.a as well as venting and flaring under 1.B.2.c.

Carbon dioxide emissions from Petroleum Refining are accounting for 3% of total greenhouse gas emissions in year 2016. Between 1990 and 2016, EU-28 + ISL CO_2 emissions decreased by 3% (Table 3.12). Emissions in 2016 were above 1990 levels in ten Member States, whereas they were decreasing in 14 and reported as not occurring for the whole time series in five countries. Italy, Poland and Greece had the largest emission increases together accounting for 78.5% of the whole increase between 1990 and 2016. In contrast France and the United Kingdom report the largest decreases together accounting for 51.1% of the whole decrease in emissions in this period.

Table 3.12 1.A.1.b Petroleum Refining: Member States' contributions to CO_2 emissions

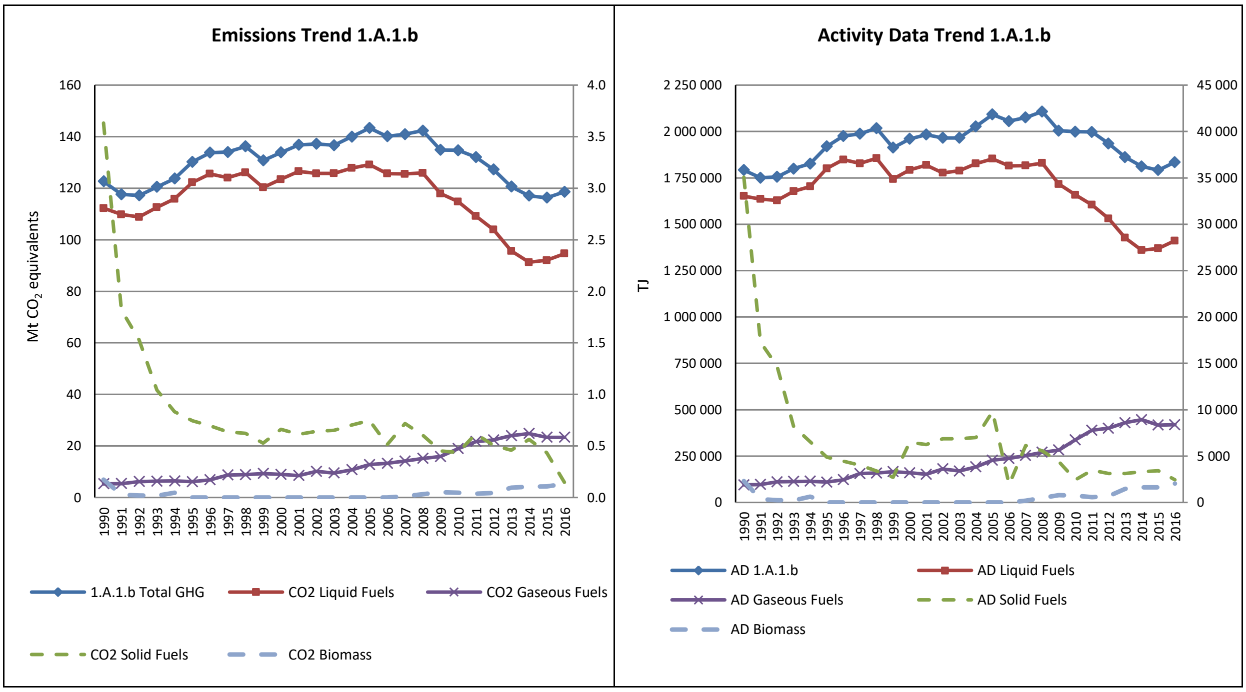
Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016	
	1990	2015	2016		kt CO2	%	kt CO2	%
Austria	2 394	2 804	2 784	2.4%	390	16%	-20	-1%
Belgium	4 299	4 682	4 621	4.0%	322	7%	-61	-1%
Bulgaria	861	1 352	1 588	1.4%	726	84%	236	17%
Croatia	2 446	1 387	1 299	1.1%	-1 148	-47%	-89	-6%
Cyprus	86	NO	NO	-	-86	-100%	-	-
Czech Republic	493	570	405	0.3%	-87	-18%	-165	-29%
Denmark	908	978	868	0.7%	-41	-4%	-111	-11%
Estonia	NO	NO	NO	-	-	-	-	-
Finland	2 042	2 216	1 662	1.4%	-381	-19%	-555	-25%
France	11 935	7 611	7 354	6.3%	-4 582	-38%	-257	-3%
Germany	20 166	18 781	19 810	17.1%	-356	-2%	1 029	5%
Greece	2 375	5 253	5 562	4.8%	3 187	134%	309	6%
Hungary	2 376	1 436	1 448	1.2%	-927	-39%	13	1%
Ireland	168	358	313	0.3%	145	86%	-45	-13%
Italy	17 201	20 947	21 030	18.1%	3 830	22%	83	0%
Latvia	NO	NO	NO	-	-	-	-	-
Lithuania	1 510	1 367	1 424	1.2%	-86	-6%	57	4%
Luxembourg	NO	NO	NO	-	-	-	-	-
Malta	NO	NO	NO	-	-	-	-	-
Netherlands	11 010	10 129	9 605	8.3%	-1 405	-13%	-524	-5%
Poland	2 163	5 277	5 412	4.7%	3 249	150%	135	3%
Portugal	1 861	2 365	2 389	2.1%	527	28%	24	1%
Romania	4 297	1 862	1 949	1.7%	-2 349	-55%	87	5%
Slovakia	2 873	1 448	1 483	1.3%	-1 390	-48%	35	2%
Slovenia	170	NO	NO	-	-170	-100%	-	-
Spain	10 858	11 547	11 554	9.9%	696	6%	7	0%
Sweden	1 778	C	2 000	-	222	12%	2 000	∞
United Kingdom	17 813	13 501	13 594	11.7%	-4 218	-24%	93	1%
EU-28	**120 306**	**115 873**	**116 154**	**100%**	**-4 152**	**-3%**	**282**	**0%**
Iceland	NO	NO	NO	-	-	-	-	-
United Kingdom (KP)	17 813	13 501	13 594	11.7%	-4 218	-24%	93	1%
EU-28 + ISL	**120 306**	**115 873**	**116 154**	**100%**	**-4 152**	**-3%**	**282**	**0%**

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

Note: EU trends in this table do not include Sweden for confidentiality reasons and to preserve time series consistency for the EU. This also explains the differences between the numbers in this table and the CRF.

Figure 3.18 shows the trends in activity data and the associated emissions originating from the refining of petroleum by fuel in the EU-28 + ISL between the years 1990 and 2016. Fuel used for petroleum refining increased by 2.4% in the EU-28 + ISL between 1990 and 2016. In the year 2016 fuel use from liquid fuels increased by 3%, after a decreasing trend in the recent decade. Liquid fuels represent 76.9% of all fuel used in the refining of petroleum. Gaseous fuels almost fully account for the remaining part (22.8%) of the activity data. Gaseous fuels use is more than three times higher in 2016 compared to 1990. There remains a small amount of solid fuels used accounting for 0.1% in petroleum refining; in France (blast furnace gas), Germany (lignite and coke oven gas) and Poland (hard coal and lignite) as well as 0.01 % other fuels use.

Figure 3.18 1.A.1.b Petroleum Refining: Total and CO_2 emission and activity trends



Note: Data displayed as dashed line refers to the secondary axis.

1.A.1.b Petroleum Refining - Liquid Fuels (CO_2)

CO_2 emissions from the combustion of liquid fuels used for petroleum refining accounted for 80% of all greenhouse gas emissions from petroleum refining in 2016. Emissions decreased by 16% between 1990 and 2016 (Table 3.13). Greece, Poland and Germany had the largest emission increases together accounting for 90% of the whole increase between 1990 and 2016. In contrast the United Kingdom and France report the largest decreases together accounting for 46.5% of the whole decrease in emissions in this period.

Table 3.13 1.A.1.b Petroleum Refining, Liquid Fuels: Member States' contributions to CO_2 emissions and information on method applied and emission factor

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016		Method	Emission factor Informa-tion
	1990	2015	2016		kt CO2	%	kt CO2	%		
Austria	1 958	2 269	2 250	2.4%	292	15%	-20	-1%	T2	CS
Belgium	4 285	3 607	3 552	3.8%	-733	-17%	-55	-2%	CS,T3	PS
Bulgaria	793	985	1 056	1.1%	263	33%	71	7%	T1	D
Croatia	2 432	1 032	909	1.0%	-1 524	-63%	-123	-12%	T1	D
Cyprus	86	NO	NO	-	-86	-100%	-	-	NA	NA
Czech Republic	176	357	226	0.2%	50	28%	-132	-37%	T1	CS,D
Denmark	908	978	868	0.9%	-41	-4%	-111	-11%	T1,T2,T3	CS,D,PS
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	1 383	1 593	1 436	1.5%	54	4%	-157	-10%	T3	CS,PS
France	11 413	5 664	5 915	6.4%	-5 498	-48%	251	4%	T2,T3	CS,PS
Germany	15 417	16 049	16 877	18.2%	1 460	9%	828	5%	CS	CS
Greece	2 375	5 253	5 562	6.0%	3 187	134%	309	6%	T2	PS
Hungary	1 683	1 054	989	1.1%	-694	-41%	-65	-6%	T3	PS
Ireland	168	339	297	0.3%	129	76%	-42	-12%	T3	CS,PS
Italy	17 041	17 201	16 811	18.1%	-230	-1%	-390	-2%	T3	CS
Latvia	NO	NO	NO	-	-	-	-	-	NA	NA
Lithuania	1 510	1 366	1 420	1.5%	-89	-6%	55	4%	T2,T3	CS,PS
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	9 968	7 154	7 077	7.6%	-2 891	-29%	-76	-1%	T2	CS,D
Poland	1 319	3 746	3 901	4.2%	2 582	196%	155	4%	T1	D
Portugal	1 861	1 317	1 285	1.4%	-577	-31%	-33	-2%	T2	CR,D,PS
Romania	4 297	1 505	1 592	1.7%	-2 705	-63%	87	6%	T2	CS
Slovakia	2 786	1 208	1 249	1.3%	-1 537	-55%	40	3%	T3	PS
Slovenia	43	NO	NO	-	-43	-100%	-	-	NA	NA
Spain	10 812	8 239	8 177	8.8%	-2 634	-24%	-62	-1%	T2	PS
Sweden	1 778	C	1 916	2.1%	138	8%	1 916	∞	T2	CS
United Kingdom	17 763	11 146	11 268	12.2%	-6 495	-37%	122	1%	T2	CS
EU-28	**110 477**	**92 062**	**92 716**	**100%**	**-17 761**	**-16%**	**654**	**1%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	17 763	11 146	11 268	12.2%	-6 495	-37%	122	1%	T2	CS
EU-28 + ISL	**110 477**	**92 062**	**92 716**	**100%**	**-17 761**	**-16%**	**654**	**1%**	**-**	**-**

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

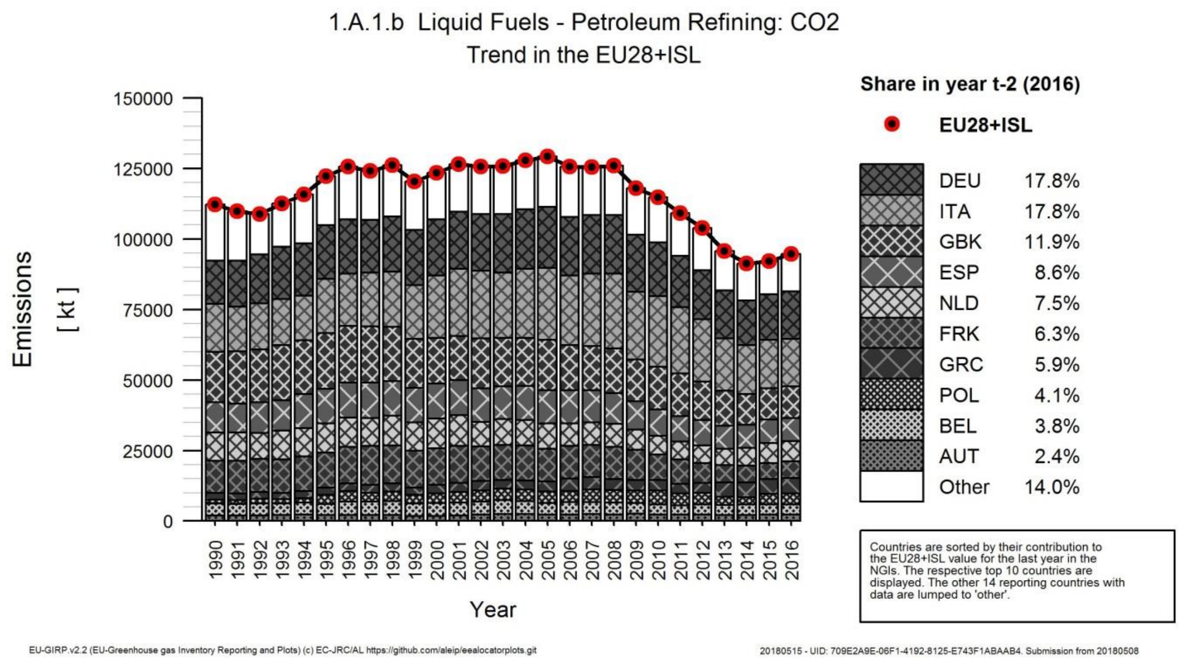
Note: EU trends in this table do not include Sweden for confidentiality reasons and to preserve time series consistency for the EU. This also explains the differences between the numbers in this table and the CRF.

Table 3.13 also shows that 93.3 % of EU-28 + ISL emissions are calculated using higher tier methods. Many Member States are using country specific information from the EU ETS and apply default emission factors for emissions that are not covered by the EU ETS. Similarly countries may use country specific emission factors for the most common fuels (for example hard coal and lignite) and use default emission factors for fuels of minor importance (for example brown coal briquettes). Therefore countries might use apparently contradicting information such as "T1, T2" for Methods used and "CS, D" for Emission Factors applied. In such cases we assumed, that 90 % of emissions are calculated using a higher tier method and 10 % of emissions are calculated using the tier 1 method.

When countries have reported country specific methods and emission factors it has been assumed, that a higher tier method has been used.

Figure 3.19 illustrates that Germany, Italy and the United Kingdom are the countries contributing most in terms of CO_2 emissions in 2016. It also can be seen that the trend for liquid fuels was continuously decreasing since the year 2009 until 2015 emissions started increasing again.

Figure 3.19 1.A.1.b Petroleum Refining, Liquid Fuels: Emission trend and share for CO_2

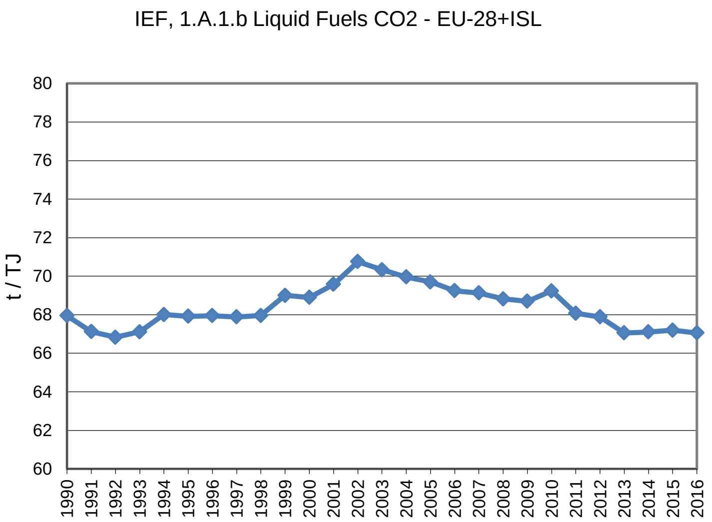


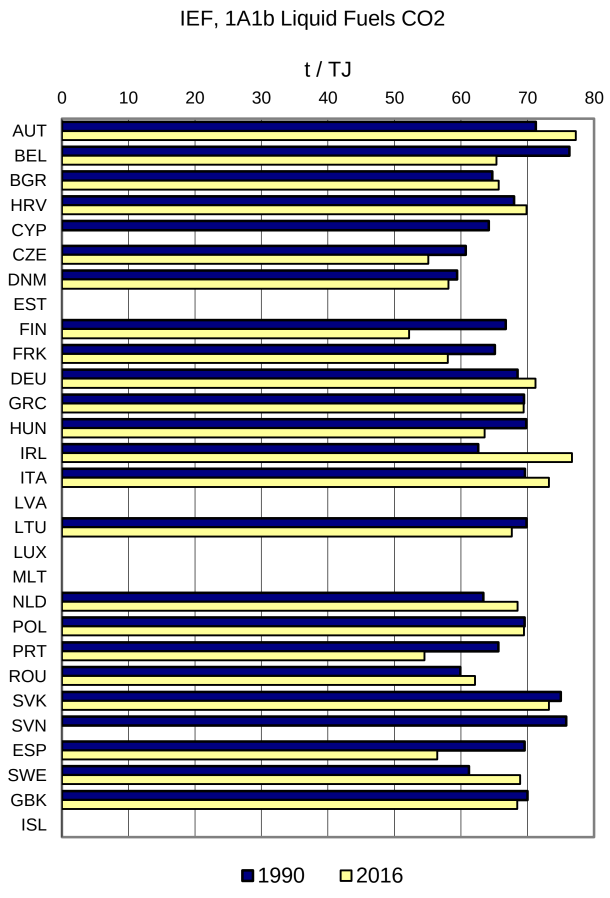
Note: *This figure does include Sweden. This also explains the differences between the countries' share of emissions in this figure and the table on MS contributions.*

Figure 3.20 (on the next page) shows the emission factors for CO_2 emissions from liquid fuels. The EU-28 + ISL implied emission factor shows variations around 68 t/TJ over the time series and amounts to 67 t/TJ in 2016. In general the fluctuating IEF is due to the annual variations of fuel consumption with different carbon content.

For example in Italy the main fuels used are refinery gases, fuel oil and petroleum coke, which have very different emission factors, and every year the amount used changes resulting in an annual variation of the IEF. Ireland reports the second highest IEF in 2016 which is due to differences in the data published in the national energy balance and the reported emissions under the EU ETS, concerning the single oil refinery in Ireland. This issue is aimed to be corrected in the 2019 submission. In this category in Sweden CO_2 emissions are based on verified EU ETS data, while AD and CO_2 emission allocations between stationary combustion and fugitive emissions are based on other information sources, like Environmental reports of the facilities, causing a low IEF. A development project to solve allocation issues is ongoing, which already lead to a reallocation of refinery gas in submission 2018. The IEF of Sweden increased significantly from 54 t/TJ to 69 t/TJ since 2014. All the calorific values for CRF code 1.A.1.b will be revised in submission 2019

Figure 3.20 1.A.1.b Petroleum Refining, Liquid Fuels: Implied Emission Factors for CO_2





1.A.1.b Petroleum Refining - Solid Fuels (CO_2)

CO_2 emissions from the combustion of solid fuels in petroleum refining represented 0.1% of all greenhouse gas emissions from 1.A.1.b in 2016. There are only three countries reporting emissions in the EU-28 + ISL in 2016 (Poland, Germany and France). Thereof only Poland reports increasing emissions between 1990 and 2016. Up until 2015 France reported the highest emissions. The strong decrease by 96% in France from 2015 to 2016, due to the closing of a refinery, lead to an overall emission decrease by 67%. Poland is now responsible for the majority of emissions in 2016 in the EU-28 + ISL. Over the whole times series emissions fell by 96% on average (Table 3.14).

Table 3.14 1.A.1.b Petroleum Refining, Solid Fuels: Member States' contributions to CO_2 emissions and information on method applied and emission factor

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016		Method	Emission factor Informa-tion
	1990	2015	2016		kt CO2	%	kt CO2	%		
Austria	NO	NO	NO	-	-	-	-	-	NA	NA
Belgium	NO	NO	NO	-	-	-	-	-	NA	NA
Bulgaria	NO	NO	NO	-	-	-	-	-	NA	NA
Croatia	NO	NO	NO	-	-	-	-	-	NA	NA
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czech Republic	NO	NO	NO	-	-	-	-	-	NA	NA
Denmark	NO	NO	NO	-	-	-	-	-	NA	NA
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	12	NO	NO	-	-12	-100%	-	-	NA	NA
France	486	288	12	8.4%	-474	-98%	-276	-96%	T2,T3	CS,PS
Germany	3 131	58	53	37.4%	-3 077	-98%	-4	-7%	CS	CS
Greece	NO	NO	NO	-	-	-	-	-	NA	NA
Hungary	NO	NO	NO	-	-	-	-	-	NA	NA
Ireland	NO	NO	NO	-	-	-	-	-	NA	NA
Italy	NO	NO	NO	-	-	-	-	-	NA	NA
Latvia	NO	NO	NO	-	-	-	-	-	NA	NA
Lithuania	NO	NO	NO	-	-	-	-	-	NA	NA
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	NO	NO	NO	-	-	-	-	-	NA	NA
Poland	4	88	78	54.2%	73	1682%	-10	-12%	T1,T2	CS,D
Portugal	NO	NO	NO	-	-	-	-	-	NA	NA
Romania	NO	NO	NO	-	-	-	-	-	NA	NA
Slovakia	NO	NO	NO	-	-	-	-	-	NA	NA
Slovenia	NO	NO	NO	-	-	-	-	-	NA	NA
Spain	NO	NO	NO	-	-	-	-	-	NA	NA
Sweden	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom	NO	NO	NO	-	-	-	-	-	NA	NA
EU-28	**3 633**	**434**	**143**	**100%**	**-3 490**	**-96%**	**-291**	**-67%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	NO	NO	NO	-	-	-	-	-	NA	NA
EU-28 + ISL	**3 633**	**434**	**143**	**100%**	**-3 490**	**-96%**	**-291**	**-67%**	**-**	**-**

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

Table 3.14 also shows that 94.6 % of EU-28 + ISL emissions are calculated using higher tier methods. Many Member States are using country specific information from the EU ETS and apply default emission factors for emissions that are not covered by the EU ETS. Similarly countries may use country specific emission factors for the most common fuels (for example hard coal and lignite) and use default emission factors for fuels of minor importance (for example brown coal briquettes). Therefore countries might use apparently contradicting information such as "T1, T2" for Methods used and "CS, D" for Emission Factors applied. In such cases we assumed, that 90 % of emissions are calculated using a higher tier method and 10 % of emissions are calculated using the tier 1 method.

When countries have reported country specific methods and emission factors it has been assumed, that a higher tier method has been used.

Figure 3.21 illustrates the trend of emissions in 1.A.1.b for solid fuels for the past 26 years. The use of solid fuels in petroleum refining has declined drastically since 1990. Emissions are down by 96%. France contributed 67% to the total emissions in this sector in 2015 and now represents 8.4%, Germany is responsible for the strong declining trend in the 1990s and due to the recent decline in France now is responsible for 37.4% again. Poland accounts now for 54.2% of the total emissions in the EU-28 + ISL for this category in 2016.

Figure 3.21 1.A.1.b Petroleum Refining, Solid Fuels: Emission trend and share for CO_2

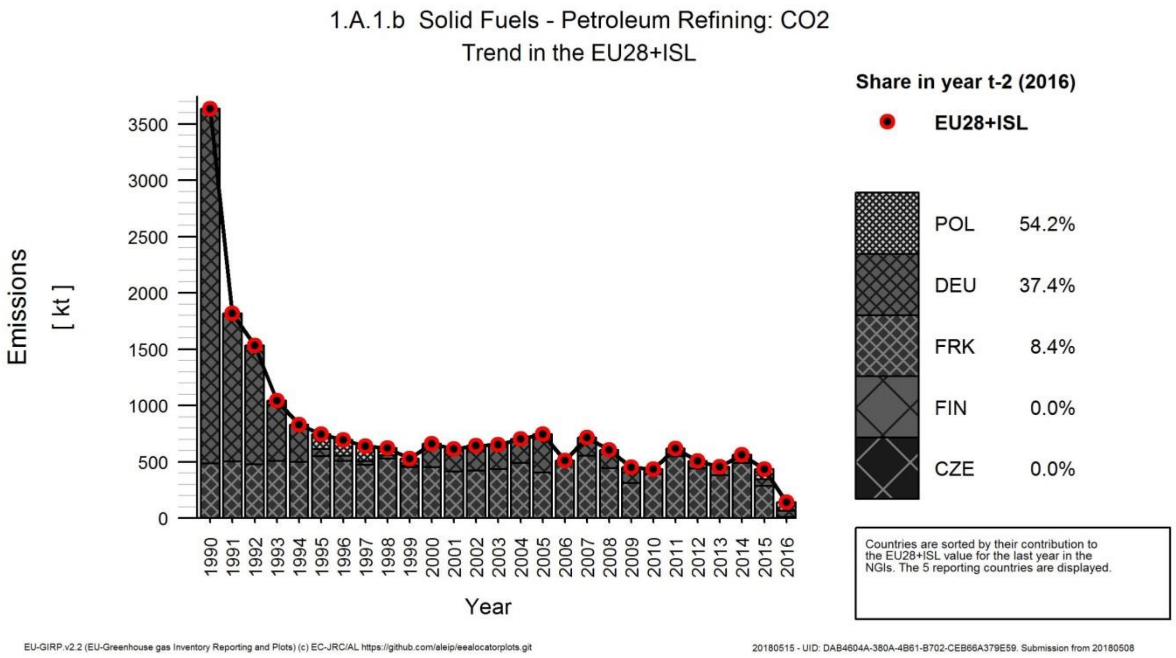
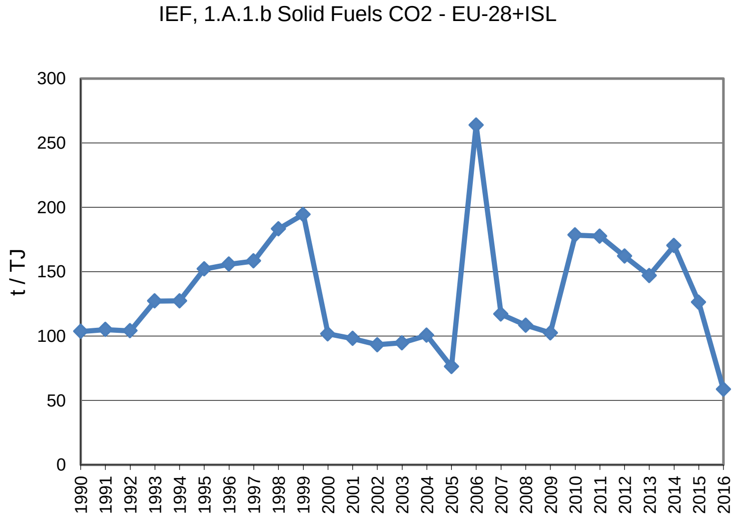
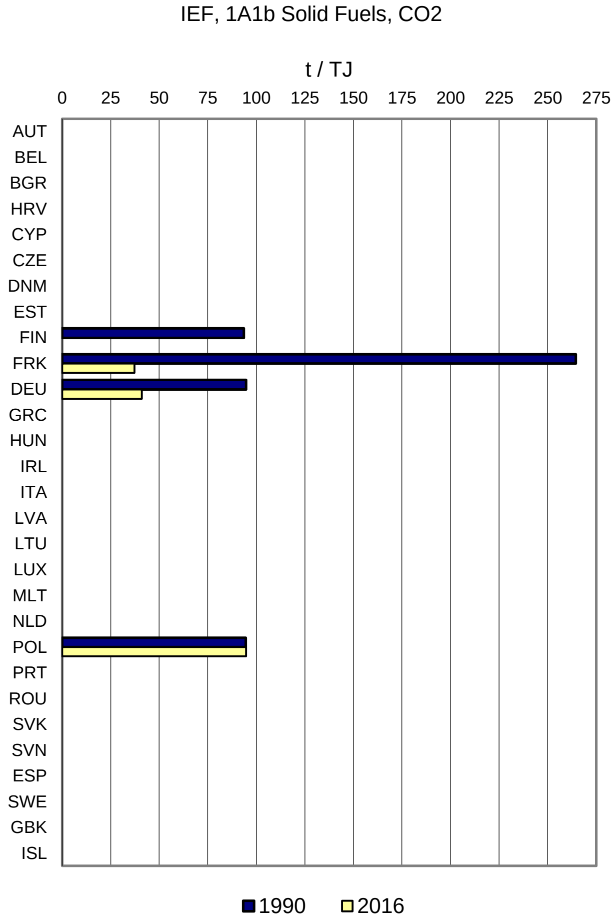


Figure 3.22 (on the next page) shows the relevant implied emission factors. The EU-28 + ISL implied emission factor showed strong fluctuations and amounts to 58.6 t/TJ in 2016. One explanation for this is the low number of countries reporting this category. Apart from that, the variation in the EU-28 + ISL factor can be partly explained by the declining use of solid fuels in petroleum refining in Germany between 1990 and 1999. This explains the gradual increase of the EU-28 + ISL IEF up to 1999 through the growing weight of the much higher implied emission factor of France. The high emission factor in France was due to the use of blast furnace gas. 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 coke oven gas. The increased EU-28 + ISL solid fuel combustion in 2000-2005 and 2007-2009 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-28 + ISL level during these years. For 2006 Germany reports only negligible amounts of solid fuel use in petroleum refining. Therefore, the EU-28 + ISL IEF was almost entirely dominated by the high French IEF in this year. The drop in the implied emission factor from 2014 to 2015 can be explained by the increased weight of Poland with their lower IEF. In 2016 a refinery in France has been closed this lead to the IEF of 1A1b solid fuels dropping from 259.5 t/TJ to 37.3 t/TJ respectively by 86% in the year 2016 compared to 2015. Because of the weight of France on the EU-28 + ISL total the overall IEF also dropped from 126.3 t/TJ to 58.6 t/TJ in 2016.

Figure 3.22 1.A.1.b Petroleum Refining, Solid Fuels: Implied Emission Factors for CO_2





1.A.1.b Petroleum Refining - Gaseous Fuels (CO_2)

In 2016, CO_2 emissions from the combustion of gaseous fuels used for petroleum refining accounted for about 20% of total greenhouse gas emissions from 1.A.1.b. Emissions in the EU-28 + ISL increased by 341% between 1990 and 2016 (Table 3.15), but decreased by 6% from 2014 to 2015 and stayed almost the same in 2016. Only four of the EU-28 Member States reduced their emissions: Hungary and Slovenia, Czech Republic and Finland over the whole time series. Italy, Spain and the United Kingdom together account for 51% of the total increase between 1990 and 2016.

Table 3.15 1.A.1.b Petroleum Refining, Gaseous Fuels: Member States' contributions to CO_2 emissions and information on method applied and emission factor

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016		Method	Emission factor Informa-tion
	1990	2015	2016		kt CO2	%	kt CO2	%		
Austria	437	535	535	2.3%	98	22%	0	0%	T2	CS
Belgium	14	1 075	1 069	4.6%	1 055	7595%	-5	-1%	CS,T3	PS
Bulgaria	69	367	532	2.3%	463	674%	164	45%	T2	CS
Croatia	14	356	390	1.7%	376	2701%	34	10%	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czech Republic	317	213	180	0.8%	-137	-43%	-33	-16%	T2	CS
Denmark	NO	NO	NO	-	-	-	-	-	NA	NA
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	648	623	225	1.0%	-422	-65%	-398	-64%	T3	CS
France	36	1 659	1 427	6.1%	1 390	3842%	-232	-14%	T2,T3	CS,PS
Germany	1 444	2 674	2 880	12.4%	1 435	99%	206	8%	CS	CS
Greece	NO	IE	IE	-	-	-	-	-	NA	NA
Hungary	693	382	460	2.0%	-233	-34%	78	20%	T3	PS
Ireland	NO	20	16	0.1%	16	∞	-3	-17%	T3	CS,PS
Italy	159	3 746	4 219	18.1%	4 060	2549%	473	13%	T3	CS
Latvia	NO	NO	NO	-	-	-	-	-	NA	NA
Lithuania	NO	1	3	0.0%	3	∞	2	288%	T2	CS
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	1 042	2 976	2 528	10.9%	1 486	143%	-448	-15%	T2	CS
Poland	92	1 443	1 433	6.2%	1 341	1450%	-9	-1%	T2	CS
Portugal	NO	1 048	1 104	4.7%	1 104	∞	57	5%	T2	CR,D,PS
Romania	NO	357	357	1.5%	357	∞	0	0%	T2	CS
Slovakia	88	240	235	1.0%	147	168%	-5	-2%	T3	PS
Slovenia	127	NO	NO	-	-127	-100%	-	-	NA	NA
Spain	46	3 292	3 359	14.4%	3 313	7205%	68	2%	T2	PS
Sweden	NO	C	85	0.4%	85	∞	85	∞	T2	CS
United Kingdom	49	2 355	2 326	10.0%	2 277	4617%	-29	-1%	T2	CS
EU-28	**5 275**	**23 359**	**23 278**	**100%**	**18 003**	**341%**	**-82**	**0%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	49	2 355	2 326	10.0%	2 277	4617%	-29	-1%	T2	CS
EU-28 + ISL	**5 275**	**23 359**	**23 278**	**100%**	**18 003**	**341%**	**-82**	**0%**	**-**	**-**

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

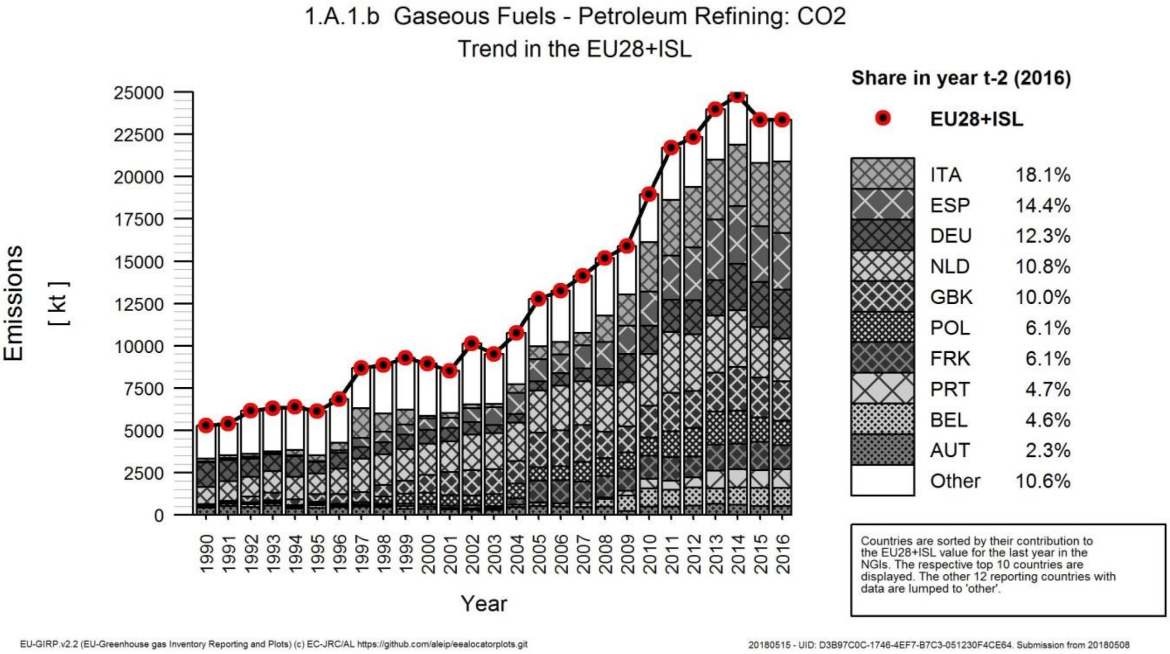
Note: EU trends in this table do not include Sweden for confidentiality reasons and to preserve time series consistency for the EU. This also explains the differences between the numbers in this table and the CRF.

Table 3.15 also shows that 98.3 % of EU-28 + ISL emissions are calculated using higher tier methods. Many Member States are using country specific information from the EU ETS and apply default emission factors for emissions that are not covered by the EU ETS. Similarly countries may use country specific emission factors for the most common fuels (for example hard coal and lignite) and use default emission factors for fuels of minor importance (for example brown coal briquettes). Therefore countries might use apparently contradicting information such as "T1, T2" for Methods used and "CS, D" for Emission Factors applied. In such cases we assumed, that 90 % of emissions are calculated using a higher tier method and 10 % of emissions are calculated using the tier 1 method.

When countries have reported country specific methods and emission factors it has been assumed, that a higher tier method has been used.

Figure 3.23 illustrates the trend of increasing emissions from gaseous fuels in category 1.A.1.b in the last 26 years. As can be seen Italy, Spain, Germany, the Netherlands as well as the United Kingdom are the five largest contributors to CO_2 emissions in this sector in 2016. They account together for 65.6% of the total emissions in this category. The largest absolute decrease in 2016 compared to 2015 was reported by the Netherlands, Finland and France (combined -1078 kt CO_2).

Figure 3.23 1.A.1.b Petroleum Refining, Gaseous Fuels: Emission trend and share for CO_2

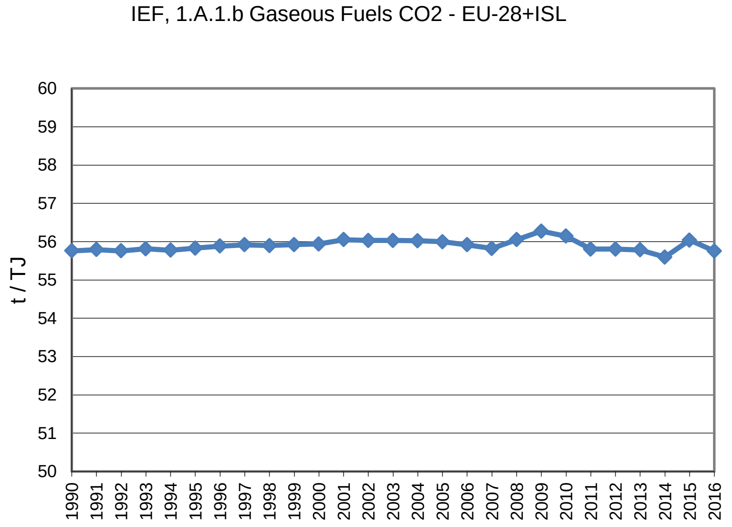


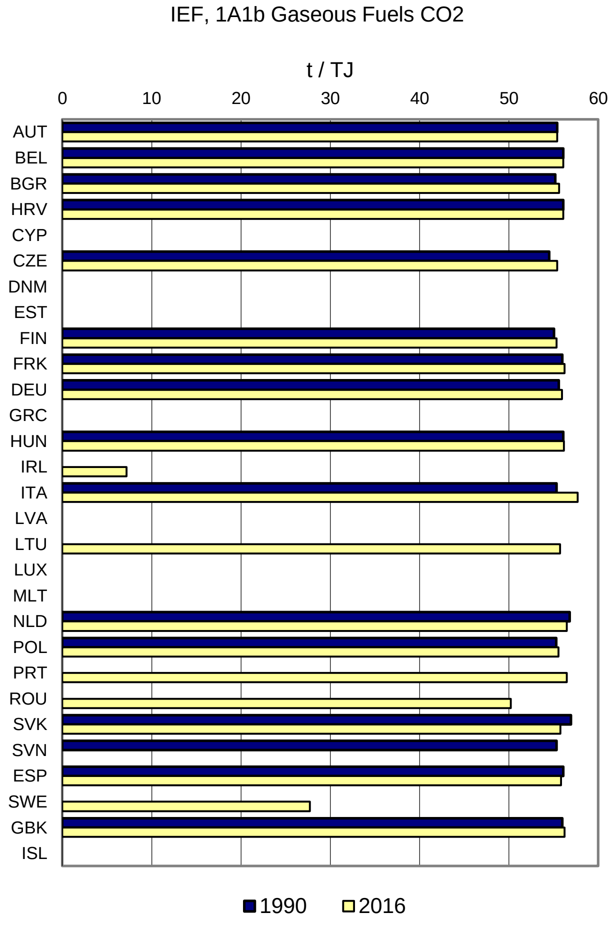
Note: This figure does include Sweden. This also explains the differences between the countries' share of emissions in this figure and the table on MS contributions.

Figure 3.24 (on the next page) shows the implied emission factors for CO_2 emissions from gaseous fuels. The EU-28 + ISL implied emission factor has remained broadly stable and amounts to 55.7 t/TJ in 2018. Ireland reports a comparably very low emission factor in 2016 which is due to differences in the data published in the national energy balance and the reported emissions under the EU ETS by the single refinery plant. This leads to a misleading activity data. The inventory compiler is working with SEAI (energy statistics) to correct this anomaly in the 2019 submission

The IEF of Sweden was the highest one in the EU-28 + ISL, due to a LNG-based plant which started to be in use in one of the refineries during 2014. LNG has a higher EF than natural gas. In the last two inventories Sweden reports a comparatively low IEF and explains as follows: One facility using LNG, CO_2 emissions are based on verified EU ETS data, while AD and CO_2 emission allocations between stationary combustion and fugitive emissions are based on other information sources, causing the low IEF. In the 2018 submission, a development project was carried out with the specific purpose to improve emission allocation between the energy sector and IPPU and to establish a procedure for annual cross-sectoral control of reported emissions. Quality control is being conducted on a facility level. In case of discrepancies, they are easily identified and further investigated regarding potential gaps or double-counting. This work is ongoing, and feasible reallocations will be done in the submission 2019. All the calorific values for CRF code 1.A.1.b will be revised in submission 2019.

Figure 3.24 1.A.1.b Petroleum Refining, Gaseous Fuels: Implied Emission Factors for CO_2





3.2.1.3 Manufacture of Solid Fuels and Other Energy Industries (1.A.1.c) (EU-28 + ISL)

According to the 2006 IPCC guidelines, 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. In addition, this category includes emissions from fuel combustion in oil and natural gas production.

Total emissions from this category accounted for 1% of total EU-28 + ISL greenhouse gas emissions in 2016. Between 1990 and 2016, CO_2 emissions fell by 54% in the EU-28 + ISL (Table 3.16). The United Kingdom, Germany, Italy and the Czech Republic together are responsible for 69.6% of the total EU-28 + ISL emissions in 2016. Germany is responsible for almost 80% of the whole decrease in this category between 1990 and 2016.

Table 3.16 1.A.1.c Manufacture of Solid Fuels and Other Energy Industries: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016	
	1990	2015	2016		kt CO2	%	kt CO2	%
Austria	510	274	271	0.5%	-239	-47%	-3	-1%
Belgium	2 024	147	155	0.3%	-1 869	-92%	8	5%
Bulgaria	362	4	4	0.0%	-359	-99%	0	-6%
Croatia	873	235	201	0.4%	-672	-77%	-35	-15%
Cyprus	NO	NO	NO	-	-	-	-	-
Czech Republic	1 516	6 156	6 364	12.0%	4 847	320%	208	3%
Denmark	545	1 436	1 329	2.5%	784	144%	-107	-7%
Estonia	86	1 204	1 302	2.5%	1 216	1413%	98	8%
Finland	347	332	336	0.6%	-11	-3%	4	1%
France	4 738	2 752	2 742	5.2%	-1 996	-42%	-10	0%
Germany	65 289	9 782	9 071	17.1%	-56 218	-86%	-711	-7%
Greece	102	30	36	0.1%	-66	-65%	6	19%
Hungary	517	310	299	0.6%	-218	-42%	-11	-3%
Ireland	100	114	125	0.2%	25	25%	11	9%
Italy	12 449	5 611	6 775	12.8%	-5 674	-46%	1 164	21%
Latvia	145	56	48	0.1%	-97	-67%	-8	-14%
Lithuania	9	85	72	0.1%	63	671%	-13	-15%
Luxembourg	NO	NO	NO	-	-	-	-	-
Malta	NO	NO	NO	-	-	-	-	-
Netherlands	2 110	3 269	2 787	5.3%	676	32%	-482	-15%
Poland	4 867	3 636	3 222	6.1%	-1 644	-34%	-414	-11%
Portugal	112	NO	NO	-	-112	-100%	-	-
Romania	146	1 087	1 014	1.9%	868	594%	-73	-7%
Slovakia	1 319	1 290	1 303	2.5%	-15	-1%	14	1%
Slovenia	82	6	6	0.0%	-76	-92%	0	2%
Spain	2 136	734	766	1.4%	-1 370	-64%	32	4%
Sweden	300	C	416	0.8%	115	38%	416	∞
United Kingdom	13 825	15 060	14 409	27.2%	584	4%	-651	-4%
EU-28	**114 511**	**53 611**	**53 054**	**100%**	**-61 457**	**-54%**	**-556**	**-1%**
Iceland	NO	NO	NO	-	-	-	-	-
United Kingdom (KP)	13 825	15 060	14 409	27.2%	584	4%	-651	-4%
EU-28 + ISL	**114 511**	**53 611**	**53 054**	**100%**	**-61 457**	**-54%**	**-556**	**-1%**

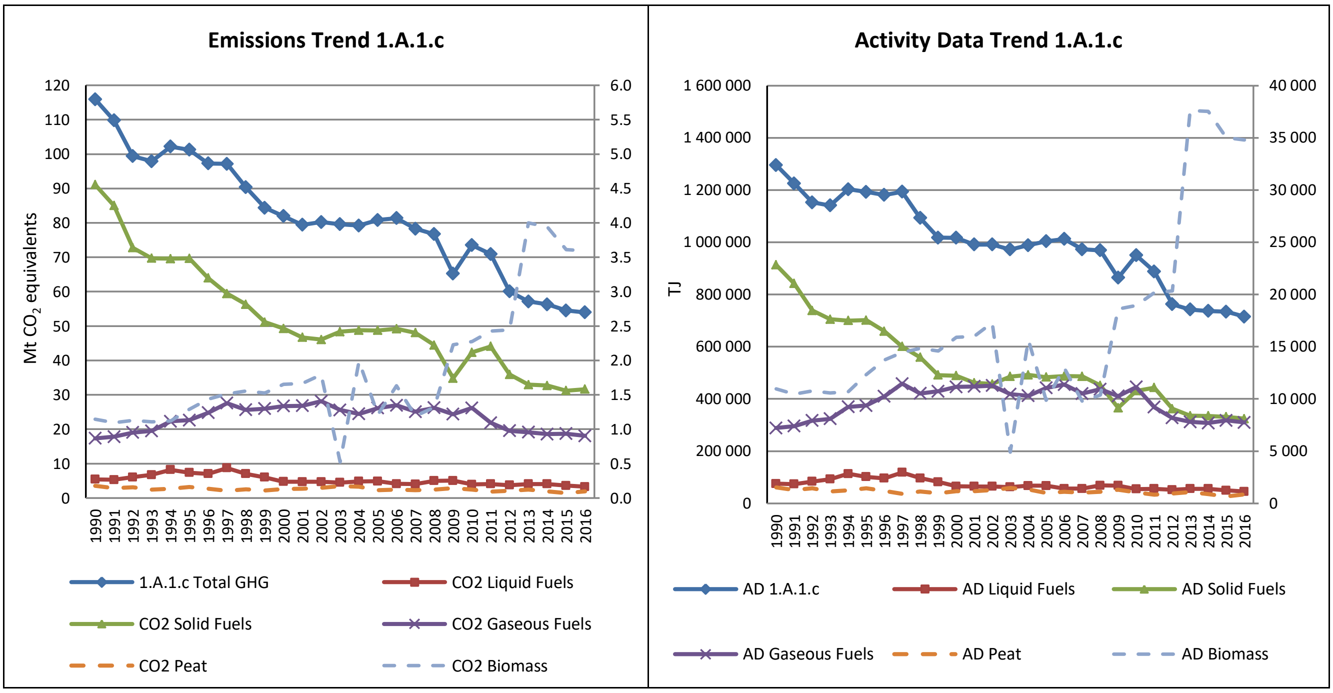
Abbreviations are explained in the Chapter 'Units and abbreviations'.

Note: EU trends in this table do not include Sweden for confidentiality reasons and to preserve time series consistency for the EU. This also explains the differences between the numbers in this table and the CRF.

Figure 3.25 shows the trends in emissions from this source category by fuel in the EU-28 + ISL between 1990 and 2016. The largest part of greenhouse gas emissions from the manufacture of solid fuels can be accounted to CO_2 emissions from solid (59%) and gaseous (33%) fuels. Emissions from solid fuels fell markedly during the 1990s and then stabilized for a few years. Since 2006 they began to decrease again. The strong drop in 2009 was due to the drop in coke production associated with the iron and steel production triggered by the economic downturn.

Fuel used for manufacturing solid fuels fell by 45% in the EU-28 + ISL between 1990 and 2016. The strongest decline was reported for solid fuels (-65%), followed by liquid fuels (-40%). On the other hand gaseous fuels and biomass increased in the period 1990 to 2016. In the year 2016 solid fuels and gaseous fuels represented 45% and 43% respectively, of all fuel used. Almost no other fuels and peat are used in this category; together accounting for 0.12% of the total fuel used in 2016.

Figure 3.25 1.A.1.c Manufacture of Solid Fuels and Other Energy Industries: Total and CO_2 emission and activity trends



Note: Data displayed as dashed line refers to the secondary axis.

1.A.1.c 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 59% of total greenhouse gas emissions from 1.A.1.c in 2016. Emissions in the EU-28 + ISL declined by 66% since 1990. This was mainly driven by a strong decline in emissions in Germany (-52 507 kt CO_2), which amounts to 79.5% of the total decline in this category.

Table 3.17 1.A.1.c Manufacture of Solid Fuels and Other Energy Industries, Solid Fuels: Member States' contributions to CO_2 emissions

Member State	Emissions in kt CO2 equiv.			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016		Method	EF information
	1990	2015	2016		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	IE	IE	IE	-	-	-	-	-	NA	NA
Belgium	1 969	147	155	0.5%	-1 814	-92%	8	5%	T3	PS
Bulgaria	274	3	2	0.0%	-273	-99%	-1	-32%	T1,T2	CS,D
Croatia	NO	NO	NO	-	-	-	-	-	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czech Republic	1 352	6 097	6 308	20.2%	4 956	367%	210	3%	T1,T2	CS,D
Denmark	NO	NO	NO	-	-	-	-	-	NA	NA
Estonia	86	1 204	1 302	4.2%	1 216	1413%	98	8%	T3	PS
Finland	347	332	336	1.1%	-11	-3%	4	1%	T3	CS
France	4 054	2 752	2 742	8.8%	-1 312	-32%	-10	0%	T2	CS
Germany	61 101	9 328	8 593	27.5%	-52 507	-86%	-734	-8%	CS	CS
Greece	NO	NO	NO	-	-	-	-	-	NA	NA
Hungary	164	203	182	0.6%	19	11%	-21	-10%	T1,T2,T3	D,CS,PS
Ireland	NO	NO	NO	-	-	-	-	-	NA	NA
Italy	10 891	4 924	5 973	19.1%	-4 918	-45%	1 049	21%	T3	CS
Latvia	NO	NO	NO	-	-	-	-	-	NA	NA
Lithuania	NO	NO	NO	-	-	-	-	-	NA	NA
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	925	1 476	1 185	3.8%	260	28%	-291	-20%	T2	CS
Poland	4 030	2 157	2 131	6.8%	-1 899	-47%	-26	-1%	T1,T2	D,CS
Portugal	62	NO	NO	-	-62	-100%	-	-	T1	D
Romania	NO	1	1	0.0%	1	∞	1	100%	T1,T2	CS,D
Slovakia	1 319	1 237	1 254	4.0%	-64	-5%	18	1%	T2	CS
Slovenia	37	NO	NO	-	-37	-100%	-	-	T2	CS
Spain	1 864	275	271	0.9%	-1 592	-85%	-4	-1%	T1,T2	D,CS,PS
Sweden	300	C	416	-	115	38%	416	∞	T2	CS
United Kingdom	2 342	1 090	785	2.5%	-1 557	-66%	-305	-28%	T1,T2	CS,D
EU-28	**90 818**	**31 227**	**31 221**	**100%**	**-59 597**	**-66%**	**-6**	**0%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	2 342	1 090	785	2.5%	-1 557	-66%	-305	-28%	T1,T2	CS,D
EU-28 + ISL	**90 818**	**31 227**	**31 221**	**100%**	**-59 597**	**-66%**	**-6**	**0%**	**-**	**-**

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

Note: EU trends in this table do not include Sweden for confidentiality reasons and to preserve time series consistency for the EU. This also explains the differences between the numbers in this table and the CRF.

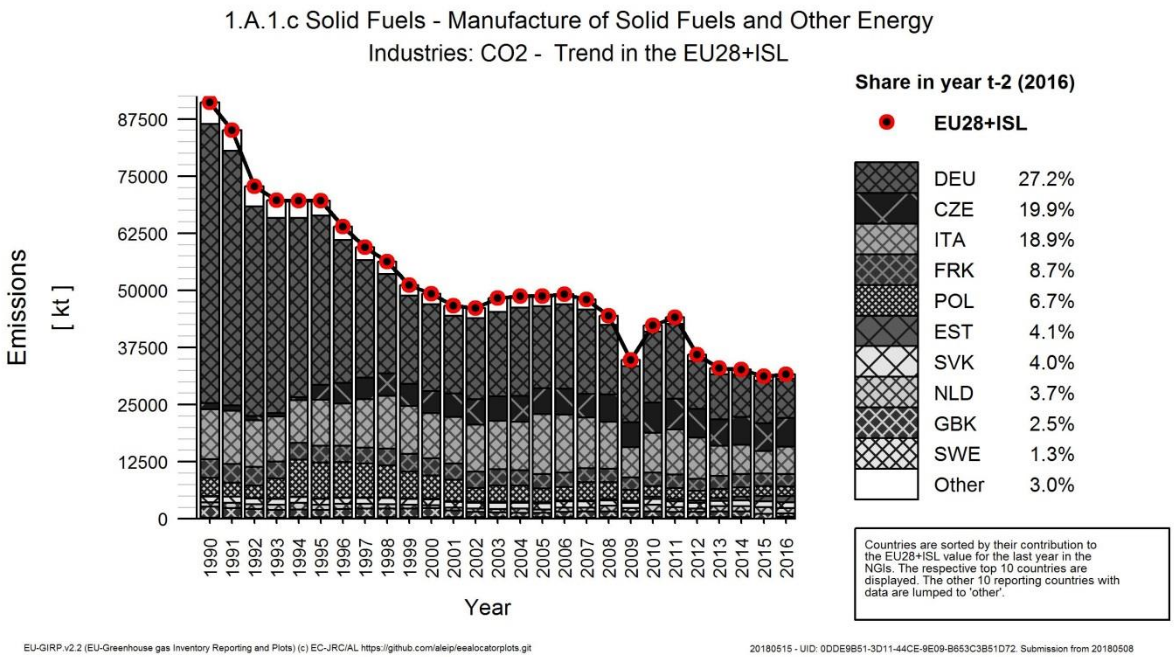
Note: Austria includes the emissions from 1.A.1.c Solid fuels (occurring in coke ovens) in 1.A.2.a Iron and Steel Industries.

Table 3.17 also shows that 96.9 % of EU-28 + ISL emissions are calculated using higher tier methods. Many Member States are using country specific information from the EU ETS and apply default emission factors for emissions that are not covered by the EU ETS. Similarly countries may use country specific emission factors for the most common fuels (for example hard coal and lignite) and use default emission factors for fuels of minor importance (for example brown coal briquettes). Therefore countries might use apparently contradicting information such as "T1, T2" for Methods used and "CS, D" for Emission Factors applied. In such cases we assumed, that 90 % of emissions are calculated using a higher tier method and 10 % of emissions are calculated using the tier 1 method.

When countries have reported country specific methods and emission factors it has been assumed, that a higher tier method has been used.

Solid fuels have fallen steadily to almost one third of the 1990 levels. The decline in emissions (see Figure 3.26 below) in Germany is mainly due to a large decline in lignite production in the 1990s. Lignite use decreased strongly in the new German Länder from usage levels of the industry of the former GDR. From raw lignite, a range of refined products used to be produced for industry, households and small commercial operations. A comprehensive transition from lignite to other fuels then took place until the end of the 1990s. The three largest emitters in 2015 were Germany, the Czech Republic and Italy, jointly responsible for 66% of all EU-28 + ISL emissions in this category.

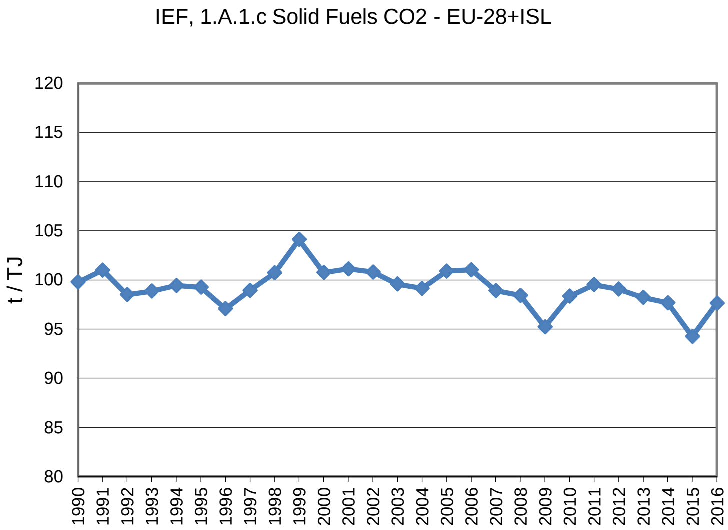
Figure 3.26 1.A.1.c Manufacture of Solid Fuels and Other Energy Industries, Solid Fuels: Emission trend and share for CO_2

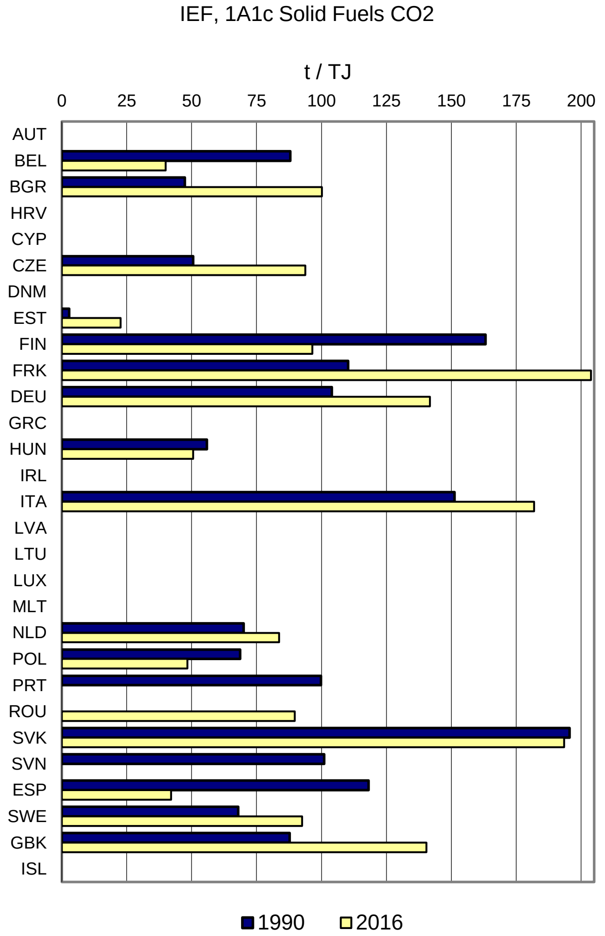


Note: This figure does include Sweden. This also explains the differences between the countries' share of emissions in this figure and the table on MS contributions.

Figure 3.27 (on the next page) shows the relevant implied emission factors for solid fuels. The EU-28 + ISL implied emission factor was relatively stable and amounted to 97.6 t/TJ in 2016. Its variation can be explained by the mix of different fuels and the shifts of their energy consumptions between years. The high implied emission factor for solid fuels in Slovakia and France can be explained with their use of blast furnace gas. Alike, the high implied emission factor for solid fuels in Italy is due to the large use of derived steel gases and in particular blast furnace gas to produce electricity in the iron and steel plant plants. Estonia has a low IEF, because the EF is calculated by using the carbon balance of the shale oil plant. The measured results are provided by the oil plants to the Estonian Ministry of Environment. To calculate the amount of carbon in flue gases into the atmosphere for this from the carbon in the oil shale is subtracted from the carbon of shale oil, semi-coke gas, gas-oil and black ash. The bend in 2015 can be explained by the confidentiality reporting by Sweden in this category.

Figure 3.27 1.A.1.c Manufacture of Solid Fuels and Other Energy Industries, Solid Fuels: Implied Emission Factors for CO_2





1.A.1.c Manufacture of Solid Fuels and Other Energy Industries – Gaseous Fuels (CO_2)

CO_2 emissions from the combustion of gaseous fuels used in category 1.A.1.c accounted for 33% of total greenhouse gas emissions from this category in 2016. Emissions in the EU-28 + ISL increased by 4% (Table 3.18 below) between the years 1990 and 2016. After a strong increases in the 1990s and stabilisation in the 2000s there has been a significant reduction in the last few years. The United Kingdom is the largest emitter in this category and is responsible for 60.6% of emissions in 2016 in the EU-28 + ISL. The top three Member States (United Kingdom, the Netherlands and Denmark) together account for almost 77% of emissions in this category.

Table 3.18 1.A.1.c Manufacture of Solid Fuels and Other Energy Industries, Gaseous Fuels: Member States' contributions to CO_2 emissions

Member State	Emissions in kt CO2 equiv.			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016		Method	EF information
	1990	2015	2016		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	506	274	271	1.5%	-235	-46%	-3	-1%	T2	CS
Belgium	51	NO	NO	-	-51	-100%	-	-	T3	PS
Bulgaria	NO	1	2	0.0%	2	∞	1	54%	T1,T2	CS,D
Croatia	833	235	201	1.1%	-632	-76%	-35	-15%	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czech Republic	NO	8	6	0.0%	6	∞	-2	-26%	T1,T2	CS,D
Denmark	545	1 436	1 329	7.4%	784	144%	-107	-7%	T3	CS,PS
Estonia	IE	IE	IE	-	-	-	-	-	NA	NA
Finland	NO	NO	NO	-	-	-	-	-	NA	NA
France	531	NO	NO	-	-531	-100%	-	-	T2	CS
Germany	2 622	421	442	2.4%	-2 180	-83%	21	5%	CS	CS
Greece	102	30	36	0.2%	-66	-65%	6	19%	T2	PS
Hungary	313	103	117	0.6%	-197	-63%	14	13%	T1, T3	D, PS
Ireland	IE	40	29	0.2%	29	∞	-12	-29%	T3	CS
Italy	615	688	802	4.4%	187	30%	115	17%	T3	CS
Latvia	45	37	29	0.2%	-16	-37%	-9	-24%	T2	CS
Lithuania	NO	71	58	0.3%	58	∞	-13	-18%	T1, T2	CS, D
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	1 184	1 792	1 602	8.9%	418	35%	-190	-11%	T2	CS
Poland	684	1 339	989	5.5%	305	44%	-350	-26%	T1	D
Portugal	NO	NO	NO	-	-	-	-	-	T1	D
Romania	NO	510	710	3.9%	710	∞	199	39%	T1,T2	CS,D
Slovakia	NO	53	49	0.3%	49	∞	-4	-7%	T2	CS
Slovenia	42	6	6	0.0%	-36	-85%	0	2%	T2	CS
Spain	82	420	447	2.5%	366	448%	27	6%	T2	CS
Sweden	NO,IE	NO,IE	NO,IE	-	-	-	-	-	NA	NA
United Kingdom	9 172	11 244	10 935	60.6%	1 764	19%	-308	-3%	T1, T2	CS, D
EU-28	**17 326**	**18 709**	**18 059**	**100%**	**733**	**4%**	**-650**	**-3%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	9 172	11 244	10 935	60.6%	1 764	19%	-308	-3%	T1, T2	CS, D
EU-28 + ISL	**17 326**	**18 709**	**18 059**	**100%**	**733**	**4%**	**-650**	**-3%**	**-**	**-**

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

Note: Estonia includes the emissions from 1.A.1.c in 1A1a.

Table 3.18 also shows that 86.9 % of EU-28 + ISL emissions are calculated using higher tier methods. Many Member States are using country specific information from the EU ETS and apply default emission factors for emissions that are not covered by the EU ETS. Similarly countries may use country specific emission factors for the most common fuels (for example hard coal and lignite) and use default emission factors for fuels of minor importance (for example brown coal briquettes). Therefore countries might use apparently contradicting information such as "T1, T2" for Methods used and "CS, D" for Emission Factors applied. In such cases we assumed, that 90 % of emissions are calculated using a higher tier method and 10 % of emissions are calculated using the tier 1 method. When countries have reported country specific methods and emission factors it has been assumed, that a higher tier method has been used.

Figure 3.28 illustrates the emission trend for gaseous fuels split by Member States over the last 26 years. Although the emissions in the year 2016 compared to 1990 increased moderately by 4% over the whole time series, there was a strong increase in the 1990s and a decline after 2009. The increase in EU-28 + ISL emissions between 1990 and 2002 and the decline in recent years were heavily influenced by the trend in the United Kingdom, which is responsible for 60.6% of the total EU-28 + ISL emissions in this category in 2016.

Figure 3.28 1.A.1.c Manufacture of Solid Fuels and Other Energy Industries, Gaseous Fuels: Emission trend and share for CO_2

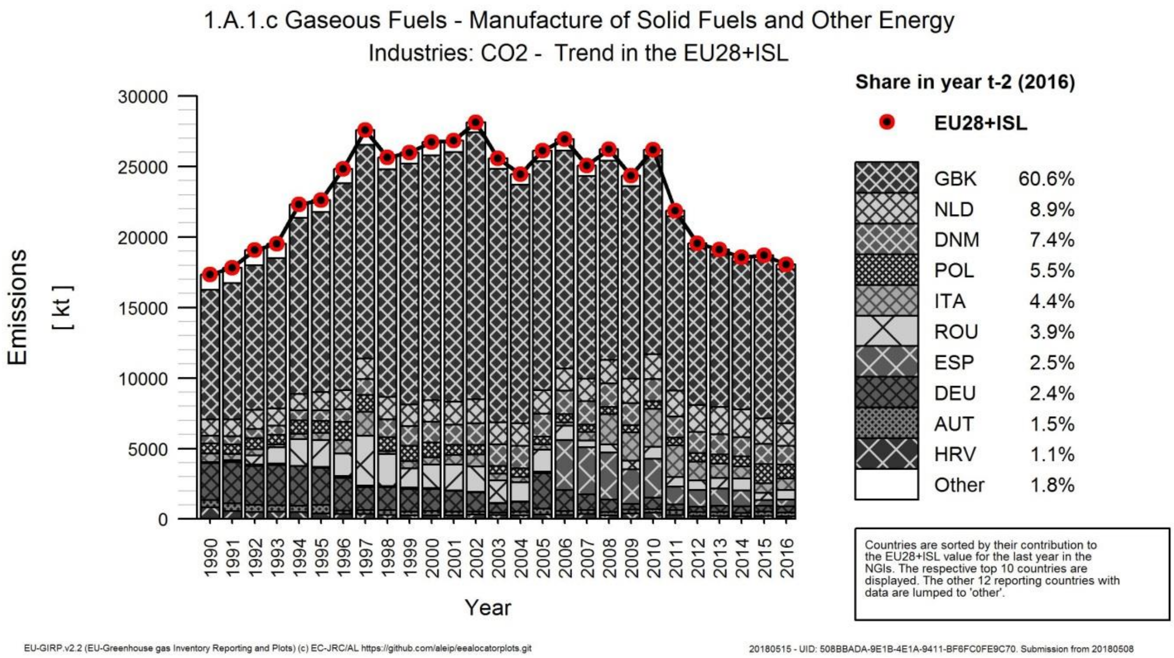
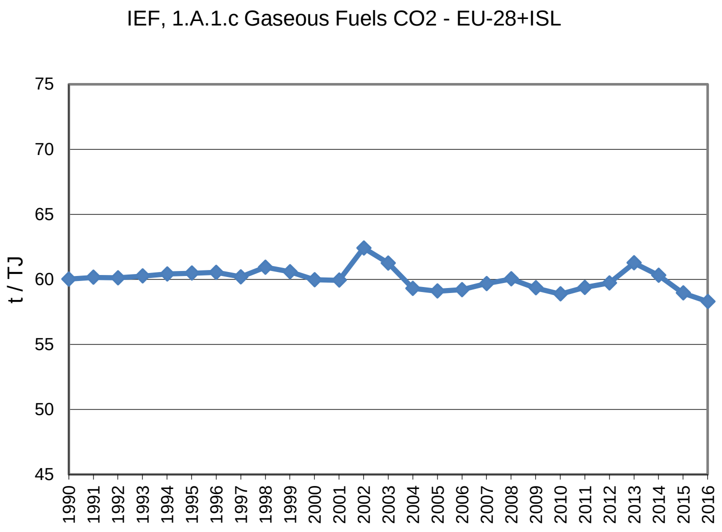
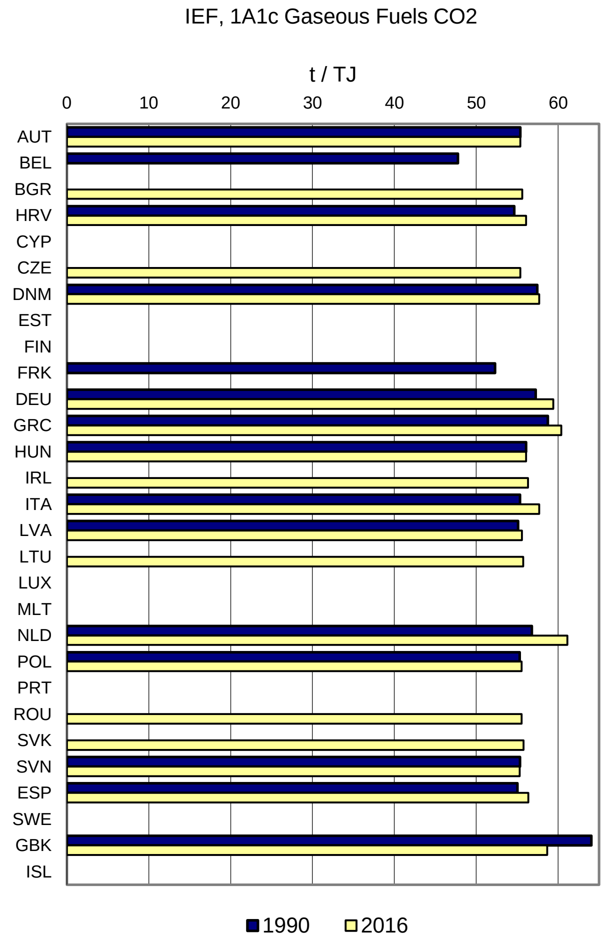


Figure 3.29 (on the next page) shows the implied emission factors for gaseous fuels. The EU-28 + ISL implied emission factor amounts 58.3 t/TJ in 2016 and remained fairly stable over the last 26 years. The IPCC default values range between 54.3 t/TJ (lower) and 58.3 t/TJ (upper). The EU-28 + ISL IEF is dominated by the IEF of the United Kingdom, which is comparatively high. The explanation for its decrease is as follows: In the United Kingdom emissions of gaseous fuels within this sector include colliery methane combustion and natural gas combustion, including offshore own gas use. The carbon emission factor for offshore own gas use is higher than the emission factor for other natural gas combustion, particularly at the start of the time series. This higher emission factor is to be expected, as the unrefined gaseous fuels used in the upstream oil and gas sector will contain heavier hydrocarbons (which are removed in gas treatment prior to injection into natural gas supply infrastructure at onshore terminals). This source is responsible for the majority of the emissions within this sector in the United Kingdom and is therefore the main driver in the trend in the implied emission factor. The emission factor for this source is based on data supplied by the offshore operators. It decreases across the time series, but remains higher than natural gas consumption in other sectors. The IEF of the Netherlands is comparatively high, which showed an increasing and fluctuating trend in recent years. The inter-annual variability in the EFs for CO_2 and CH_4 emissions from gas combustion (non-standard natural gas) is mainly due to the reported emissions in the AERs of individual companies. The comparatively

high IEF of Greece in 2016 is due to the fact, that the domestic natural gas is produced from reservoirs, which have different high carbon contents. The varied development of the IEF is caused by the interannual changes of the share of each reservoir in the total natural gas production.

Figure 3.29 1.A.1.c Manufacture of Solid Fuels and Other Energy Industries, Gaseous Fuels: 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 (auto producers). According to the guidelines, emissions from fuel combustion in coke oven plants are reported under 1A1c. Austria reports emissions from onsite 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 and some MS are reporting emissions from refinery gas under 1A2. 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 1A2g. Emissions from non-energy fuel use (e.g. reducing agents used in blast furnaces or natural gas used for ammonia production) should be reported under category 2 Industrial Processes.

The following enumeration shows the correspondence of 1A2 sub categories and ISIC Rev 3.1 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 Non-metallic Minerals: ISIC Division 26
- 1 A 2 g Other manufacturing industries: ISIC Divisions 17 to 20, 25, 28 to 37 and 45.

The following table shows the share of higher tier methods used for each key source of category 1A2. It comprises all methods and method combinations as reported by member states for any of the 1A2 key sources.

Table 3.19: *Share of higher Tier methods for 1A2 by type of reported method and method combinations.*

Methods and method combinations	Share of emissions which are estimated with a 'higher Tier method'
CS	100%
T1	0%
T1,T2	50%
T1,T3	50%
T2	100%
T2,T3	100%
T3	100%

For category 1A2g information on methodologies is not included in the submission files. Therefore a weighted average of categories 1A2a to 1A2f by type of fuel has been used to estimate the share of higher tier methods except for ‘other fossil fuels’ which has been estimated by the dominating share of Germany (about 90%).

Table 3.20: Key categories for sector 1A2 (Table excerpt)

Source category gas	kt CO_2 equ.		Trend	Level		share of higher Tier
	1990	2016		1990	2016	
1.A.2.a Iron and Steel: Gaseous Fuels (CO_2)	30905	18053	T	L	L	81%
1.A.2.a Iron and Steel: Liquid Fuels (CO_2)	8512	1377	T	L	0	85%
1.A.2.a Iron and Steel: Solid Fuels (CO_2)	142975	76691	T	L	L	92%
1.A.2.b Non-Ferrous Metals: Gaseous Fuels (CO_2)	3918	6715	T	0	L	87%
1.A.2.b Non-Ferrous Metals: Liquid Fuels (CO_2)	4529	830	T	0	0	80%
1.A.2.b Non-Ferrous Metals: Solid Fuels (CO_2)	8047	1165	T	0	0	61%
1.A.2.c Chemicals: Gaseous Fuels (CO_2)	54677	35420	T	L	L	92%

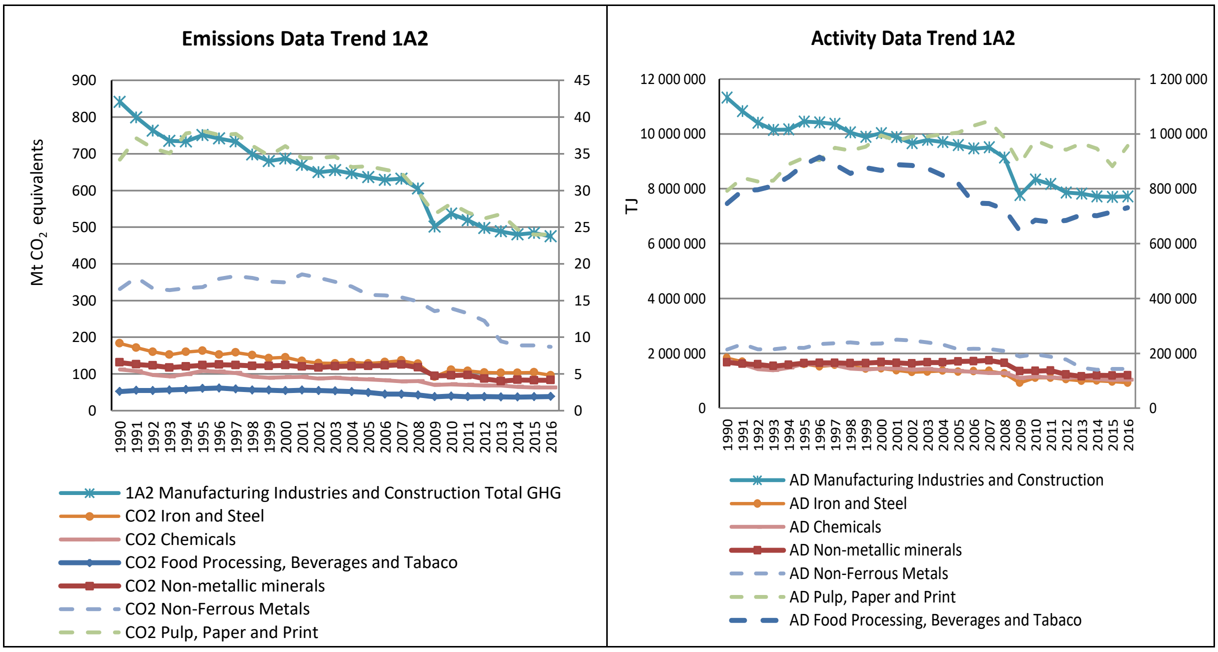
Source category gas	kt CO_2 equ.		Trend	Level		share of higher Tier
	1990	2016		1990	2016	
1.A.2.c Chemicals: Liquid Fuels (CO_2)	39330	17111	T	L	L	93%
1.A.2.c Chemicals: Solid Fuels (CO_2)	14893	8869	0	L	L	73%
1.A.2.d Pulp, Paper and Print: Gaseous Fuels (CO_2)	13199	17950	T	L	L	94%
1.A.2.d Pulp, Paper and Print: Liquid Fuels (CO_2)	11414	1907	T	L	0	89%
1.A.2.d Pulp, Paper and Print: Solid Fuels (CO_2)	8359	2882	T	0	0	80%
1.A.2.e Food Processing, Beverages and Tobacco: Gaseous Fuels (CO_2)	19307	29728	T	L	L	88%
1.A.2.e Food Processing, Beverages and Tobacco: Liquid Fuels (CO_2)	20047	4172	T	L	0	78%
1.A.2.e Food Processing, Beverages and Tobacco: Solid Fuels (CO_2)	12486	4573	T	L	0	69%
1.A.2.f Non-metallic minerals: Gaseous Fuels (CO_2)	27322	28503	T	L	L	87%
1.A.2.f Non-metallic minerals: Liquid Fuels (CO_2)	44635	24475	T	L	L	90%
1.A.2.f Non-metallic minerals: Other Fuels (CO_2)	1422	12543	T	0	L	72%
1.A.2.f Non-metallic minerals: Solid Fuels (CO_2)	57641	16478	T	L	L	85%
1.A.2.g Other Manufacturing Industries and Constructions: Gaseous Fuels (CO_2)	95218	87230	T	L	L	96%
1.A.2.g Other Manufacturing Industries and Constructions: Liquid Fuels (CO_2)	113836	47730	T	L	L	91%
1.A.2.g Other Manufacturing Industries and Constructions: Solid Fuels (CO_2)	93501	13793	T	L	L	95%

In 2016 category 1A2 contributed to 474 695 kt CO_2 equivalents of which 98.7% CO_2, 0.9% N_2O and 0.4% CH_4.

Figure 3.30 shows the emission trends within source category 1A2, which is dominated by CO_2 from 1A2g Other contributing by 33% ,1A2a Iron and steel contributing by 20% and 1A2f Non- metallic Minerals contributing by 17%. Some Member States do not allocate emissions to all sub-categories under 1A2, which is one reason for 1A2g being the largest sub-category within 1A2 source category.

Croatia reports total 1A2 emissions under category 1A2g in the period from 1990 to 2000 due to lack of detailed data in the national energy balance. Greece reports emissions which should be reported in category 1A2g under category 1A2f for the whole time series. Germany reports some fuels of subcategories 1A2a-1A2e as included elsewhere (Notation key 'IE') and reports the specific emissions and activity data under 1A2g. For the years 2013 to 2016 Sweden makes excessive use of confidential reporting (Notation key 'C'), which implies that sub-categories include emissions without providing detailed fuel specific emissions (1A2a,1A2c, 1A2f and 1A2g) or even that sub categories are reported as confidential while fuel specific emissions are reported as values or as confidential (1A2b, 1A2d and 1A2e). However, all Swedish confidential emissions are included in the total emissions of 1A2 and have been included in 'other fossil fuels' of the EU inventory.

Figure 3.30 1A2 Manufacturing Industries and Construction: Total and CO_2 emission trends



Data displayed as dashed line refers to the secondary axis.

Table 3.2 summarizes information by Member State on GHG emission trends and CO_2 emissions from 1A2 Manufacturing Industries and Construction.

Table 3.21 1A2 Manufacturing Industries and Construction: Member States' contributions to total GHG and CO_2 emissions

Member State	GHG emissions in 1990 (kt CO2 equivalents)	GHG emissions in 2016 (kt CO2 equivalents)	CO2 emissions in 1990 (kt)	CO2 emissions in 2016 (kt)
Austria	9 889	10 821	9 807	10 661
Belgium	23 242	13 318	23 084	13 195
Bulgaria	17 768	2 910	17 670	2 873
Croatia	5 529	2 215	5 502	2 207
Cyprus	515	603	512	599
Czech Republic	51 234	9 397	50 930	9 302
Denmark	5 436	3 938	5 371	3 884
Estonia	2 507	523	2 498	516
Finland	13 663	7 187	13 478	7 012
France	78 074	49 076	77 369	48 477
Germany	186 700	126 406	185 107	125 308
Greece	9 405	5 362	9 338	5 292
Hungary	13 623	4 733	13 587	4 701
Ireland	3 962	4 555	3 943	4 530
Italy	93 235	47 945	91 713	46 955
Latvia	3 928	614	3 914	581
Lithuania	6 165	1 185	6 108	1 169
Luxembourg	6 265	1 125	6 250	1 114
Malta	53	33	53	33
Netherlands	34 561	26 559	34 457	26 461
Poland	43 053	28 510	42 770	28 234
Portugal	9 745	7 423	9 609	7 283
Romania	49 998	11 325	49 893	11 281
Slovakia	16 097	6 710	16 027	6 660
Slovenia	3 150	1 592	3 119	1 571
Spain	45 099	40 865	44 732	39 918
Sweden	11 344	7 581	11 183	7 412
United Kingdom	96 820	51 838	95 616	50 928
EU-28	**841 059**	**474 349**	**833 640**	**468 159**
Iceland	377	198	362	186
United Kingdom (KP)	96 929	51 986	95 724	51 074
EU-28 + ISL	**841 545**	**474 695**	**834 110**	**468 491**

Abbreviations explained in the Chapter 'Units and abbreviations'.
Note: The difference between EU-28 and EU-28 + ISL is not only Iceland but also the different geographical coverage of the UK included in the EU submission (GBE) The EU-28 numbers are the numbers submitted under the UNFCCC and include the EU territory for the UK. The EU-28 + ISL numbers are the numbers submitted under the Kyoto Protocol and include the Kyoto Protocol territory of the UK (GBK).

CO_2 emissions from 1A2 Manufacturing Industries and Construction is the fourth largest sector in the EU-28+ISL accounting for 10.9 % of total GHG emissions in 2016. Between 1990 and 2016, CO_2 emissions from manufacturing industries declined by 44 %. The emissions from this key source are caused by fossil fuel consumption in manufacturing industries and construction, which was 35% below

1990 levels in 2016. A shift from solid and liquid fuels to mainly natural gas took place and an increase of biomass by 145% and an increase of other fossil fuels by 62% has been recorded.

Between 1990 and 2016, Germany, the Czech Republic, France, Italy, Romania and the United Kingdom show by far the largest emission reductions in absolute terms. Only Austria, Cyprus and Ireland report emission increases. The main reason for the large decline in Germany was the restructuring of the industry and efficiency improvements after German reunification. The main reasons for the large decline in the Czech Republic were the loss of markets and the energy saving behavior of newly privatized enterprises, following the political changes in the country in the early 1990s. Main reasons of the decline in Romania were the transition to a market economy and the reduction of energy intensive activities. The decrease of United Kingdom was mainly due to a strong reduction of liquid and solid fuel consumption among all sectors. The decline of emissions in Italy started in 2009 due to the effects of the economic recession. In 2010 and 2011 production levels have been restored for the iron and steel and pulp and paper sectors while the other sectors still continue to suffer from the economic crisis. In 2013 a further drop is noted for the iron and steel industry also due to environmental constraints of the main integrated iron and steel plant in Italy, located in Taranto, which had to reduce its steel production level.

Table 3.22 provides information on Member States recalculations in CO_2 from 1A2 Manufacturing Industries for 1990 and 2015 and main explanations for the largest recalculations in absolute terms. The largest recalculations in 2015 were due to Finland, France, Italy, the United Kingdom, the Netherlands and Spain. The reason for year 2015 revisions are mostly changes in activity data/revised energy balances.

Table 3.22: 1A2 Manufacturing Industries and Construction: Recalculations in CO_2 for 1990 and 2015 (difference between latest submission and previous submission in kt of CO_2 and percent)

	1990		2015		Main explanations
	kt CO_2	%	kt CO_2	%	
Austria	-	-	270	2.6	Revised energy balance. 41 kt CO_2 moved to 2.C.1
Belgium	-	-	-68	-0.5	Revised energy balance
Bulgaria	-	-	-0	-0.0	NA
Croatia	-	-	-	-	NA
Cyprus	-	-	57	10.4	Revised energy balance (NIR 3.2.4.5)
Czech Republic	-	-	-221	-2.3	Updated activity data
Denmark	-23	-0.4	-25	-0.7	Revised energy data. Revised waste and gasoil CO_2 emission factor. Revised fuel oil disaggregation between stationary and mobile sources. (NIR 3.2.8)
Estonia	-	-	-	-	NA
Finland	-	-	-1 498	-18.1	Allocation of plants from 1A2 to 1A1a and from 1A1b to 1A1a due to ownership change.
France	-4 015	-4.9	1 873	3.7	Revision of energy consumption for all fuels.
Germany	-	-	-230	-0.2	Revised energy balance
Greece	-	-	-	-	NA
Hungary	-	-	-126	-2.9	Revised IEA Annual Questionnaires, removal of some double counted emission between 1A1c and IPPU
Ireland	-	-	-65	-1.4	Revised fuel consumption in national energy balance
Italy	7 178	8.5	-1 640	-3.2	Update of activity data (energy conversion factor from TOE to TJ)

	1990		2015		Main explanations
	kt CO_2	%	kt CO_2	%	
Latvia	-	-	-	-	NA
Lithuania	-	-	-	-	NA
Luxembourg	-0	-0.0	-19	-1.7	energy balance revised, error correction
Malta	7	14.3	-12	-29.1	Recalculations were performed for emissions of direct GHGs due to a revision in the methodology used to apportion the total fuel used between the various NACE categories, while maintaining the sectoral fuel balance, in-line with the total fuel use in the inland market. Recalculations were also made due to the use of data on fuel oil and gasoil obtained from the customs department, which was considered to be superior to the survey results.
Netherlands	2 442	7.6	706	2.9	Reallocation of process emissions from 2C
Poland	-82	-0.2	-89	-0.3	AD update and change of CO_2 EF for natural gas.
Portugal	4	0.0	1	0.0	It was made a correction in glass production activity data that is also reflected in combustion related emissions.
Romania	-1 226	-2.4	-263	-2.1	Country specific CO_2 EFs for the corresponding fuels from 2015 EU ETS reports were used for all 1A2 categories. Net calorific values determined from the 2015 EU-ETS reports were used for the specific fuels in 1A2 categories. In 1.A.2 Manufacturing Industries and Construction category – 1.A.2.c Chemicals sub-category, the reported quantities of the natural gas consumption used for energy purposes, was subtracted from in Annex 4.1 Energy Balance 1989 (the column Natural Gas, line 63) for the 1989 year. In 1.A.2 Manufacturing Industries and Construction category – 1.A.2.c Chemicals sub-category, the reported quantities of the natural gas consumption used for energy purposes, was subtracted from in Annex 4.4 Energy Balance_1990_2016_natural gas (the sheet Table 2b_TFC_Energy use, the line 12) for the 1990-2016 period. These quantities of the natural gas consumption, used in energy goal, were subtracted as above, and are reported in the Industrial Processes and Product Use sector (IPPU), in the 2B1, Ammonia Production category, in according to the 2006 IPCC methodology.
Slovakia	200	1.3	15	0.2	Recalculation due to reallocation of the industrial waste incineration with energy use (previously reported in the 1.A.1.a.iii - other solid fuels)
Slovenia	-	-	-	-	NA
Spain	-16	-0.0	-625	-1.6	Incorporation of new non-energy fuel consumption data from hydrogen production plants inside and outside refineries. Apart from recalculations in corresponding source categories 1B2a4 and 2B10, changes in the balance made between national energy statistics and the Inventory fuel consumption registry have occurred, affecting source category 1A2, where differences between energy statistics and the Inventory are allocated. Main fuel involved: natural gas. Other fuels, with minor contribution were naphta, LPG and refinery gas.
Sweden	-7	-0.1	43	0.6	Updating of EF for combustion in industry sector and improved classification of tractors.
United Kingdom	306	0.3	2 356	4.4	DUKES (Digest of UK Energy Statistics) revisions
EU28	**4 766**	**0.6**	**440**	**0.1**	
Iceland	119	48.9	98	143.4	Correction of AD for 1A2a where one source stream of one small factory was missing.

	1990		2015		Main explanations
	kt CO_2	%	kt CO_2	%	
United Kingdom (KP)	306	0.3	2 365	4.4	DUKES (Digest of UK Energy Statistics) revisions
EU28+ISL	**4 885**	**0.6**	**547**	**0.1**	

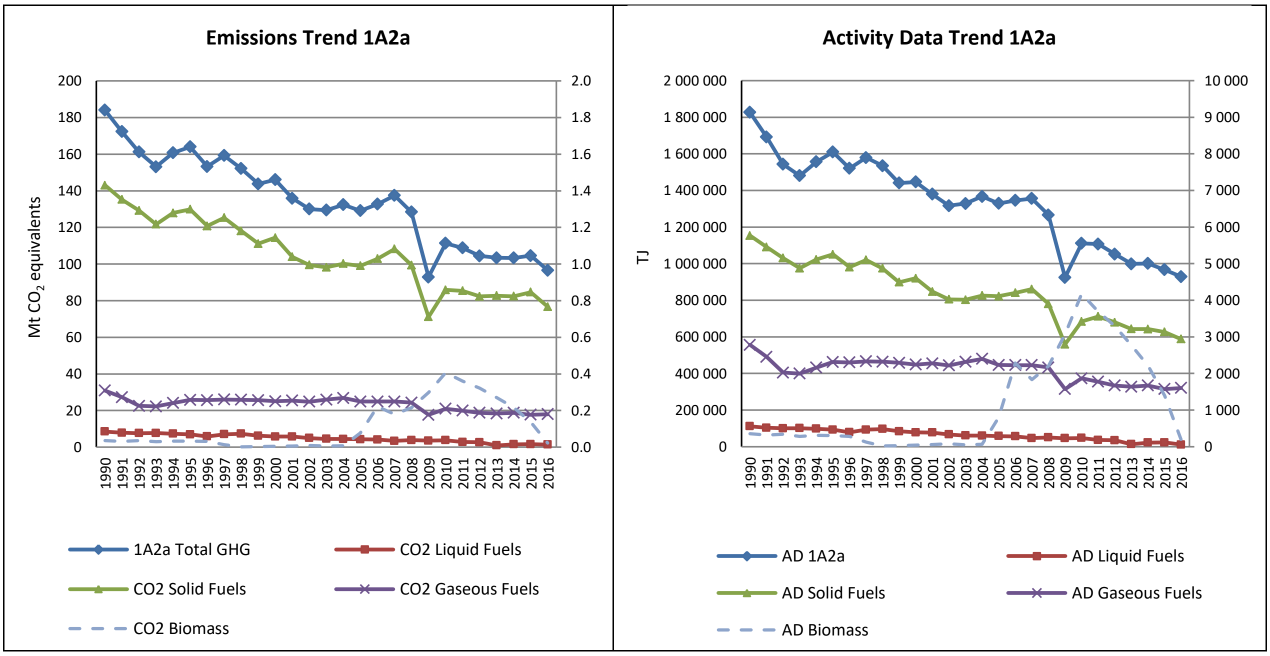
3.2.2.1 Iron and Steel (1A2a)

This chapter provides information about emission trends, Member States contribution, activity data and emission factors for category 1A2a on a fuel base. GHG emissions from 1A2a Iron and Steel accounted for 20% of 1A2 source category and 2.2% of total GHG emissions in 2016.

Figure 3.31 shows the emission trend within the category 1A2a, which is dominated by CO_2 emissions from solid fuels. Between 1990 to 2016 total GHG emissions decreased by 48%, mainly due to improved efficiency of restructured iron and steel plants and ongoing consequences of the economic crisis in 2009. The strong increase of 20% between 2009 and 2010 correlates with crude steel production which was 25% higher in 2010. Between 2015 and 2016 emissions decreased by 8% and crude steel production decreased by 3%. Between 1990 and 2016, CO_2 emissions from solid fuels decreased by 46%, CO_2 emissions from liquid fuels by 84% and CO_2 emissions from gaseous fuels decreased by 42%. Some Member States report emissions from blast furnace gas under categories 1A1a or other sub-categories of 1A2 and even under 1A4a where it is used as a fuel in the respective industrial branches. Emissions from onsite coke ovens of Austrian integrated iron and steel plants are fully included in category 1A2a. Emissions from blast furnace and coke oven gas flaring without energy recovery are partly reported under category 1B1b. According to the IPCC 2006 Guidelines, CO_2 emissions from reductants should be reported under category 2C1 which indicates that most of emissions from iron and steel production should be allocated to this category. 23 MS are reporting CO_2 emissions under 2C1 in 2016. However, the share of 1A2a on total 1A2a plus 2C1 CO_2 emissions is mostly over 50% with a range between 12% (Austria) to 89% (Italy). This indicates that not all MS are following the allocation-principle of the new Guidelines yet (see also Chapter 4.3.2.1).

A main driver of category 1A2a CO_2 emissions is crude steel production which decreased from about 192 million tonnes in 1990 to 162 million tonnes in 2016 (www.worldsteel.org statistics) as well as blast furnace iron production (BFI), which decreased from about 126 million tonnes to 91 million tonnes in 2016 (www.worldsteel.org statistics).

Figure 3.31 1A2a Iron and Steel: CO_2 emissions and activity data trends



Data displayed as dashed line refers to the secondary axis.

Between 1990 and 2016, CO_2 emissions from 1A2a Iron and Steel decreased by 47% (Table 3.23), mainly due to decreases in the Czech Republic, France, Poland, Italy, the United Kingdom, Poland, Luxembourg and Romania. Between 2015 and 2016 emissions decreased by 8% with the highest decrease reported by the United Kingdom, Germany and France.

Table 3.23 1A2a Iron and Steel: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016		Method	Emission factor Information
	1990	2015	2016		kt CO2	%	kt CO2	%		
Austria	2 060	1 404	1 420	1.5%	-641	-31%	16	1%	T1,T2	CS,D
Belgium	5 662	1 141	1 181	1.2%	-4 481	-79%	40	3%	T1,T3	D,PS
Bulgaria	2 705	116	114	0.1%	-2 592	-96%	-2	-2%	T2	CS
Croatia	NO,IE	52	34	0.0%	34	∞	-18	-34%	T1	D
Cyprus	NO,IE	NO,IE	NO,IE	-	-	-	-	-	NA	NA
Czech Republic	14 861	1 923	1 747	1.8%	-13 114	-88%	-176	-9%	T1,T2	CS,D
Denmark	128	89	92	0.1%	-36	-28%	3	4%	T1,T2,T3	CS,D
Estonia	3	NO	3	0.0%	0	-13%	3	∞	T1,T2	CS,D
Finland	2 499	833	926	1.0%	-1 573	-63%	93	11%	T3	CS,PS
France	21 239	13 458	11 324	11.8%	-9 916	-47%	-2 134	-16%	T2,T3	CS,PS
Germany	35 269	39 962	37 210	38.7%	1 941	6%	-2 752	-7%	CS	CS
Greece	447	65	121	0.1%	-327	-73%	56	86%	T2	CS,PS
Hungary	2 341	174	169	0.2%	-2 171	-93%	-5	-3%	T1,T2	CS,D
Ireland	175	2	2	0.0%	-173	-99%	0	-2%	T2	CS
Italy	24 389	9 424	10 609	11.0%	-13 780	-56%	1 185	13%	T2	CS
Latvia	391	22	3	0.0%	-389	-99%	-20	-88%	T2	CS
Lithuania	NO	NO	NO	-	-	-	-	-	NA	NA
Luxembourg	5 404	274	267	0.3%	-5 137	-95%	-7	-3%	T1,T2	CS,D
Malta	NO,IE	NO,IE	NO,IE	-	-	-	-	-	NA	NA
Netherlands	5 599	4 436	4 752	4.9%	-846	-15%	316	7%	T2	CS,D
Poland	16 189	5 160	5 043	5.2%	-11 145	-69%	-117	-2%	T1,T2	CS,D
Portugal	1 207	134	88	0.1%	-1 119	-93%	-46	-35%	T2	CR,D,PS
Romania	7 813	1 429	1 277	1.3%	-6 536	-84%	-151	-11%	T1,T2	CS,D
Slovakia	2 682	2 867	2 786	2.9%	105	4%	-81	-3%	T2	CS
Slovenia	421	193	202	0.2%	-219	-52%	9	5%	T1,T2	CS,D
Spain	8 323	5 830	5 529	5.7%	-2 794	-34%	-302	-5%	T1,T2	CS,D,OTH,PS
Sweden	1 705	1 585	1 229	1.3%	-476	-28%	-356	-22%	T2	CS
United Kingdom	21 534	13 432	10 024	10.4%	-11 510	-53%	-3 408	-25%	T2	CS
EU-28	**183 047**	**104 005**	**96 151**	**100%**	**-86 896**	**-47%**	**-7 854**	**-8%**	**-**	**-**
Iceland	0	1	2	0.0%	1	323%	0	23%	T1	D
United Kingdom (KP)	21 534	13 432	10 024	10.4%	-11 510	-53%	-3 408	-25%	T2	CS
EU-28 + ISL	**183 047**	**104 006**	**96 153**	**100%**	**-86 894**	**-47%**	**-7 853**	**-8%**	**-**	**-**

From 1990 to 2000 Croatia includes emissions under 1.A.2.g. Cyprus reports an 'IE' for liquid fuels (included in 1A2b) and a 'NO' for all other fuels. Malta includes emissions under 1.A.2.g.
Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

1A2a Iron and Steel - Liquid Fuels (CO_2)

In 2016 CO_2 from liquid fuels had a share of 1% within this category compared to 5% in 1990. Between 1990 and 2016 emissions decreased by 84% (Table 3.24). Significant absolute decreases have been achieved in Belgium, France, Germany, Poland and Spain. According to the methodology as described in chapter 3.2.2 about 85% of EU-28 emissions are calculated by using higher tier methods in 2016.

Table 3.24 1A2a Iron and Steel, liquid fuels: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016		Method	Emission factor Informa-tion
	1990	2015	2016		kt CO2	%	kt CO2	%		
Austria	75	3	6	0.4%	-70	-92%	2	66%	T2	CS
Belgium	885	27	25	1.8%	-860	-97%	-3	-10%	T1,T3	D,PS
Bulgaria	37	NO	NO	-	-37	-100%	-	-	NA	NA
Croatia	IE	9	7	0.5%	7	∞	-1	-14%	T1	D
Cyprus	IE	IE	IE	-	-	-	-	-	NA	NA
Czech Republic	427	NO	NO	-	-427	-100%	-	-	NA	NA
Denmark	17	1	1	0.1%	-16	-94%	0	-4%	T1,T2	CS,D
Estonia	NO	NO	0	0.0%	0	∞	0	∞	T1,T2	CS,D
Finland	305	271	284	20.6%	-21	-7%	13	5%	T3	CS
France	1 065	134	139	10.1%	-927	-87%	5	4%	T2,T3	CS,PS
Germany	916	16	19	1.4%	-896	-98%	3	21%	CS	CS
Greece	447	43	34	2.4%	-414	-92%	-10	-22%	T2	PS
Hungary	392	NO	NO	-	-392	-100%	-	-	NA	NA
Ireland	16	NO	NO	-	-16	-100%	-	-	NA	NA
Italy	156	272	12	0.9%	-143	-92%	-260	-95%	T2	CS
Latvia	94	NO	NO	-	-94	-100%	-	-	NA	NA
Lithuania	NO	NO	NO	-	-	-	-	-	NA	NA
Luxembourg	48	1	1	0.1%	-47	-98%	0	9%	T1,T2	CS,D
Malta	IE	IE	IE	-	-	-	-	-	NA	NA
Netherlands	19	14	12	0.8%	-7	-38%	-2	-15%	T2	CS,D
Poland	864	16	16	1.1%	-849	-98%	0	0%	T1	D
Portugal	163	0	0	0.0%	-163	-100%	0	61%	T2	CR,D,PS
Romania	NO	18	18	1.3%	18	∞	0	1%	T2	CS
Slovakia	164	1	1	0.1%	-163	-99%	0	5%	T2	CS
Slovenia	54	4	4	0.3%	-50	-92%	0	-2%	T1	D
Spain	1 073	117	161	11.7%	-912	-85%	44	38%	T1	CS,PS
Sweden	831	589	589	42.8%	-242	-29%	0	0%	T2	CS
United Kingdom	462	89	46	3.4%	-416	-90%	-43	-48%	T2	CS
EU-28	**8 511**	**1 626**	**1 375**	**100%**	**-7 136**	**-84%**	**-250**	**-15%**	**-**	**-**
Iceland	0	1	2	0.1%	1	323%	0	23%	T1	D
United Kingdom (KP)	462	89	46	3.4%	-416	-90%	-43	-48%	T2	CS
EU-28 + ISL	**8 512**	**1 627**	**1 377**	**100%**	**-7 135**	**-84%**	**-250**	**-15%**	**-**	**-**

From 1990 to 2000 Croatia includes emissions under 1.A.2.g. Cyprus reports an 'IE' for liquid fuels (included in 1A2b) and a 'NO' for all other fuels. Malta includes emissions under 1.A.2.g.
Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

Figure 3.32 and Figure 3.33 show CO_2 emissions and implied emission factors as well as the share of the Member States with the highest contributions. Liquid fuel consumption decreased by 90% between 1990 and 2016. The CO_2 implied emission factor for liquid fuels was 71.3 t/TJ in 2016. The comparatively high 2016 implied emission factor of Romania is due to a high share of petrol coke included in this category. Sweden reports 2013 emissions as confidential. The implied emission factor 2016 is high because Sweden reports 43% of EU-28+ISL emissions but activity data as 'confidential'. Therefore below there are two graphs related to the EU IEF: one with Sweden and one excluding Sweden.

Figure 3.32 1A2a Iron and Steel, Liquid fuels: Emission trend and share for CO_2

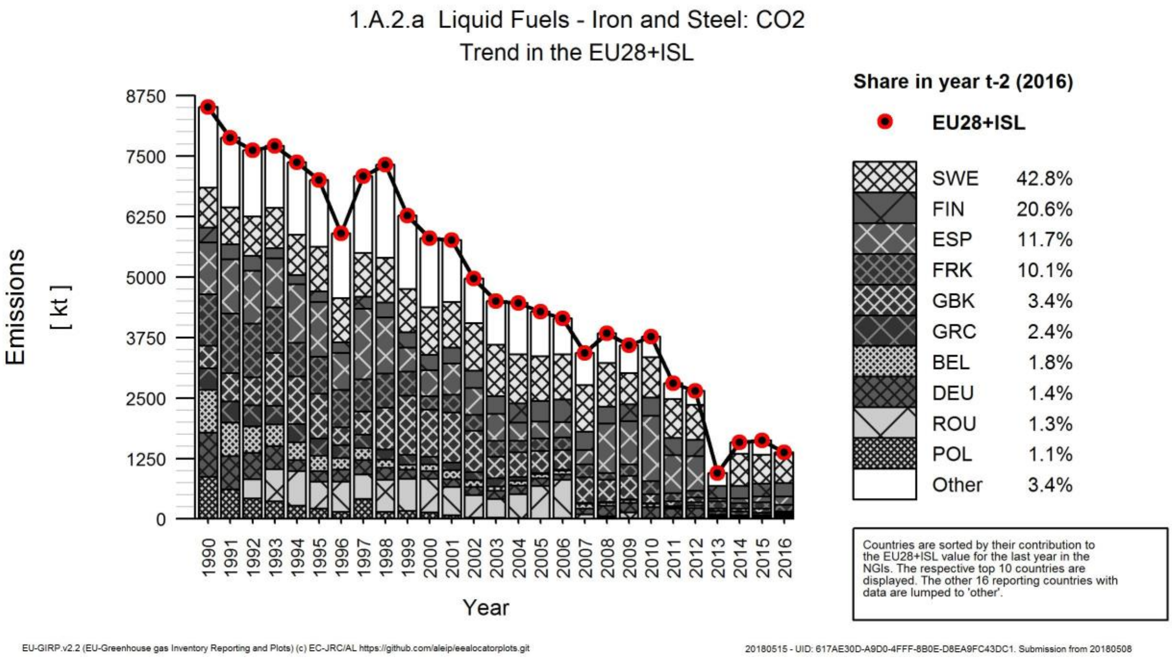
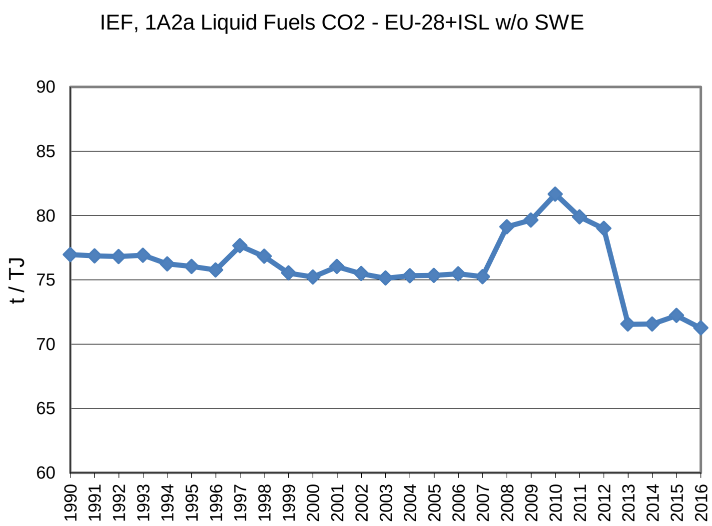
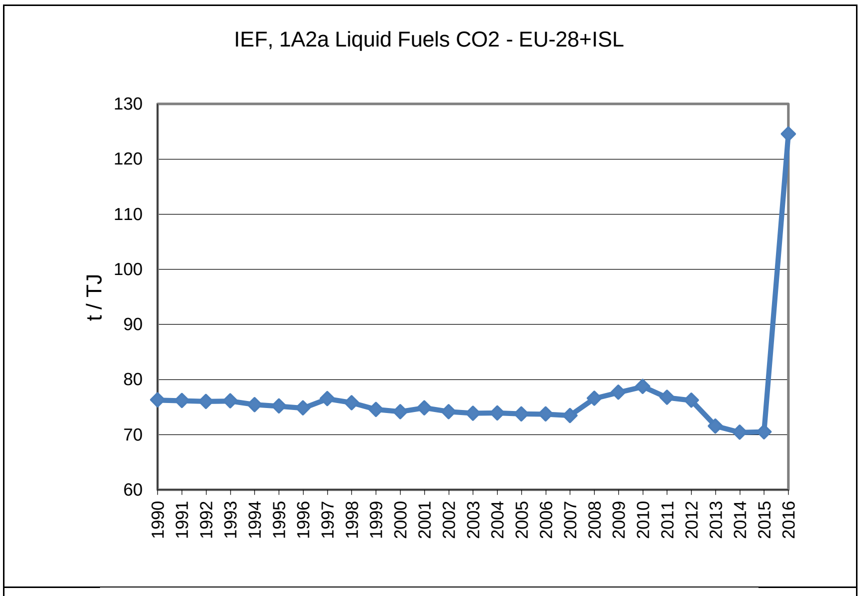


Figure 3.33 1A2a Iron and Steel, Liquid fuels: Implied Emission Factors for CO_2 (in t/TJ)




IEF, 1A2a Liquid Fuels CO2 - EU-28+ISL
t / TJ
130
120
110
100
90
80
70
60
1990
1991
1992
1993
1994
1995
1996
1997
1998
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2001
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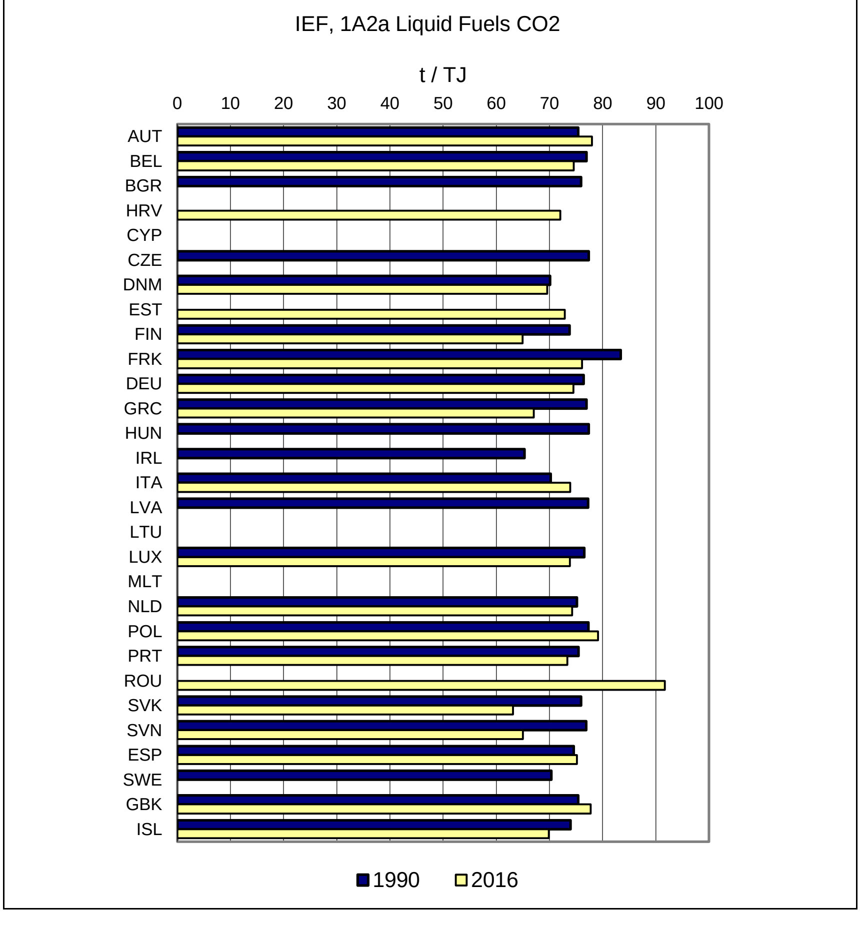
2012
2013
2014
2015
2016


IEF, 1A2a Liquid Fuels CO2
t / TJ
0
10
20
30
40
50
60
70
80
90
100
AUT
BEL
BGR
HRV
CYP
CZE
DNM
EST
FIN
FRK
DEU
GRC
HUN
IRL
ITA
LVA
LTU
LUX
MLT
NLD
POL
PRT
ROU
SVK
SVN
ESP
SWE
GBK
ISL
1990
2016

1A2a Iron and Steel - Solid Fuels (CO_2)

In 2016, CO_2 from solid fuels had a share of 79% within this category and a share of 78% in 1990. Between 1990 and 2016 the emissions decreased by 46% (Table 3.25). Between 1990 and 2016 the Czech Republic, Belgium, Poland, Spain, France, Italy, Luxembourg and the United Kingdom showed major decreases. Between 2015 to 2016 Germany, France and the United Kingdom show significant decreases. The increase of Germany in 2015 is due to allocation of two power plants from the public sector (1A1a) to the industry sector (1A2a). According to the methodology as described in chapter 3.2.2 about 92% of EU-28 emissions are calculated by using higher tier methods in 2016.

Table 3.25 1A2a Iron and Steel, solid fuels: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016		Method	Emission factor Informa-tion
	1990	2015	2016		kt CO2	%	kt CO2	%		
Austria	1 335	289	433	0.6%	-902	-68%	144	50%	T2	CS
Belgium	3 284	17	15	0.0%	-3 269	-100%	-1	-9%	T3	PS
Bulgaria	1 631	NO	NO	-	-1 631	-100%	-	-	NA	NA
Croatia	IE	9	1	0.0%	1	∞	-8	-86%	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czech Republic	13 709	1 423	1 234	1.6%	-12 475	-91%	-189	-13%	T2	CS,D
Denmark	5	NO	NO	-	-5	-100%	-	-	NA	NA
Estonia	3	NO	2	0.0%	-1	-35%	2	∞	T2	CS
Finland	2 084	440	513	0.7%	-1 571	-75%	73	17%	T3	CS,PS
France	18 155	11 542	9 427	12.3%	-8 727	-48%	-2 114	-18%	T2,T3	CS,PS
Germany	29 912	36 671	33 989	44.3%	4 077	14%	-2 682	-7%	CS	CS
Greece	NO	NO	NO	-	-	-	-	-	NA	NA
Hungary	625	95	61	0.1%	-564	-90%	-34	-36%	T1,T2	CS,D
Ireland	115	NO	NO	-	-115	-100%	-	-	NA	NA
Italy	19 955	6 299	6 858	8.9%	-13 096	-66%	560	9%	T2	CS
Latvia	NO	NO	NO	-	-	-	-	-	NA	NA
Lithuania	NO	NO	NO	-	-	-	-	-	NA	NA
Luxembourg	4 959	NO	NO	-	-4 959	-100%	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	4 913	3 794	4 131	5.4%	-781	-16%	338	9%	T2	CS
Poland	11 817	4 217	3 947	5.1%	-7 870	-67%	-269	-6%	T1,T2	CS,D
Portugal	1 041	37	NO	-	-1 041	-100%	-37	-100%	NA	NA
Romania	1 149	73	126	0.2%	-1 022	-89%	53	73%	T1,T2	CS,D
Slovakia	2 296	2 775	2 674	3.5%	378	16%	-101	-4%	T2	CS
Slovenia	57	25	25	0.0%	-33	-57%	0	0%	T1	D
Spain	6 472	3 884	3 704	4.8%	-2 768	-43%	-180	-5%	T1	CS,PS
Sweden	849	821	462	0.6%	-387	-46%	-359	-44%	T2	CS
United Kingdom	18 610	12 221	9 087	11.8%	-9 523	-51%	-3 135	-26%	T2	CS
EU-28	**142 975**	**84 632**	**76 691**	**100%**	**-66 284**	**-46%**	**-7 940**	**-9%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	18 610	12 221	9 087	11.8%	-9 523	-51%	-3 135	-26%	T2	CS
EU-28 + ISL	**142 975**	**84 632**	**76 691**	**100%**	**-66 284**	**-46%**	**-7 940**	**-9%**	**-**	**-**

From 1990 to 2000 Croatia includes emissions under 1.A.2.g.
Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

Figure 3.34 and Figure 3.35 show CO_2 emissions and implied emission factors for EU-28+ISL and the Member States as well as the share of the Member States with the highest contributions. In 2016 the largest emitters are France, Germany, and the UK; together they cause 68% of the CO_2 emissions from solid fuels in 1A2a. Solid fuel consumption decreased by 49% between 1990 and 2016. The high variation of the IEFs across MS is due to usage of derived coal gases which have significant lower (coke oven gas) or higher carbon content (blast furnace gas) than coal. The CO_2 implied emission factor for solid fuels was 130.5 t/TJ in 2016.

Figure 3.34 1A2a Iron and Steel, solid fuels: Emission trend and share for CO_2

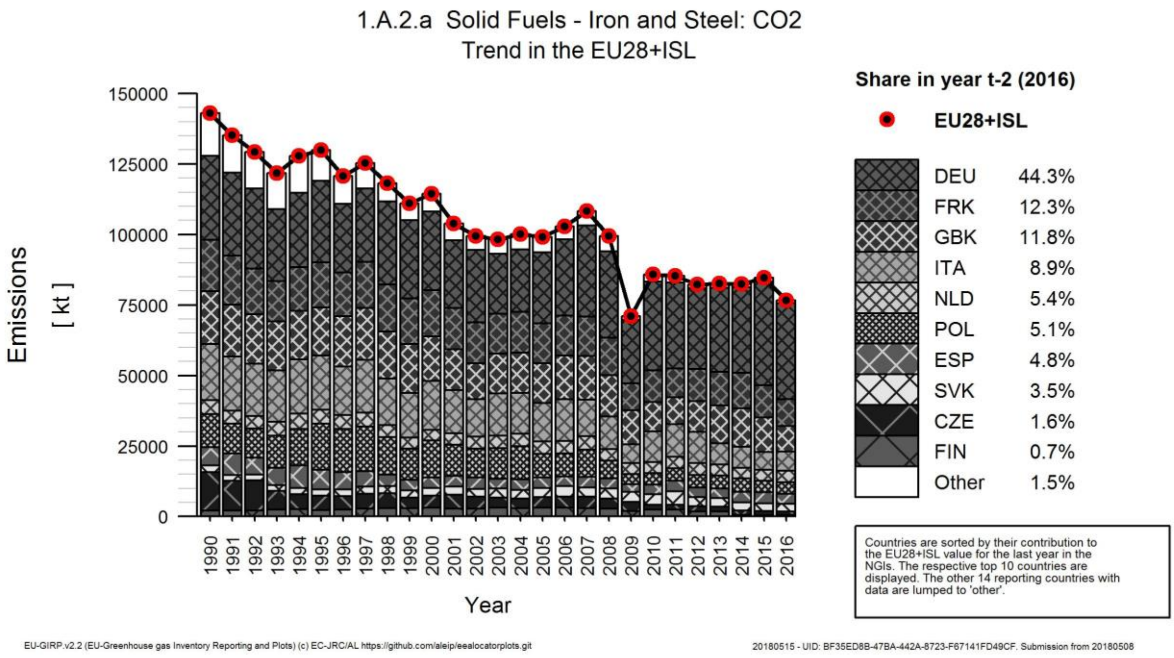
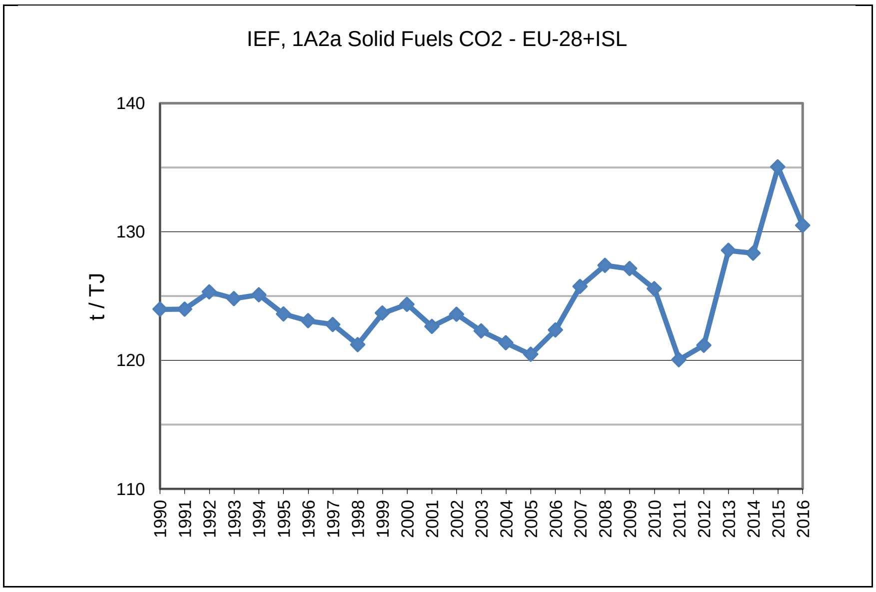
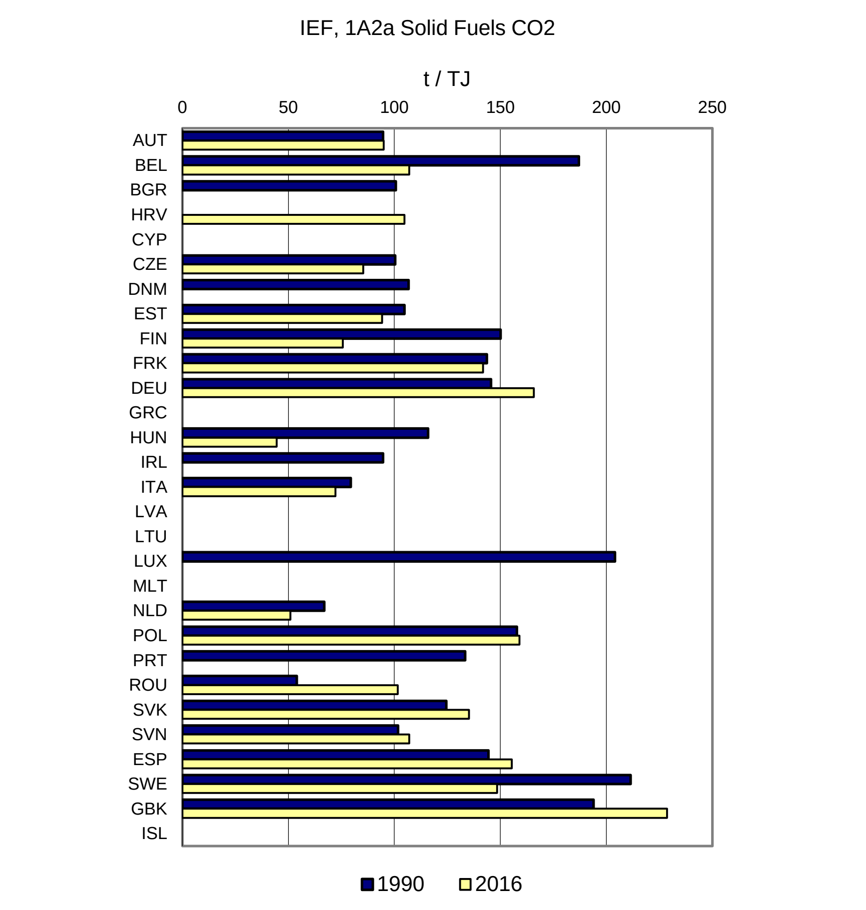


Figure 3.35 1A2a Iron and Steel, Solid fuels: Implied Emission Factors for CO_2 (in t/TJ)





1A2a Iron and Steel - Gaseous Fuels (CO_2)

In 2016 CO_2 from gaseous fuels had a share of 18% within source category 1A2a. Between 1990 and 2016 the emissions decreased by 42% (Table 3.26). Sweden reports 2013 emissions as confidential. According to the methodology as described in chapter 3.2.2 about 81% of EU-28 emissions are calculated by using higher tier methods in 2016.

Table 3.26 1A2a Iron and Steel, gaseous fuels: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016		Method	Emission factor Informa-tion
	1990	2015	2016		kt CO2	%	kt CO2	%		
Austria	650	1 112	981	5.4%	331	51%	-131	-12%	T2	CS
Belgium	1 493	1 092	1 135	6.3%	-358	-24%	43	4%	T1,T3	D,PS
Bulgaria	1 037	116	114	0.6%	-923	-89%	-2	-2%	T2	CS
Croatia	IE	34	25	0.1%	25	∞	-9	-25%	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czech Republic	724	500	513	2.8%	-212	-29%	13	3%	T2	CS
Denmark	107	88	91	0.5%	-15	-14%	4	4%	T3	CS
Estonia	NO	NO	1	0.0%	1	∞	1	∞	T2	CS
Finland	110	122	129	0.7%	19	17%	7	6%	T3	CS
France	2 012	1 750	1 734	9.6%	-277	-14%	-16	-1%	T2,T3	CS,PS
Germany	4 442	3 275	3 202	17.7%	-1 240	-28%	-73	-2%	CS	CS
Greece	NO	22	87	0.5%	87	∞	65	299%	T2	CS
Hungary	1 324	79	109	0.6%	-1 215	-92%	30	38%	T1	D
Ireland	44	2	2	0.0%	-41	-95%	0	-2%	T2	CS
Italy	4 279	2 854	3 739	20.7%	-540	-13%	885	31%	T2	CS
Latvia	236	22	3	0.0%	-233	-99%	-20	-88%	T2	CS
Lithuania	NO	NO	NO	-	-	-	-	-	NA	NA
Luxembourg	397	273	266	1.5%	-131	-33%	-7	-3%	T2	CS
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	667	628	609	3.4%	-58	-9%	-19	-3%	T2	CS
Poland	2 924	928	1 081	6.0%	-1 843	-63%	153	16%	T2	CS
Portugal	NO	96	88	0.5%	88	∞	-9	-9%	T2	CR,D,PS
Romania	6 665	1 334	1 130	6.3%	-5 535	-83%	-204	-15%	T2	CS
Slovakia	221	91	111	0.6%	-110	-50%	20	22%	T2	CS
Slovenia	310	164	173	1.0%	-137	-44%	9	6%	T2	CS
Spain	778	1 829	1 663	9.2%	885	114%	-166	-9%	T1	CS,PS
Sweden	25	175	178	1.0%	153	605%	3	2%	T2	CS
United Kingdom	2 463	1 122	891	4.9%	-1 572	-64%	-231	-21%	T2	CS
EU-28	**30 905**	**17 707**	**18 053**	**100%**	**-12 852**	**-42%**	**346**	**2%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	2 463	1 122	891	4.9%	-1 572	-64%	-231	-21%	T2	CS
EU-28 + ISL	**30 905**	**17 707**	**18 053**	**100%**	**-12 852**	**-42%**	**346**	**2%**	**-**	**-**

From 1990 to 2000 Croatia includes emissions under 1.A.2.g.
Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

Error! Reference source not found. and Figure 3.36 show CO_2 emissions and implied emission factors for EU-28+ISL and the Member States as well as the share of the Member States with the highest contributions. The largest emissions are reported by France, Germany, Italy and Spain which contribute 57% to CO_2 emissions from gaseous fuels in 1A2a. Gaseous fuel consumption in the EU-28 decreased by 42% between 1990 and 2016. The CO_2-implied emission factor for gaseous fuels was 56.3 t/TJ in 2016. The increased CO_2-implied emission factor from 2008 onwards is mainly caused due to NGL (Natural gas liquids) imports by Italy (e.g from Oman) which has a significantly higher propane-butane content than natural gas which comes from pipeline systems.

Figure 3.36 1A2a Iron and Steel, Gaseous fuels: Emission trend and share for CO_2

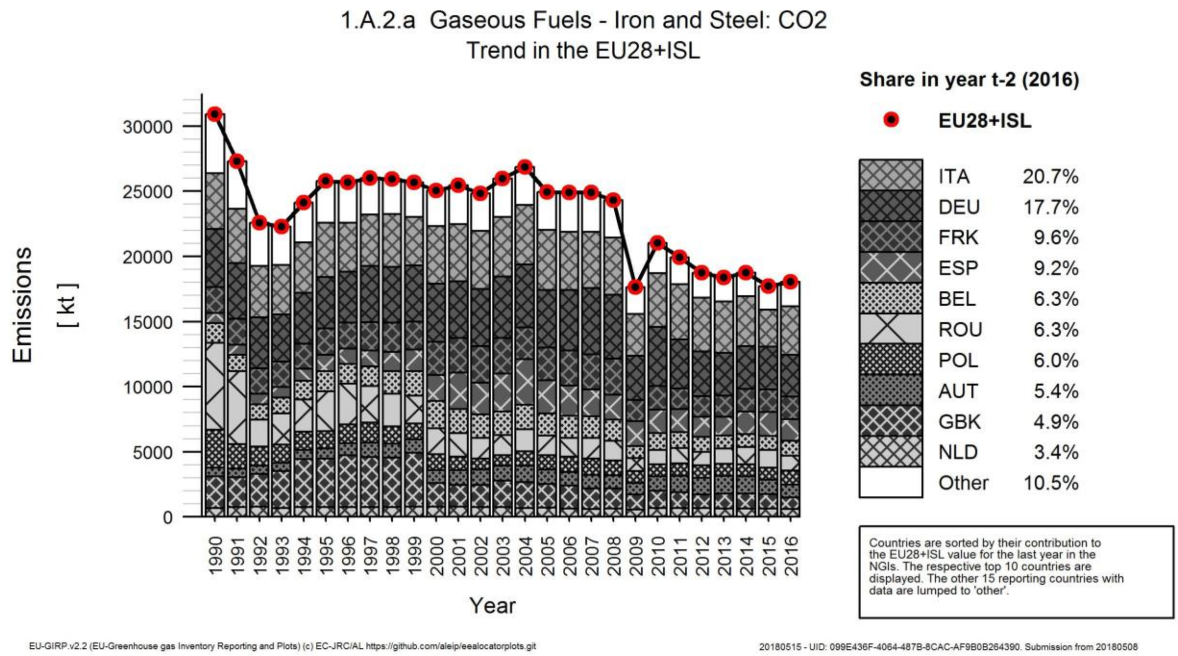
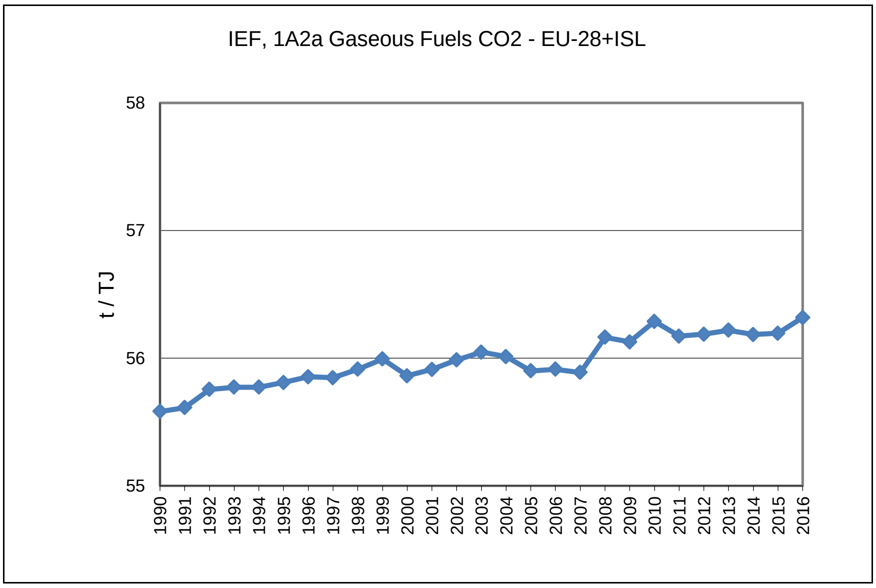
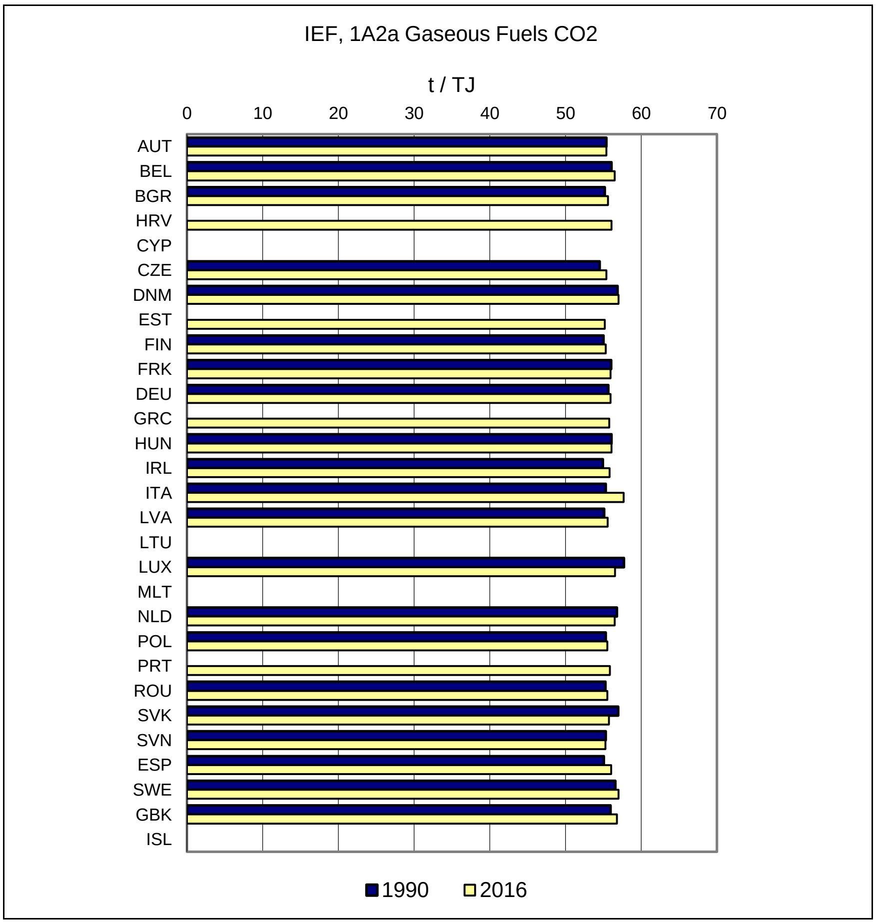


Figure 3.36 1A2a Iron and Steel, Gaseous fuels: Implied Emission Factors for CO_2 (in t/TJ)



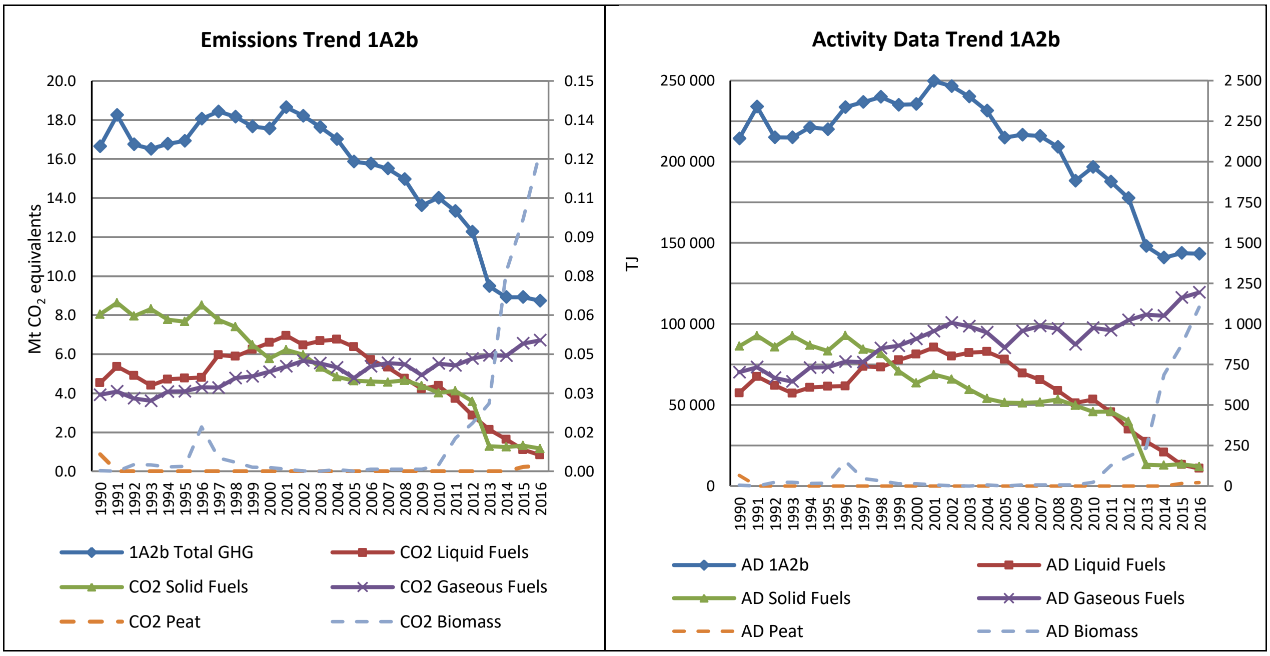


3.2.2.2 Non Ferrous Metals (1A2b)

In this chapter information is provided about emission trends, Member States contribution and activity data for category 1A2b by fuels. GHG emissions from 1A2b Non-Ferrous Metals accounted for 1.8% of 1A2 source category and 0.2% of total GHG emissions in 2016.

Figure 3.37 shows the emission trend within the category 1A2b, which is dominated by CO_2 emissions from gaseous fuels in 2016. The share of solid fuels CO_2 emissions decreased from 48% in 1990 to 13% in 2016. In 2016 total GHG emissions were 48% below 1990 level. Increasing emissions were reported for CO_2 from gaseous fuels (+71%) while CO_2 emissions from all other fossil fuels decreased.

Figure 3.37   1A2b Non-ferrous Metals: CO_2 emissions and activity data trends



Data displayed as dashed line refers to the secondary axis.

CO_2 emissions from 1A2b were 48% below 1990 levels in 2016. In absolute terms, France, Germany, Slovakia and the United Kingdom reported the highest decreases, while Ireland and Italy reported substantial increases in this period (Table 3.27). Sweden reports 2015 emissions as confidential.

Table 3.27 1A2b Non-ferrous Metals: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016		Method	Emission factor Informa-tion
	1990	2015	2016		kt CO2	%	kt CO2	%		
Austria	132	347	356	4.1%	224	169%	9	3%	T1,T2	CS,D
Belgium	629	421	448	5.2%	-180	-29%	27	6%	T1	D
Bulgaria	298	146	164	1.9%	-134	-45%	18	12%	T1,T2	CS,D
Croatia	NO,IE	11	11	0.1%	11	∞	0	-2%	T1	D
Cyprus	5	3	6	0.1%	1	26%	3	107%	T1	D
Czech Republic	102	105	135	1.6%	33	33%	30	29%	T1,T2	CS,D
Denmark	NO	NO	NO	-	-	-	-	-	NA	NA
Estonia	NO	0	3	0.0%	3	∞	3	1366%	T1,T2	CS,D
Finland	337	97	102	1.2%	-235	-70%	5	5%	T3	CS
France	2 437	858	864	10.0%	-1 573	-65%	7	1%	T2,T3	CS,PS
Germany	1 377	167	102	1.2%	-1 274	-93%	-64	-39%	CS	CS
Greece	582	587	562	6.5%	-20	-3%	-25	-4%	T2	CS,PS
Hungary	239	165	175	2.0%	-64	-27%	10	6%	T1	D
Ireland	809	1 445	1 402	16.3%	594	73%	-42	-3%	T1,T2	CS,D
Italy	728	1 105	1 018	11.8%	290	40%	-88	-8%	T2	CS
Latvia	NO	3	2	0.0%	2	∞	-1	-38%	T2	CS
Lithuania	NO	NO	NO	-	-	-	-	-	NA	NA
Luxembourg	28	50	51	0.6%	22	79%	1	2%	T2	CS
Malta	NO,IE	NO,IE	NO,IE	-	-	-	-	-	NA	NA
Netherlands	214	158	158	1.8%	-56	-26%	0	0%	T2	CS
Poland	1 085	1 215	1 099	12.8%	13	1%	-116	-10%	T1,T2	CS,D
Portugal	NO,IE	NO,IE	NO,IE	-	-	-	-	-	NA	NA
Romania	73	NO,IE	NO,IE	-	-73	-100%	-	-	NA	NA
Slovakia	1 256	137	113	1.3%	-1 144	-91%	-25	-18%	T2	CS
Slovenia	439	105	103	1.2%	-336	-77%	-2	-2%	T1,T2	CS,D
Spain	1 323	1 246	1 224	14.2%	-99	-7%	-22	-2%	T2	CS,OTH,PS
Sweden	128	C	101	1.2%	-27	-21%	101	∞	T2	CS
United Kingdom	4 332	511	510	5.9%	-3 822	-88%	-1	0%	T2	CS
EU-28	**16 424**	**8 883**	**8 607**	**100%**	**-7 817**	**-48%**	**-276**	**-3%**	**-**	**-**
Iceland	14	10	6	0.1%	-8	-58%	-5	-45%	T1	D
United Kingdom (KP)	4 332	511	510	5.9%	-3 822	-88%	-1	0%	T2	CS
EU-28 + ISL	**16 438**	**8 893**	**8 613**	**100%**	**-7 825**	**-48%**	**-280**	**-3%**	**-**	**-**

From 1990 to 2000 Croatia includes emissions under 1.A.2.g. Malta and Portugal include emissions under 1.A.2.g.*Romania includes emissions under 1.A.2.a.*

EU trends in this table do not include Sweden for confidentiality reasons and to preserve time series consistency for the EU. This also explains the differences between the numbers in this table and the CRF.

Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

1A2b Non-Ferrous Metals - Liquid Fuels (CO_2)

In 2016 CO_2 from liquid fuels had a share of 9% within source category 1A2b (compared to 27% in 1990). Between 1990 and 2016 CO_2 emissions from liquid fuels decreased by 82% (Table 3.29). Malta, Portugal and Romania reported emissions as 'Included elsewhere'. Substantial decreases between 1990 and 2016 were reported by France, Greece, Ireland and Spain. Sweden reports 2013 and 2014 emissions and 2013 to 2015 activity data as confidential. According to the methodology as described in chapter 3.2.2 about 80% of EU-28 emissions are calculated by using higher tier methods in 2016.

Table 3.28 1A2b Non-ferrous Metals, liquid fuels: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016		Method	Emission factor Informa-tion
	1990	2015	2016		kt CO2	%	kt CO2	%		
Austria	35	19	9	1.1%	-26	-73%	-10	-51%	T2	CS
Belgium	220	46	53	6.3%	-168	-76%	6	13%	T1	D
Bulgaria	199	40	40	4.8%	-160	-80%	0	0%	T1	D
Croatia	IE	6	5	0.6%	5	∞	-1	-15%	T1	D
Cyprus	5	3	6	0.7%	1	26%	3	107%	T1	D
Czech Republic	3	NO	NO	-	-3	-100%	-	-	NA	NA
Denmark	NO	NO	NO	-	-	-	-	-	NA	NA
Estonia	NO	0	0	0.0%	0	∞	0	100%	T1,T2	CS,D
Finland	173	70	73	8.7%	-101	-58%	3	4%	T3	CS
France	698	46	63	7.6%	-635	-91%	17	36%	T2,T3	CS,PS
Germany	144	125	60	7.2%	-84	-58%	-65	-52%	CS	CS
Greece	582	9	12	1.4%	-570	-98%	3	33%	T2	PS
Hungary	143	NO	NO	-	-143	-100%	-	-	NA	NA
Ireland	766	32	24	2.9%	-742	-97%	-8	-24%	T1,T2	CS,D
Italy	18	187	35	4.2%	17	95%	-153	-82%	T2	CS
Latvia	NO	NO	NO	-	-	-	-	-	NA	NA
Lithuania	NO	NO	NO	-	-	-	-	-	NA	NA
Luxembourg	15	NO	NO	-	-15	-100%	-	-	NA	NA
Malta	IE	IE	IE	-	-	-	-	-	NA	NA
Netherlands	NO	NO	NO	-	-	-	-	-	NA	NA
Poland	62	19	31	3.8%	-31	-49%	12	66%	T1	D
Portugal	IE	IE	IE	-	-	-	-	-	NA	NA
Romania	IE	IE	IE	-	-	-	-	-	NA	NA
Slovakia	23	11	8	0.9%	-15	-66%	-3	-28%	T2	CS
Slovenia	120	22	18	2.1%	-103	-85%	-5	-21%	T1	D
Spain	1 063	374	302	36.4%	-762	-72%	-72	-19%	T2	CS,PS
Sweden	110	88	85	10.2%	-25	-23%	-4	-4%	T2	CS
United Kingdom	134	2	2	0.2%	-132	-99%	0	0%	T2	CS
EU-28	**4 515**	**1 098**	**824**	**99%**	**-3 691**	**-82%**	**-274**	**-25%**	**-**	**-**
Iceland	14	10	6	0.7%	-8	-58%	-5	-45%	T1	D
United Kingdom (KP)	134	2	2	0.2%	-132	-99%	0	0%	T2	CS
EU-28 + ISL	**4 529**	**1 108**	**830**	**100%**	**-3 699**	**-82%**	**-278**	**-25%**	**-**	**-**

From 1990 to 2000 Croatia includes emissions under 1.A.2.g.
Portugal and Malta include emissions under 1A2g. Romania includes emissions under 1A2a.
Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

Error! Reference source not found.show CO_2 emissions and implied emission factors for EU-28+ISL and the Member States as well as the share of the Member States with the highest contributions. The largest emissions are reported by Spain, Sweden, Finland and France which contribute 63% to CO_2 emissions from gaseous fuels in 1A2a. Liquid fuel consumption in the EU-28 decreased by 81 % between 1990 and 2016. The CO_2-implied emission factor for liquid fuels was 77.0 t/TJ in 2016. Particularly higher implied CO_2 emission factors are due to the use of petrol coke, which has a significantly higher carbon content than liquid oil products. The peak in the 2015 implied emission factor as presented in the figure below occurs because Sweden reported activity data as confidential.

Figure 3.38 1A2b Non-ferrous Metals, liquid fuels: Emission trend and share for CO_2

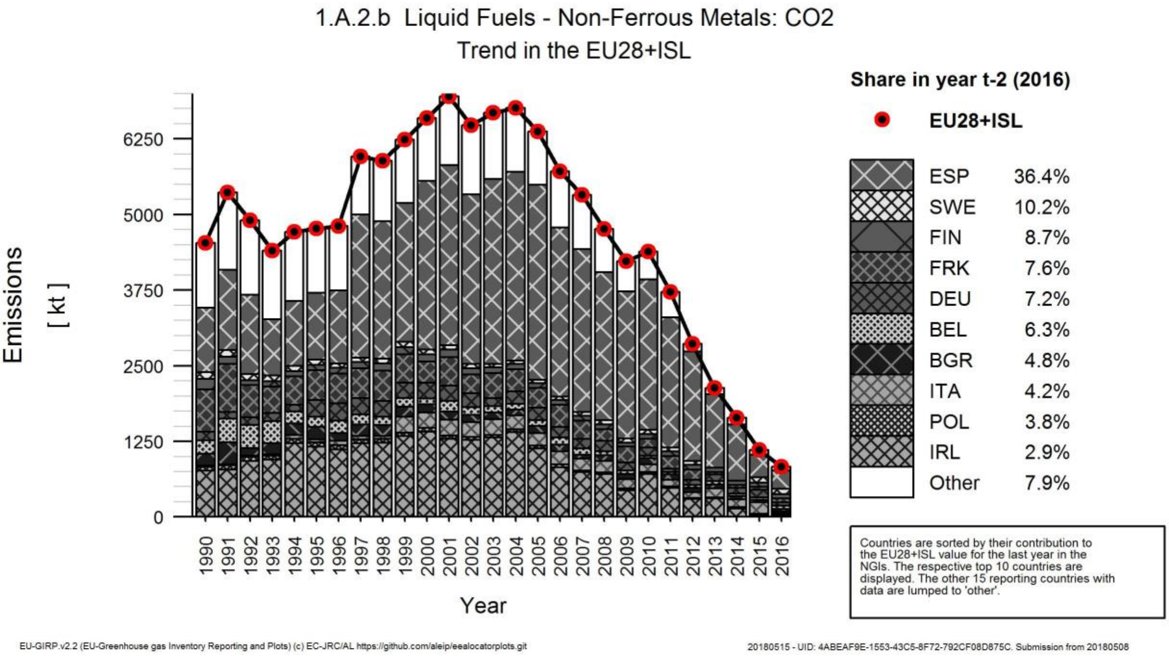
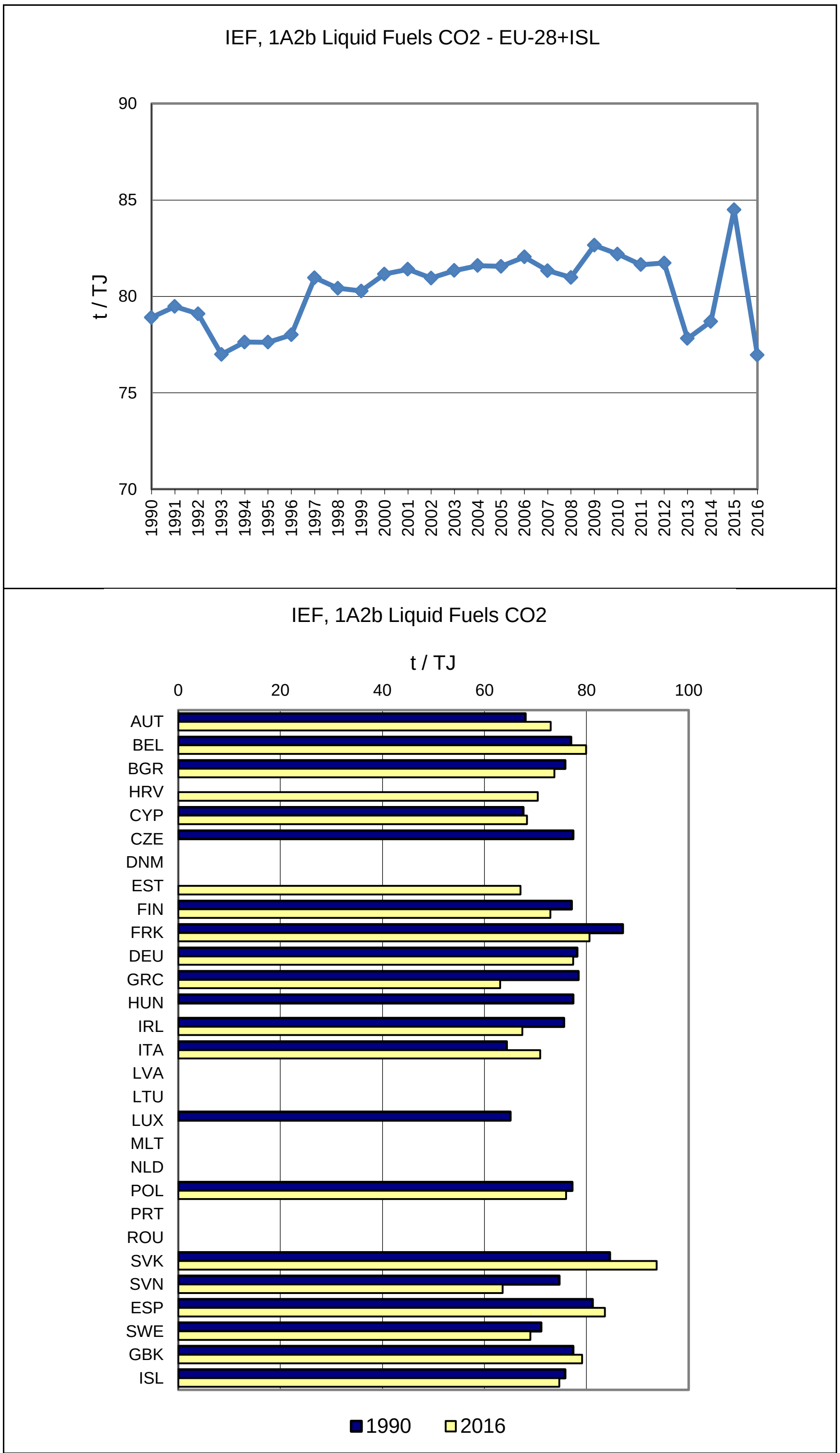


Figure 3.39 1A2b Non-ferrous Metals, liquid fuels: Implied Emission Factors for CO_2 (in t/TJ)



1A2b Non-Ferrous Metals - Solid Fuels (CO_2)

In 2016 CO_2 from solid fuels had a share of 13% within source category 1A2b (compared to 48% in 1990). Between 1990 and 2016 the emissions decreased by 86% (Table 3.29). Greece, Portugal and Romania reported emissions as 'Included elsewhere'. Substantial decreases between 1990 and 2016 were reported by France, Germany, Slovakia and the United Kingdom. According to the methodology as described in chapter 3.2.2 about 92% of EU-28 emissions are calculated by using higher tier methods in 2016.

Table 3.29 1A2b Non-ferrous Metals, solid fuels: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016		Method	Emission factor Informa-tion
	1990	2015	2016		kt CO2	%	kt CO2	%		
Austria	22	17	14	1.2%	-8	-38%	-4	-21%	T2	CS
Belgium	147	85	89	7.6%	-59	-40%	4	5%	T1	D
Bulgaria	75	30	49	4.2%	-26	-35%	18	60%	T1,T2	CS,D
Croatia	NO	NO	1	0.1%	1	∞	1	∞	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czech Republic	46	12	12	1.0%	-34	-74%	0	-2%	T2	CS,D
Denmark	NO	NO	NO	-	-	-	-	-	NA	NA
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	155	23	25	2.1%	-131	-84%	2	7%	T3	CS
France	898	2	2	0.2%	-896	-100%	0	1%	T2,T3	CS,PS
Germany	1 233	42	42	3.6%	-1 190	-97%	0	1%	CS	CS
Greece	IE	IE	IE	-	-	-	-	-	NA	NA
Hungary	9	NO	NO	-	-9	-100%	-	-	NA	NA
Ireland	4	NO	NO	-	-4	-100%	-	-	NA	NA
Italy	152	13	NO	-	-152	-100%	-13	-100%	NA	NA
Latvia	NO	0	0	0.0%	0	∞	0	9%	T2	CS
Lithuania	NO	NO	NO	-	-	-	-	-	NA	NA
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	0	NO	NO	-	0	-100%	-	-	NA	NA
Poland	706	795	666	57.2%	-40	-6%	-129	-16%	T1,T2	CS,D
Portugal	IE	IE	IE	-	-	-	-	-	NA	NA
Romania	73	IE	IE	-	-73	-100%	-	-	NA	NA
Slovakia	798	55	36	3.1%	-762	-95%	-18	-33%	T2	CS
Slovenia	154	5	5	0.4%	-150	-97%	0	-7%	T1,T2	CS,D
Spain	188	108	102	8.7%	-86	-46%	-7	-6%	T2	CS
Sweden	7	NO	NO	-	-7	-100%	-	-	NA	NA
United Kingdom	3 379	133	123	10.6%	-3 256	-96%	-10	-7%	T2	CS
EU-28	**8 047**	**1 320**	**1 165**	**100%**	**-6 882**	**-86%**	**-155**	**-12%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	3 379	133	123	10.6%	-3 256	-96%	-10	-7%	T2	CS
EU-28 + ISL	**8 047**	**1 320**	**1 165**	**100%**	**-6 882**	**-86%**	**-155**	**-12%**	**-**	**-**

Portugal includes emissions under 1A2g. Romania includes emissions under 1A2a.
Greece includes emissions in the Industrial processes sector (as non-energy use of fuels).

Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

Figure 3.40 and *Figure 3.41* show CO_2 emissions and implied emission factors for EU-28+ISL and the Member States as well as the share of the Member States with the highest contributions. The largest emissions are reported by Belgium, Spain, Poland and the United Kingdom; together they cause 84% of the CO_2 emissions from solid fuels in 2016. Consumption of solid fuels decreased by 87% between 1990 and 2016. The strong decline in 2013 is mainly due to a high decrease reported by the United Kingdom. The reason for the decrease in the emissions of the UK is due to a change in allocation of an industrial coal power plant which is part of the public electricity grid since 2013 and therefore emissions are allocated to category 1A1a. The CO_2-implied emission factor for solid fuels was 97.6 t/TJ in 2016. The reason for the increase of the EU IEF in 2013 is also the reallocation of the UK power plant mentioned above: the EU IEF increased in 2014 compared to 2013 because of the growing weight in EU emissions and Poland having a higher IEF than the UK.

Figure 3.40 1A2b Non-ferrous Metals, solid fuels: Emission trend and share for CO_2

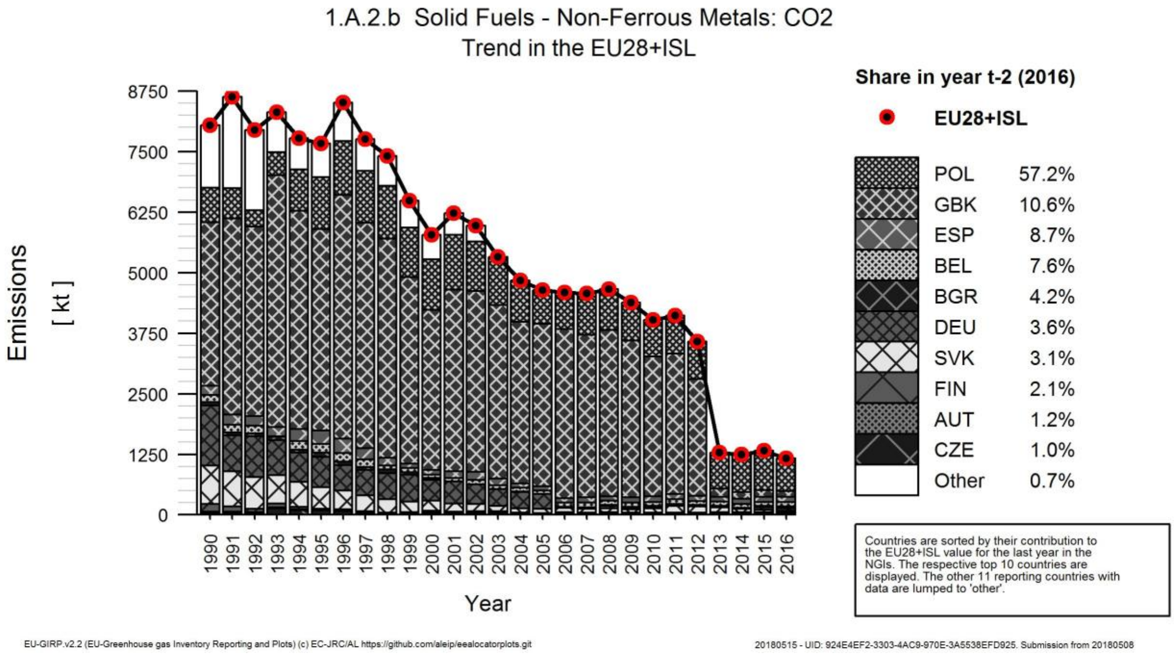
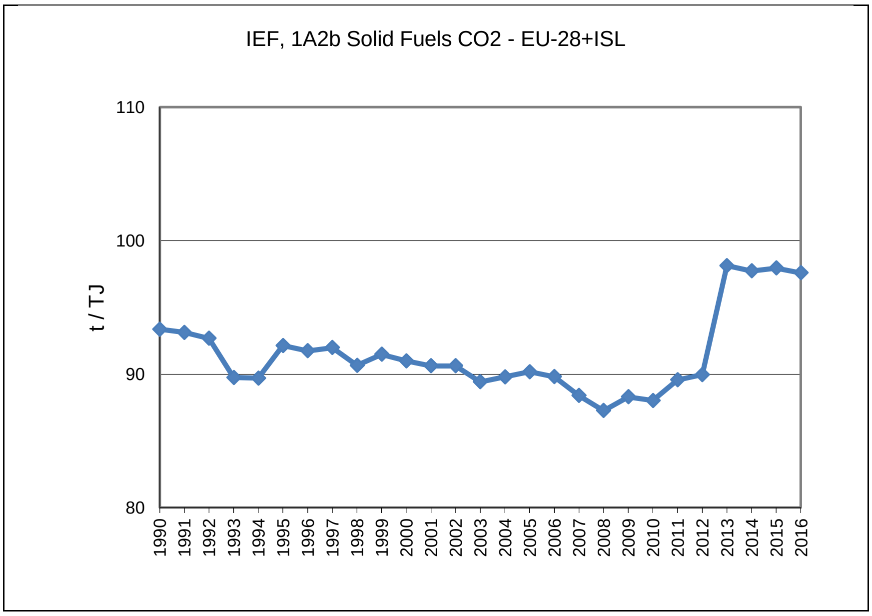
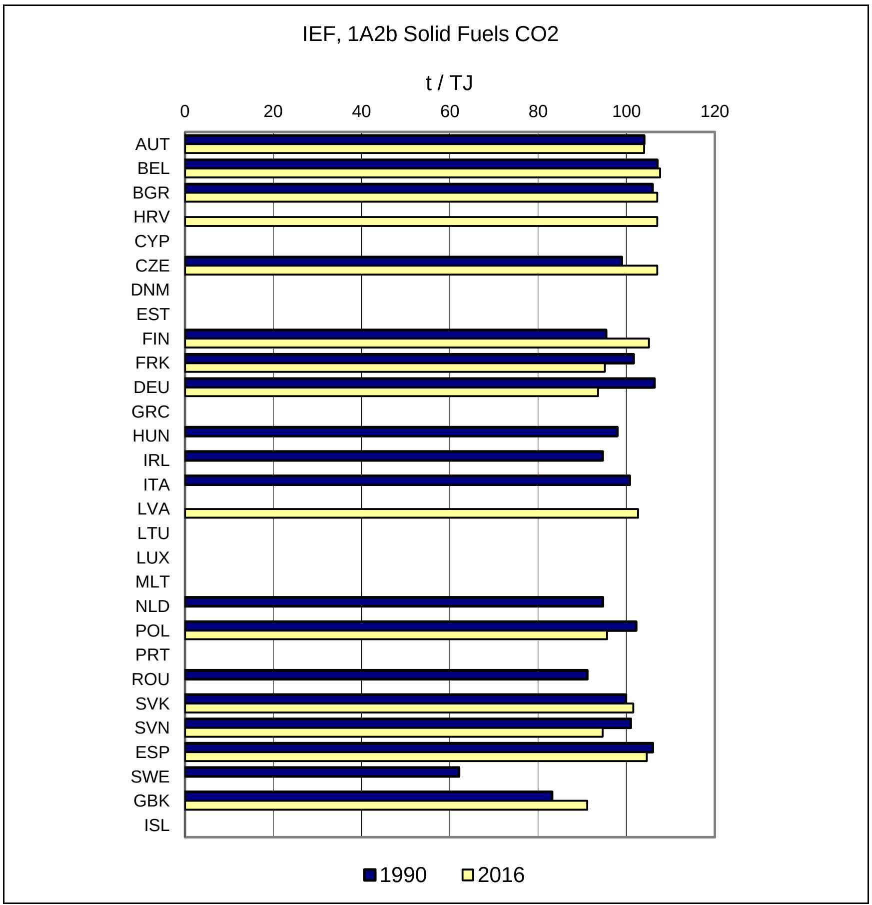


Figure 3.41: 1A2b Non-ferrous Metals, solid fuels: Implied Emission Factors for CO_2 (in t/TJ)





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

In 2016 CO_2 from gaseous fuels had a share of 77% within source category 1A2b (compared to 24% in 1990). Between 1990 and 2016 the emissions increased by 71% (Table 3.30). Between 1990 and 2016 the highest absolute increases occurred in Ireland, Greece, Italy and Spain. For confidentiality reasons Germany reports emissions in 1A2g. Sweden reports 2013 to 2015 emissions as confidential. According to the methodology as described in chapter 3.2.2 about 87% of EU-28 emissions are calculated by using higher tier methods in 2016.

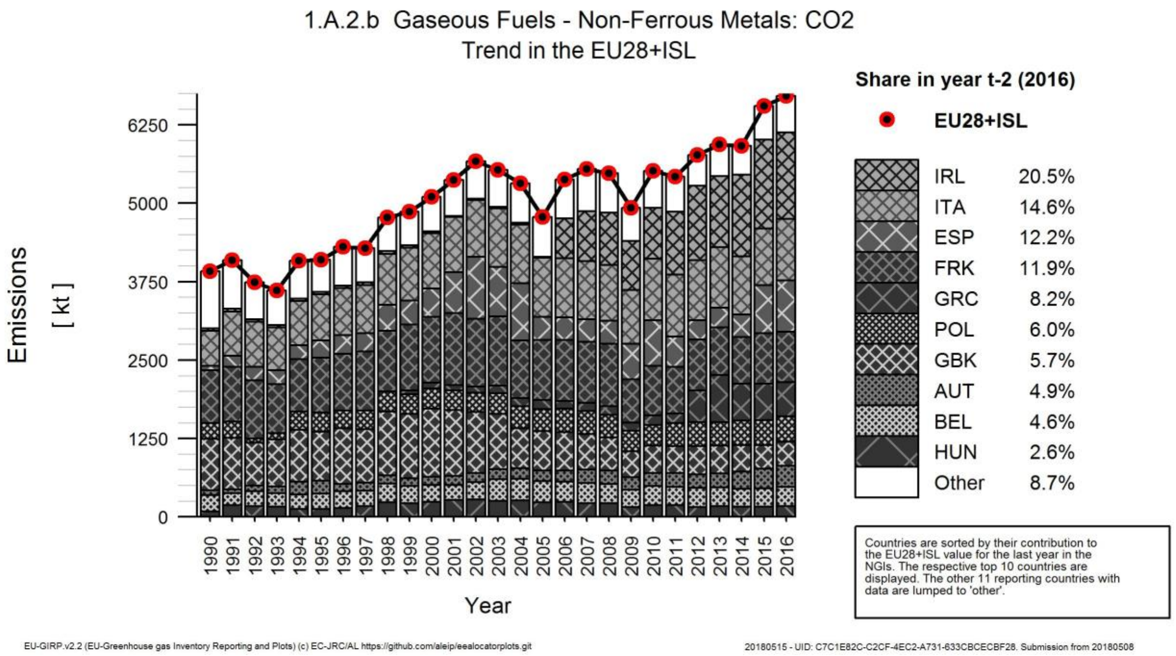
Table 3.30 1A2b Non-ferrous Metals, Gaseous fuels: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016		Method	Emission factor Informa-tion
	1990	2015	2016		kt CO2	%	kt CO2	%		
Austria	75	310	332	5.0%	257	343%	22	7%	T2	CS
Belgium	261	290	307	4.6%	46	18%	16	6%	T1	D
Bulgaria	23	76	75	1.1%	52	221%	-1	-1%	T2	CS
Croatia	IE	5	5	0.1%	5	∞	0	1%	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czech Republic	53	93	123	1.8%	70	132%	30	33%	T2	CS
Denmark	NO	NO	NO	-	-	-	-	-	NA	NA
Estonia	NO	NO	3	0.0%	3	∞	3	∞	T2	CS
Finland	NO	3	3	0.0%	3	∞	0	-11%	T3	CS
France	841	809	799	11.9%	-42	-5%	-10	-1%	T2,T3	CS,PS
Germany	IE	IE	IE	-	-	-	-	-	NA	NA
Greece	NO	578	550	8.2%	550	∞	-28	-5%	T2	CS
Hungary	87	165	175	2.6%	88	101%	10	6%	T1	D
Ireland	39	1 413	1 379	20.6%	1 340	3475%	-35	-2%	T2	CS
Italy	558	905	983	14.7%	425	76%	78	9%	T2	CS
Latvia	NO	3	2	0.0%	2	∞	-1	-39%	T2	CS
Lithuania	NO	NO	NO	-	-	-	-	-	NA	NA
Luxembourg	13	50	51	0.8%	37	278%	1	2%	T2	CS
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	213	158	158	2.4%	-56	-26%	0	0%	T2	CS
Poland	254	402	401	6.0%	147	58%	0	0%	T2	CS
Portugal	IE	IE	IE	-	-	-	-	-	NA	NA
Romania	IE	IE	IE	-	-	-	-	-	NA	NA
Slovakia	435	72	68	1.0%	-366	-84%	-3	-4%	T2	CS
Slovenia	164	77	80	1.2%	-83	-51%	3	4%	T2	CS
Spain	72	764	820	12.2%	749	1045%	56	7%	T2	CS
Sweden	10	C	16	0.2%	6	56%	16	∞	T2	CS
United Kingdom	819	377	385	5.7%	-435	-53%	8	2%	T2	CS
EU-28	**3 908**	**6 550**	**6 699**	**100%**	**2 791**	**71%**	**148**	**2%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	819	377	385	5.7%	-435	-53%	8	2%	T2	CS
EU-28 + ISL	**3 908**	**6 550**	**6 699**	**100%**	**2 791**	**71%**	**148**	**2%**	**-**	**-**

From 1990 to 2000 Croatia includes emissions under 1.A.2.g.
Portugal includes emissions under 1A2g Romania includes emissions under 1A2a. Germany reported emissions under 1A2g other (unspecified industrial power plants) because of confidential data.
EU trends in this table do not include Sweden for confidentiality reasons and to preserve time series consistency for the EU. This also explains the differences between the numbers in this table and the CRF.
Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

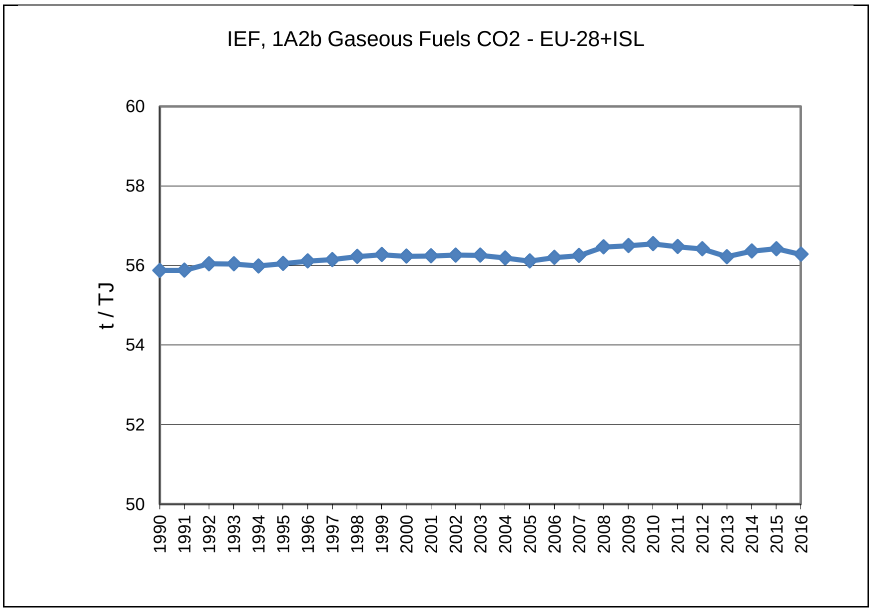
Figure 3.42 and Figure 3.43 show CO_2 emissions and implied emission factors for EU-28+ISL and the Member States as well as the share of the Member States with the highest contributions. The largest emissions are reported by France, Ireland, Spain and Italy; together they cause around 59% of the CO_2 emissions in 2016 from gaseous fuels in 1A2b. Consumption of gaseous fuels rose by 70% between 1990 and 2016. The jump in 2006 is mainly due to Ireland which reports a high increase in 2006 and Spain which reports a high decrease in 2005. The CO_2-implied emission factor for gaseous fuels was 56.3 t/TJ in 2016.

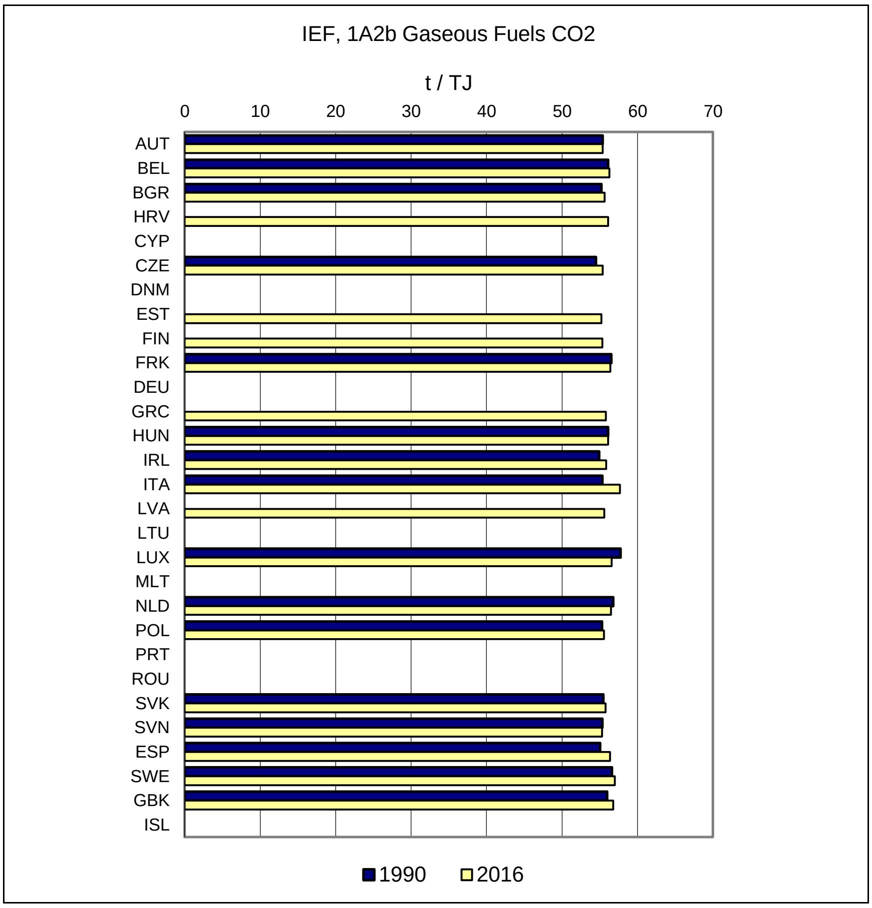
Figure 3.42   1A2b Non-ferrous Metals, Gaseous fuels: Emission trend and share for CO_2



Note: This figure does include Sweden. This also explains the differences between the share of countries in this figure and the table on MS contributions.

Figure 3.43 1A2b Non-ferrous Metals, Gaseous fuels: Implied Emission Factors for CO_2 (in t/TJ)



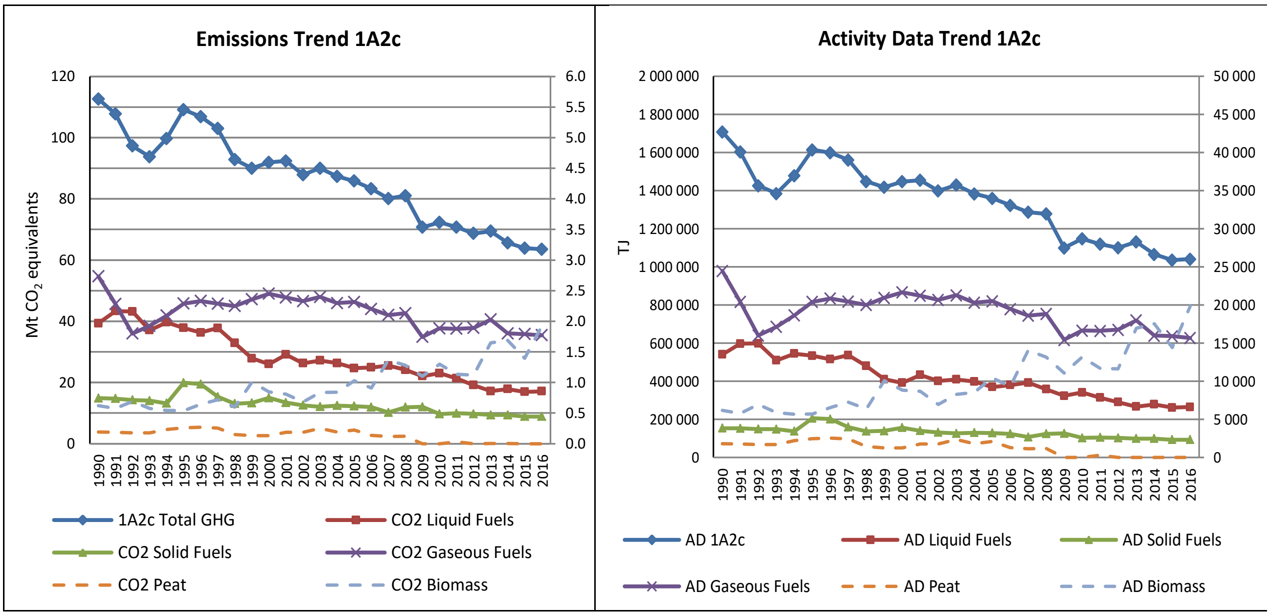


3.2.2.3 Chemicals (1A2c)

In this chapter information is provided about emission trends, Member States contribution and activity data for category 1A2c on a fuel base. GHG emissions from 1A2c Chemicals accounted for 13.4% of 1A2 category and 1.5% of total GHG emissions in 2016.

Figure 3.44 shows the emission trend of category 1A2c, which is mainly dominated by CO_2 emissions from liquid and gaseous fuels. Total emissions decreased by 44%, mainly due to decreases in emissions from liquid (-56%) and gaseous (-35%) fuels.

Figure 3.44 1A2c Chemicals: Total and CO_2 emission and activity trends



Data displayed as dashed line refers to the secondary axis.

Between 1990 and 2016, CO_2 emissions from 1A2c Chemicals decreased by 44% in the EU-28+ISL (Table 3.31), mainly due to decreases in France, Italy, Romania, the Netherlands and the United Kingdom; Poland and Spain reported substantial emission increases in this period. Between 2015 and 2016 emissions decreased substantially in France and Spain while emissions from the Netherlands and Italy increased substantially.

Table 3.31 1A2c Chemicals: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016		Method	Emission factor Informa-tion
	1990	2015	2016		kt CO2	%	kt CO2	%		
Austria	892	1 468	1 378	2.2%	486	55%	-90	-6%	T1,T2	CS,D
Belgium	4 786	3 112	3 138	5.0%	-1 648	-34%	26	1%	T1,T3	D,PS
Bulgaria	966	348	380	0.6%	-586	-61%	32	9%	T1,T2	CS,D
Croatia	NO,IE	294	296	0.5%	296	∞	2	1%	T1	D
Cyprus	2	6	6	0.0%	4	187%	0	0%	T1	D
Czech Republic	2 996	1 391	1 350	2.1%	-1 647	-55%	-42	-3%	T1,T2	CS,D
Denmark	328	396	358	0.6%	30	9%	-38	-10%	T1,T2,T3	CS,D
Estonia	806	34	8	0.0%	-798	-99%	-26	-76%	T1,T2	CS,D
Finland	1 245	735	787	1.2%	-458	-37%	52	7%	T3	CS,D
France	15 171	11 621	10 840	17.2%	-4 331	-29%	-781	-7%	T2,T3	CS,PS
Germany	IE,NA	IE,NA	IE,NA	-	-	-	-	-	NA	NA
Greece	808	444	92	0.1%	-716	-89%	-352	-79%	T2	CS
Hungary	1 540	340	431	0.7%	-1 109	-72%	92	27%	T1	D
Ireland	410	266	275	0.4%	-135	-33%	9	3%	T2	CS
Italy	19 424	7 927	8 493	13.5%	-10 931	-56%	566	7%	T2	CS
Latvia	303	27	31	0.0%	-272	-90%	3	12%	T2	CS,D
Lithuania	399	307	292	0.5%	-107	-27%	-14	-5%	T2	CS
Luxembourg	170	154	164	0.3%	-6	-4%	10	6%	T1,T2	CS,D
Malta	NO,IE	NO,IE	NO,IE	-	-	-	-	-	NA	NA
Netherlands	17 276	11 661	12 832	20.4%	-4 444	-26%	1 172	10%	T2	CS,D
Poland	4 016	5 994	5 969	9.5%	1 953	49%	-25	0%	T1,T2	CS,D
Portugal	1 346	1 029	1 045	1.7%	-301	-22%	17	2%	T2	CR,D
Romania	17 871	2 019	1 620	2.6%	-16 251	-91%	-399	-20%	T1,T2	CS,D
Slovakia	2 652	483	502	0.8%	-2 150	-81%	18	4%	T2	CS
Slovenia	209	71	71	0.1%	-138	-66%	1	1%	T1,T2	CS,D
Spain	5 322	7 203	6 432	10.2%	1 111	21%	-770	-11%	T2	CS,OTH,PS
Sweden	1 149	1 035	1 249	2.0%	100	9%	214	21%	T2	CS
United Kingdom	12 077	5 001	5 001	7.9%	-7 076	-59%	0	0%	T2	CS
EU-28	**112 165**	**63 364**	**63 041**	**100%**	**-49 123**	**-44%**	**-323**	**-1%**	**-**	**-**
Iceland	7	NO	NO	-	-7	-100%	-	-	NA	NA
United Kingdom (KP)	12 077	5 001	5 001	7.9%	-7 076	-59%	0	0%	T2	CS
EU-28 + ISL	**112 172**	**63 364**	**63 041**	**100%**	**-49 131**	**-44%**	**-323**	**-1%**	**-**	**-**

From 1990 to 2000 Croatia includes emissions under 1.A.2.g.
Emissions of Germany and Malta are included in 1A2g.
Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

1A2c Chemicals - Liquid Fuels (CO_2)

In 2016, CO_2 from liquid fuels had a share of 27% within source category 1A2c (compared to 35% in 1990). Between 1990 and 2016 CO_2 emissions decreased by 56% (Table 3.32). Most Member States reported decreasing CO_2 emissions from this source category with Italy, France, Spain and the United Kingdom showing the highest reduction in absolute terms. Germany and Malta include emissions under 1A2g. According to the methodology as described in chapter 3.2.2 about 80% of EU-28 emissions are calculated by using higher tier methods in 2016.

Table 3.32 1A2c Chemicals, Liquid fuels: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016		Method	Emission factor Informa-tion
	1990	2015	2016		kt CO2	%	kt CO2	%		
Austria	93	61	58	0.3%	-34	-37%	-3	-4%	T2	CS
Belgium	1 852	164	153	0.9%	-1 699	-92%	-11	-7%	T1	D
Bulgaria	857	41	93	0.5%	-764	-89%	52	128%	T1	D
Croatia	IE	9	12	0.1%	12	∞	3	28%	T1	D
Cyprus	2	6	6	0.0%	4	187%	0	0%	T1	D
Czech Republic	175	126	42	0.2%	-133	-76%	-84	-67%	T1	D
Denmark	211	17	2	0.0%	-208	-99%	-15	-86%	T1,T2	CS,D
Estonia	13	27	6	0.0%	-7	-55%	-21	-79%	T1,T2	CS,D
Finland	731	686	701	4.1%	-30	-4%	15	2%	T3	CS
France	6 266	3 521	2 929	17.1%	-3 338	-53%	-593	-17%	T2,T3	CS,PS
Germany	IE	IE	IE	-	-	-	-	-	NA	NA
Greece	639	56	59	0.3%	-580	-91%	3	6%	T2	CS
Hungary	380	3	3	0.0%	-377	-99%	0	-2%	T1	D
Ireland	131	81	83	0.5%	-48	-37%	2	2%	T2	CS
Italy	11 218	2 248	2 249	13.1%	-8 969	-80%	1	0%	T2	CS
Latvia	279	9	9	0.1%	-271	-97%	0	-5%	T2	CS
Lithuania	69	2	2	0.0%	-67	-98%	-1	-26%	T2	CS
Luxembourg	112	17	19	0.1%	-93	-83%	2	9%	T1,T2	CS,D
Malta	IE	IE	IE	-	-	-	-	-	NA	NA
Netherlands	6 493	6 312	7 286	42.6%	794	12%	974	15%	T2	CS,D
Poland	306	636	622	3.6%	315	103%	-15	-2%	T1	D
Portugal	1 308	681	719	4.2%	-589	-45%	38	6%	T2	CR,D
Romania	NO	610	504	2.9%	504	∞	-106	-17%	T1,T2	D
Slovakia	51	5	7	0.0%	-44	-86%	2	52%	T2	CS
Slovenia	32	12	13	0.1%	-18	-58%	1	9%	T1	D
Spain	2 852	670	368	2.2%	-2 483	-87%	-302	-45%	T2	CS
Sweden	861	857	1 074	6.3%	212	25%	216	25%	T2	CS
United Kingdom	4 392	93	92	0.5%	-4 300	-98%	-1	-1%	T2	CS
EU-28	**39 322**	**16 953**	**17 111**	**100%**	**-22 211**	**-56%**	**157**	**1%**	**-**	**-**
Iceland	7	NO	NO	-	-7	-100%	-	-	NA	NA
United Kingdom (KP)	4 392	93	92	0.5%	-4 300	-98%	-1	-1%	T2	CS
EU-28 + ISL	**39 330**	**16 953**	**17 111**	**100%**	**-22 219**	**-56%**	**157**	**1%**	**-**	**-**

From 1990 to 2000 Croatia includes emissions under 1.A.2.g.
Emissions of Germany and Malta are included in 1A2g
Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

Figure 3.45 and Figure **3.45** show CO_2 emissions and implied emission factors for EU-28+ISL as well as the share of the Member States with the highest contributions. The largest contributions are reported by France, the Netherlands and Italy; together they cause around 73% of the CO_2 emissions from liquid fuels in 1A2c. Liquid fuel combustion in decreased by 51% between 1990 and 2016. The decline in 1999 is due to the strong decrease reported by Italy. The CO_2-implied emission factor for liquid fuels was 64.6 t/TJ in 2016. Lower implied emissions factors are associated with a high share of refinery gas used within this sector.

Figure 3.45 1A2c Chemicals, Liquid fuels: Emission trend and share for CO_2

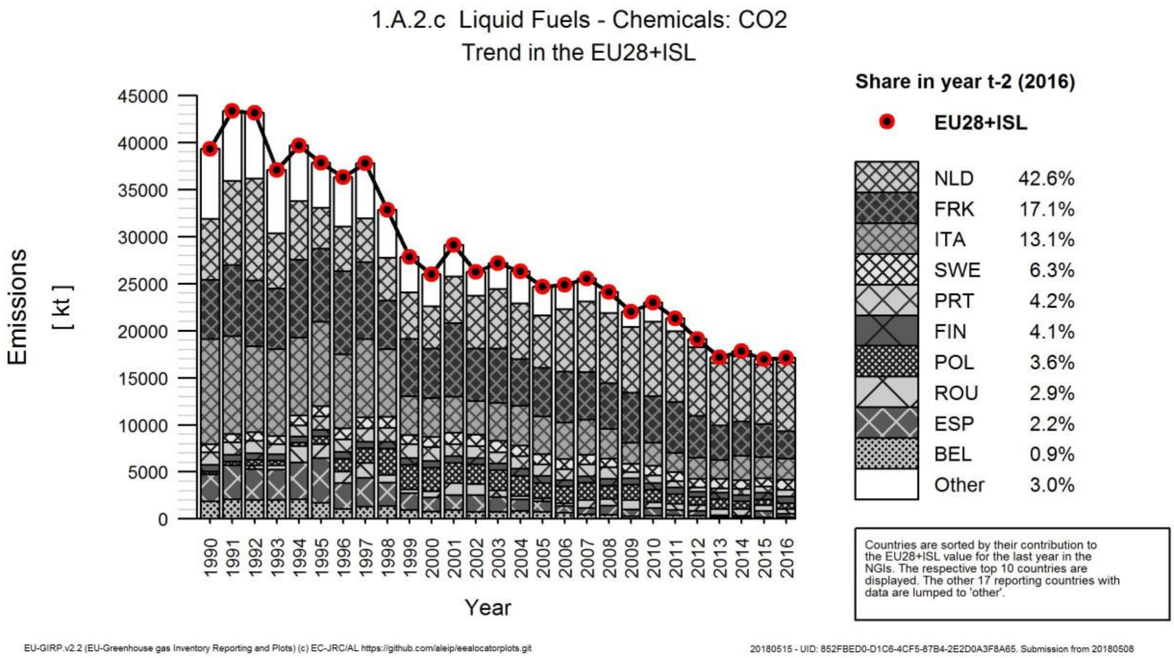
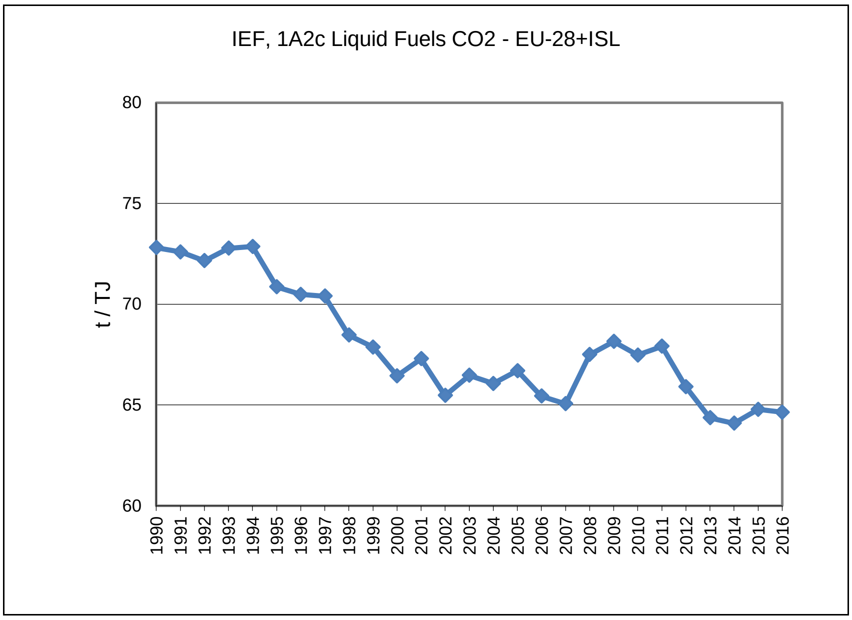
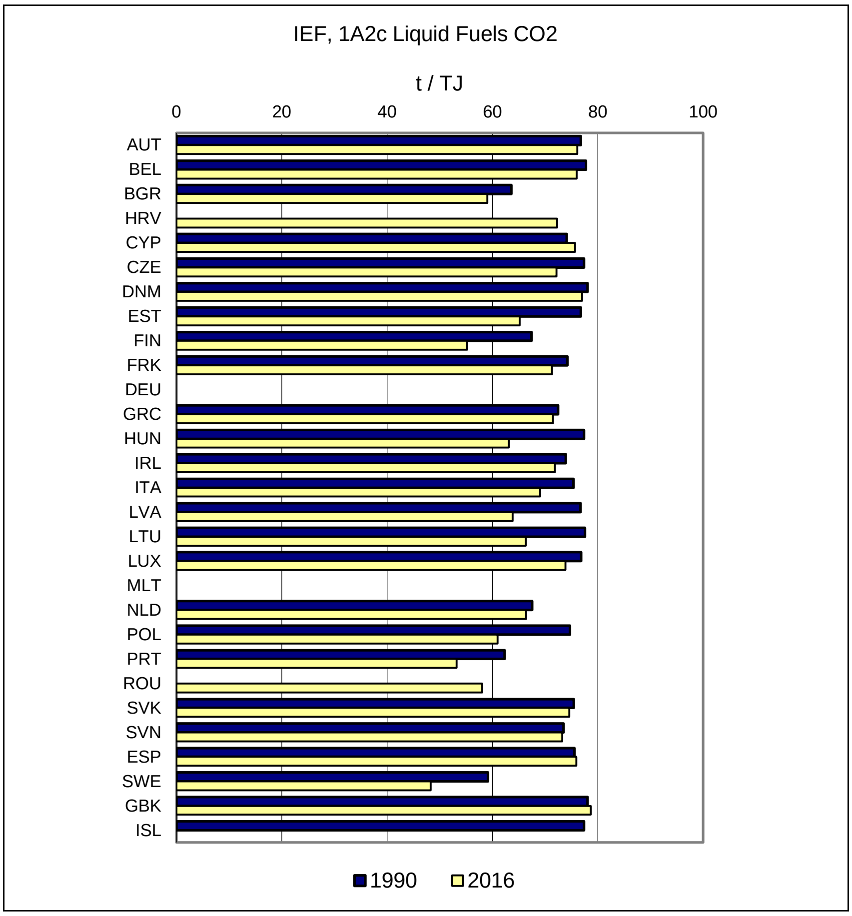


Figure 3.46 1A2c Chemicals, Liquid fuels: Implied Emission Factors for CO_2 (in t/TJ)





1A2c Chemicals - Solid Fuels (CO_2)

In 2016, solid fuels had a share of 14% within source category 1A2c (compared to 13% in 1990). Between 1990 and 2016 CO_2 emissions decreased by 40% (Table 3.33). In absolute terms the Czech Republic, Slovakia, the Netherlands and the United Kingdom reported a significant decrease during this period while Poland reported a significant increase. Germany includes emissions from this source category in source category 1A2g. Sweden reports 2013 to 2015 emissions and activity data as confidential and for other years it reports emissions from peat together with solid fuels (for confidential reasons). According to the methodology as described in chapter 3.2.2 about 93% of EU-28 emissions are calculated by using higher tier methods in 2016.

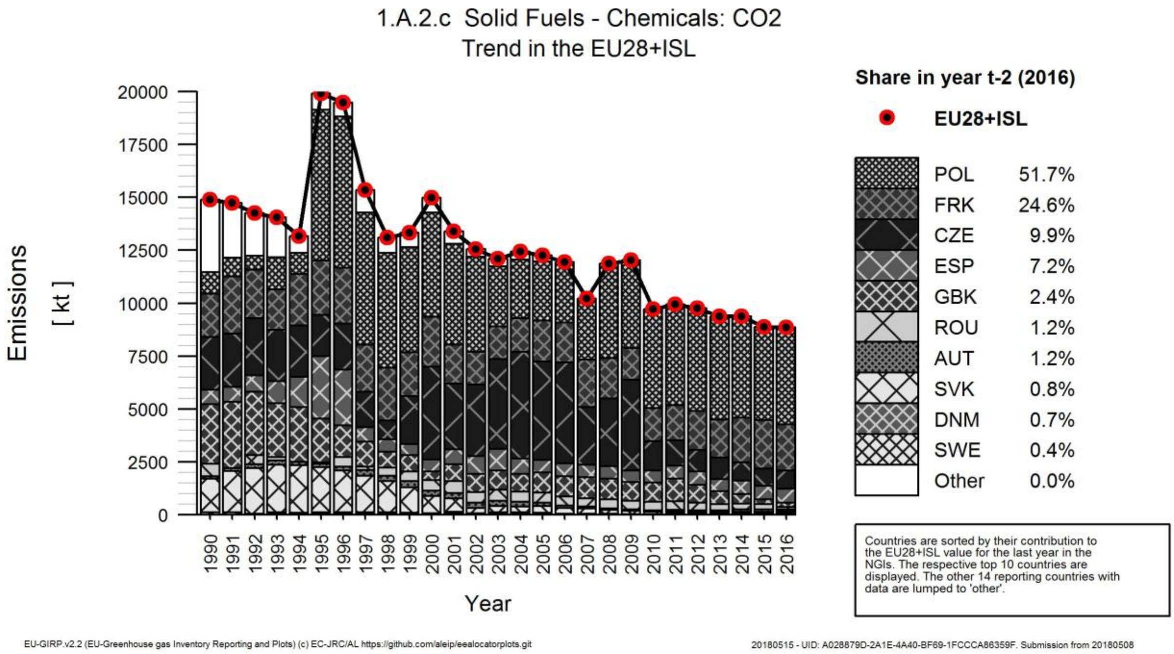
Table 3.33 1A2c Chemicals, Solid fuels: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016		Method	Emission factor Informa-tion
	1990	2015	2016		kt CO2	%	kt CO2	%		
Austria	106	103	105	1.2%	-1	-1%	2	2%	T2	CS
Belgium	402	3	3	0.0%	-399	-99%	0	-11%	T1	D
Bulgaria	79	15	NO	-	-79	-100%	-15	-100%	NA	NA
Croatia	NO	NO	NO	-	-	-	-	-	NA	NA
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czech Republic	2 487	812	880	10.0%	-1 607	-65%	68	8%	T2	CS,D
Denmark	7	76	59	0.7%	53	811%	-17	-22%	T1	D
Estonia	626	NO	NO	-	-626	-100%	-	-	NA	NA
Finland	214	NO	NO	-	-214	-100%	-	-	NA	NA
France	2 043	2 284	2 179	24.7%	135	7%	-106	-5%	T2,T3	CS,PS
Germany	IE	IE	IE	-	-	-	-	-	NA	NA
Greece	169	NO	NO	-	-169	-100%	-	-	NA	NA
Hungary	96	NO	NO	-	-96	-100%	-	-	NA	NA
Ireland	72	NO	NO	-	-72	-100%	-	-	NA	NA
Italy	640	3	NO	-	-640	-100%	-3	-100%	NA	NA
Latvia	NO	NO	NO	-	-	-	-	-	NA	NA
Lithuania	NO	NO	NO	-	-	-	-	-	NA	NA
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	1 087	NO	NO	-	-1 087	-100%	-	-	NA	NA
Poland	1 027	4 398	4 583	51.9%	3 556	346%	185	4%	T1,T2	CS,D
Portugal	39	NO	NO	-	-39	-100%	-	-	NA	NA
Romania	581	249	107	1.2%	-474	-82%	-142	-57%	T1,T2	CS,D
Slovakia	1 584	73	72	0.8%	-1 511	-95%	-1	-1%	T2	CS
Slovenia	1	NO	NO	-	-1	-100%	-	-	NA	NA
Spain	691	647	640	7.2%	-51	-7%	-7	-1%	T2	CS,PS
Sweden	127	C	32	0.4%	-96	-75%	32	∞	T2	CS
United Kingdom	2 815	227	209	2.4%	-2 606	-93%	-17	-8%	T2	CS
EU-28	**14 765**	**8 890**	**8 837**	**100%**	**-5 928**	**-40%**	**-53**	**-1%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	2 815	227	209	2.4%	-2 606	-93%	-17	-8%	T2	CS
EU-28 + ISL	**14 765**	**8 890**	**8 837**	**100%**	**-5 928**	**-40%**	**-53**	**-1%**	**-**	**-**

Emissions of Germany are included in 1A2g.
EU trends in this table do not include Sweden for confidentiality reasons and to preserve time series consistency for the EU. This also explains the differences between the numbers in this table and the CRF.
Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

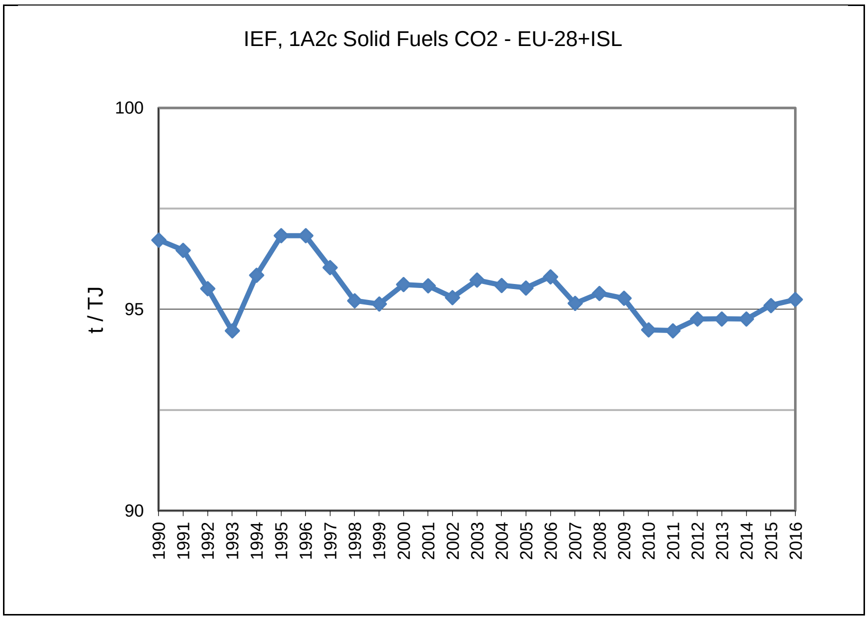
Figure 3.47 and Figure 3.48 show CO_2 emissions and implied emission factors for EU-28+ISL as well as the share of the Member States with the highest contributions. The largest emissions are reported by Poland, the Czech Republic, France and Spain; together they cause 93% of the CO_2 emissions from solid fuels in 1A2c. Solid fuel combustion decreased by 40% between 1990 and 2016. The CO_2-implied emission factor for solid fuels was 95.2 t/TJ in 2016. The high implied emission factor for Estonia is due to the use of oil shale generator gas which has a high carbon content.

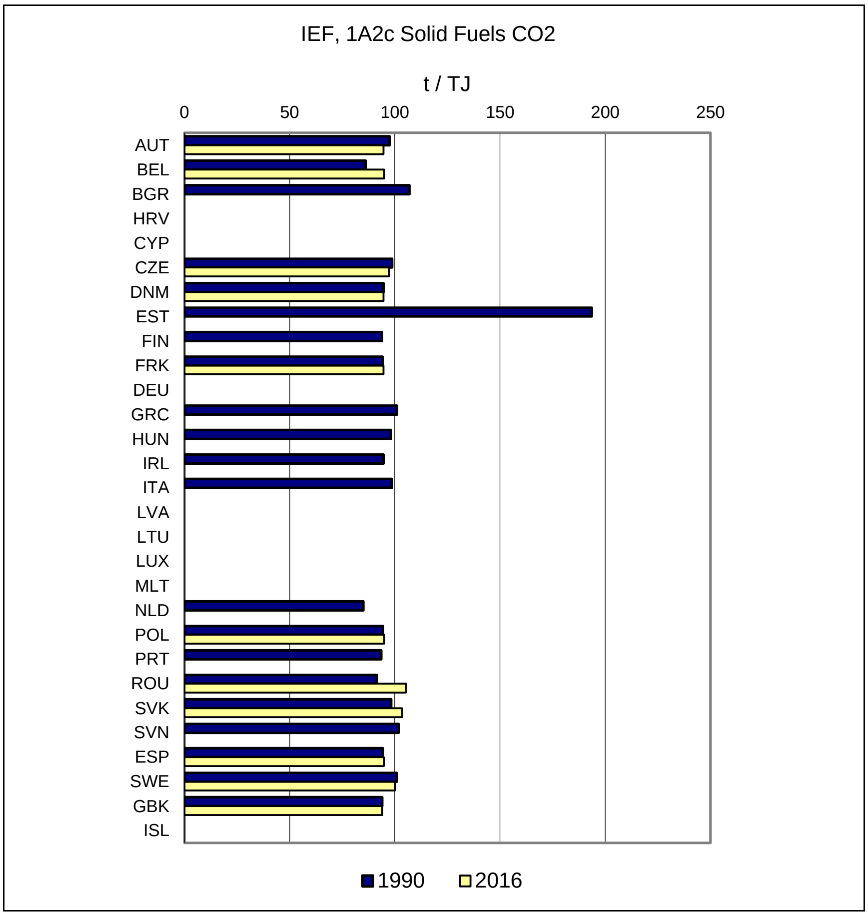
Figure 3.47 1A2c Chemicals, Solid fuels: Emission trend and share for CO_2



Note: This figure does include Sweden. This also explains the differences between the share of countries in this figure and the table on MS contributions.

Figure 3.48 1A2c Chemicals, Solid fuels: Implied Emission Factors for CO_2 (in t/TJ)





1A2c Chemicals – Gaseous Fuels (CO_2)

In 2016, CO_2 from gaseous fuels had a share of 56% within source category 1A2c (compared to 49% in 1990). Between 1990 and 2016, CO_2 emissions decreased by 35% (Table 3.34). Between 1990 and 2016 Italy, France, the Netherlands and Romania reported substantial decreases while the highest increase occurred in Spain. Germany includes emissions from this source category in source category 1A2g. According to the methodology as described in chapter 3.2.2 about 92% of EU-28 emissions are calculated by using higher tier methods in 2016.

Table 3.34 1A2c Chemicals, gaseous fuels: Member States' contributions to CO_2

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016		Method	Emission factor Informa-tion
	1990	2015	2016		kt CO2	%	kt CO2	%		
Austria	519	983	984	2.8%	466	90%	1	0%	T2	CS
Belgium	2 532	2 930	2 968	8.4%	436	17%	38	1%	T1,T3	D,PS
Bulgaria	30	293	287	0.8%	257	851%	-5	-2%	T2	CS
Croatia	IE	285	285	0.8%	285	∞	0	0%	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czech Republic	334	453	428	1.2%	94	28%	-25	-6%	T2	CS
Denmark	111	303	297	0.8%	186	168%	-6	-2%	T3	CS
Estonia	167	7	2	0.0%	-165	-99%	-4	-66%	T2	CS
Finland	99	32	72	0.2%	-26	-27%	41	128%	T3	CS
France	6 387	4 772	4 571	12.9%	-1 816	-28%	-201	-4%	T2,T3	CS,PS
Germany	IE	IE	IE	-	-	-	-	-	NA	NA
Greece	NO	388	33	0.1%	33	∞	-355	-92%	T2	CS
Hungary	1 064	335	426	1.2%	-638	-60%	91	27%	T1	D
Ireland	207	185	192	0.5%	-15	-7%	7	4%	T2	CS
Italy	7 566	5 675	6 244	17.6%	-1 322	-17%	568	10%	T2	CS
Latvia	24	18	22	0.1%	-2	-8%	4	20%	T2	CS
Lithuania	331	305	291	0.8%	-40	-12%	-14	-5%	T2	CS
Luxembourg	57	137	145	0.4%	87	152%	8	6%	T2	CS
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	9 696	5 348	5 546	15.7%	-4 150	-43%	198	4%	T2	CS
Poland	293	826	670	1.9%	378	129%	-156	-19%	T2	CS
Portugal	NO	348	326	0.9%	326	∞	-22	-6%	T2	CR,D
Romania	17 290	1 093	954	2.7%	-16 336	-94%	-138	-13%	T2	CS
Slovakia	989	390	406	1.1%	-583	-59%	17	4%	T2	CS
Slovenia	176	58	58	0.2%	-118	-67%	0	0%	T2	CS
Spain	1 780	5 886	5 424	15.3%	3 645	205%	-461	-8%	T2	CS
Sweden	155	91	88	0.2%	-67	-43%	-3	-3%	T2	CS
United Kingdom	4 870	4 681	4 700	13.3%	-170	-3%	19	0%	T2	CS
EU-28	**54 677**	**35 820**	**35 420**	**100%**	**-19 257**	**-35%**	**-401**	**-1%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	4 870	4 681	4 700	13.3%	-170	-3%	19	0%	T2	CS
EU-28 + ISL	**54 677**	**35 820**	**35 420**	**100%**	**-19 257**	**-35%**	**-401**	**-1%**	**-**	**-**

From 1990 to 2000 Croatia includes emissions under 1.A.2.g.
Emissions of Germany are included in 1A2g.
Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

Figure 3.49 and Figure 3.50 show CO_2 emissions and implied emission factors for EU-28+ISL as well as the share of the Member States with the highest contributions. The largest emissions are reported by France, Italy, the Netherlands, Spain and the United Kingdom; together they cause 75% of the CO_2 emissions from gaseous fuels in 1A2c. Gaseous fuel consumption in the EU-28 decreased by 36% between 1990 and 2016. The CO_2-implied emission factor for gaseous fuels was 56.5 t/TJ in 2016.

Figure 3.49   1A2c Chemicals, Gaseous fuels: Emission trend and share for CO_2

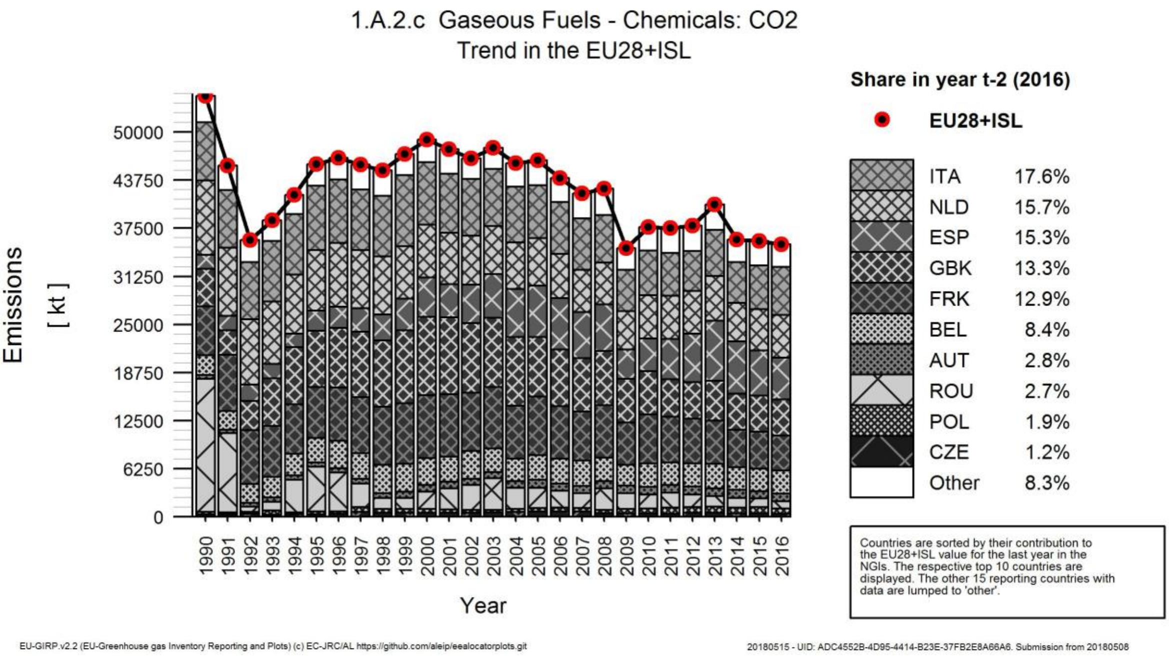
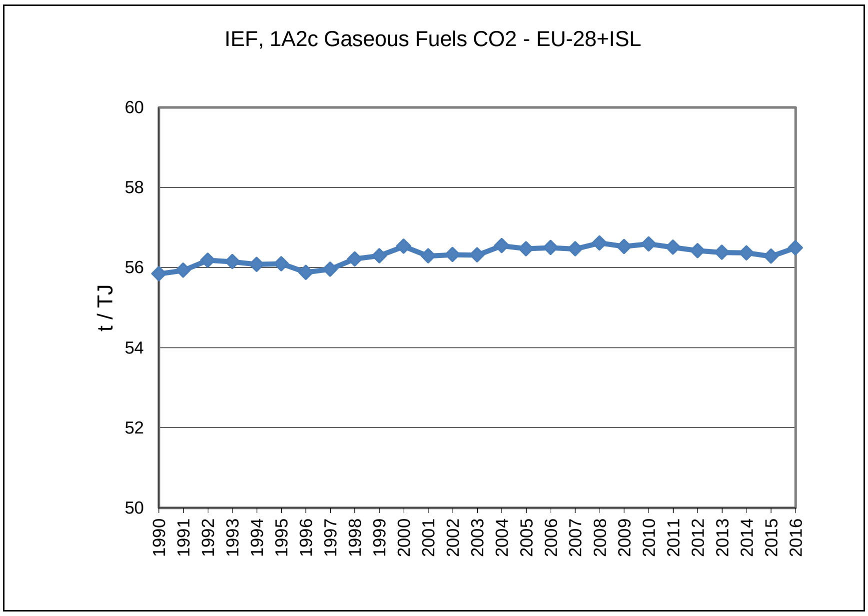
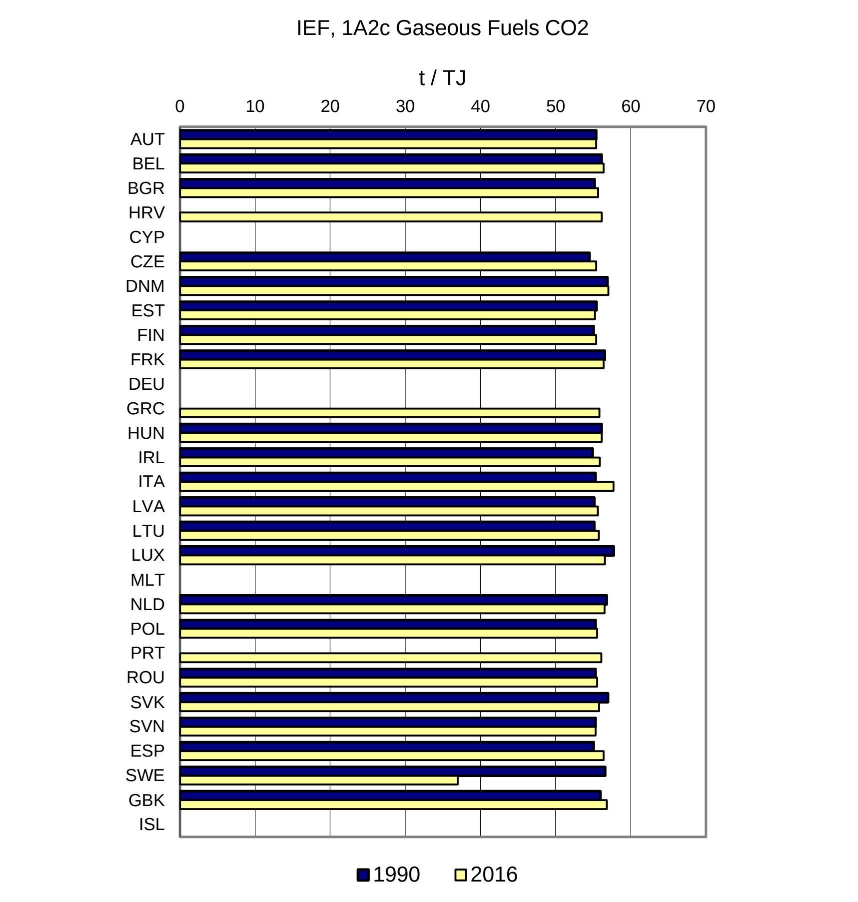


Figure 3.50 1A2c Chemicals, Gaseous fuels: Implied Emission Factors for CO_2 (in t/TJ)





1A2c Chemicals - Other Fossil Fuels (CO_2)

In 2016, CO_2 from other fossil fuels had a share of 3% within source category 1A2c (compared to 3% in 1990). Between 1990 and 2016, the emissions decreased by 47% (Table 3.35). Most Member States reported emissions as 'Not occurring'. Germany includes emissions in 1A2g. The major absolute increase was reported by France while Poland reports a significant decrease of emissions. Sweden reports 2013 to 2015 emissions as confidential.

Table 3.35 1A2c Chemicals, other fossil fuels: Member States' contributions to CO_2

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016		Method	Emission factor Informa-tion
	1990	2015	2016		kt CO2	%	kt CO2	%		
Austria	174	320	230	14.5%	56	32%	-90	-28%	T2	CS
Belgium	IE	14	14	0.9%	14	∞	0	-1%	T3	PS
Bulgaria	NO	NO	NO	-	-	-	-	-	NA	NA
Croatia	NO	NO	NO	-	-	-	-	-	NA	NA
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czech Republic	NO	NO	NO	-	-	-	-	-	NA	NA
Denmark	NO	NO	NO	-	-	-	-	-	NA	NA
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	11	17	14	0.9%	3	32%	-3	-19%	T3	CS
France	474	1 044	1 162	73.2%	687	145%	118	11%	T2,T3	CS,PS
Germany	IE	IE	IE	-	-	-	-	-	NA	NA
Greece	NO	NO	NO	-	-	-	-	-	NA	NA
Hungary	NO	1	2	0.2%	2	∞	1	70%	T1	D
Ireland	NO	NO	NO	-	-	-	-	-	NA	NA
Italy	NO	NO	NO	-	-	-	-	-	NA	NA
Latvia	NO	NO	NO	-	-	-	-	-	NA	NA
Lithuania	NO	NO	NO	-	-	-	-	-	NA	NA
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	NO	NO	NO	-	-	-	-	-	NA	NA
Poland	2 390	134	93	5.9%	-2 297	-96%	-41	-30%	T1	D
Portugal	NO	0	0	0.0%	0	∞	0	89%	T2	CR,D
Romania	NO	67	55	3.5%	55	∞	-13	-19%	T2	CS
Slovakia	28	15	16	1.0%	-12	-43%	0	2%	T2	CS
Slovenia	1	NO	NO	-	-1	-100%	-	-	NA	NA
Spain	NO	NO	NO	-	-	-	-	-	NA	NA
Sweden	6	C	55	3.5%	50	893%	55	∞	T2	CS
United Kingdom	NO	NO	NO	-	-	-	-	-	NA	NA
EU-28	**3 077**	**1 614**	**1 586**	**100%**	**-1 491**	**-48%**	**-28**	**-2%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	NO	NO	NO	-	-	-	-	-	NA	NA
EU-28 + ISL	**3 077**	**1 614**	**1 586**	**100%**	**-1 491**	**-48%**	**-28**	**-2%**	**-**	**-**

Emissions of Germany are included in 1A2g.
The numbers for 2015 for EU-28 and EU-28 + ISL in this table differ from the numbers in the respective CRF tables because the EU CRF includes under "Other fossil fuels" CO_2 emissions from solid fuels reported by Sweden as confidential. These emissions are not reflected in this table in order to preserve time series consistency.
Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

Figure 3.52 Figure 3.53 and show CO_2 emissions and implied emission factor for EU-28+ISL as well as the share of the Member States with the highest contributions. 71% of CO_2 emissions are reported by France; Other fuel consumption in the EU-28 decreased by 47% between 1990 and 2016. The CO_2-implied emission factor for other fossil fuels was 45.2 t/TJ in 2016. The strong drop in the implied emission factor 1997 to 1998 is due to the strong drop in emissions from Poland which uses the IPCC default value (143 t/TJ) while emissions from 1998 onwards are dominated by France which uses a country specific methodology (IEFs between 38 to 54 t/TJ). The drop in the IEF in 2016 is also mainly caused by France which dominates EU-28 emissions in 2016.

In general the high variance of the emission factors is caused by the use of country specific emission factors which are considerably lower than the IPCC default value (143 t/TJ) and the different type of fuels which are considered in this category (e.g. 'waste gas' from chemical bulk production).

Figure 3.51: 1A2c Chemicals, Gaseous fuels: Implied Emission Factors for CO_2 (in t/TJ)

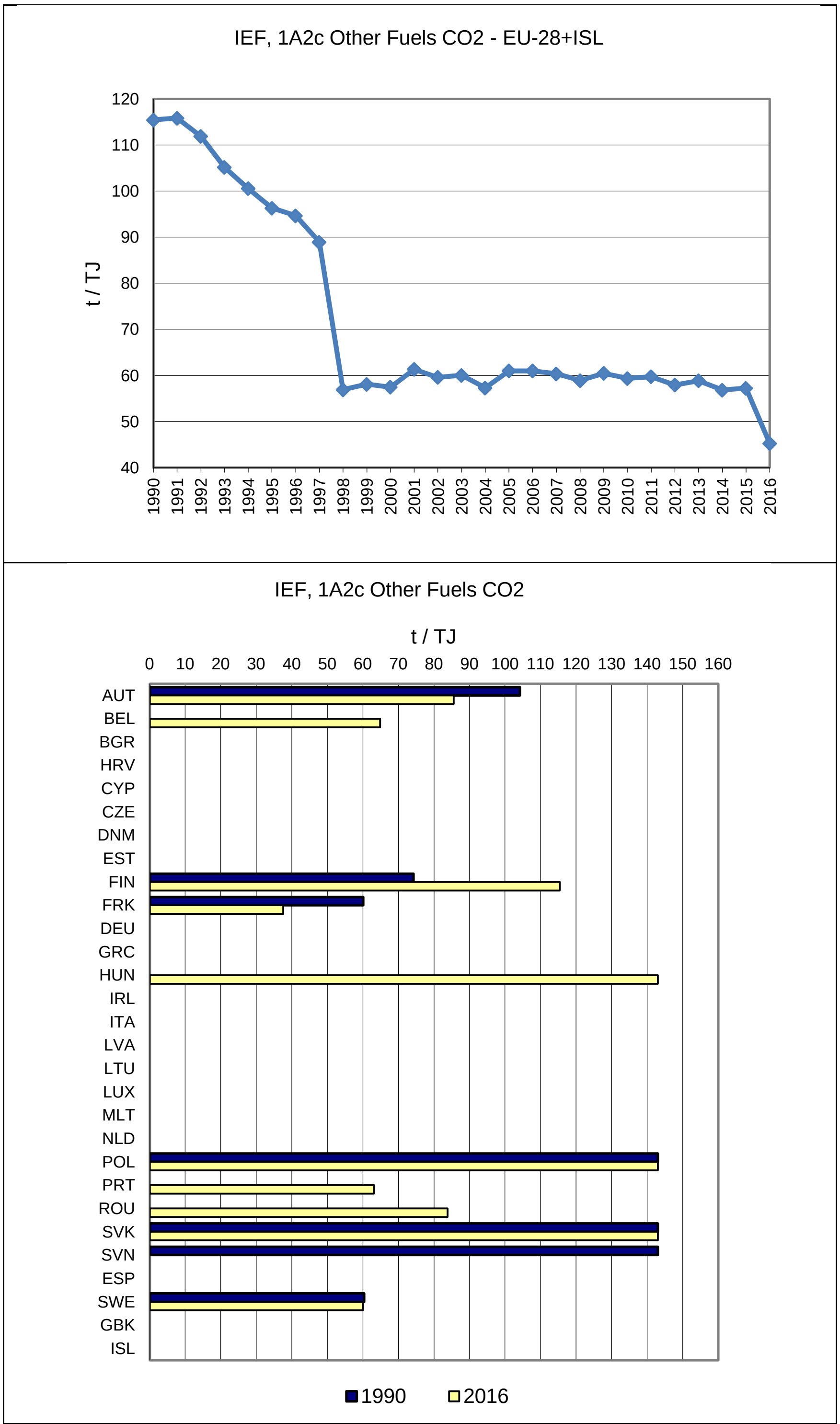
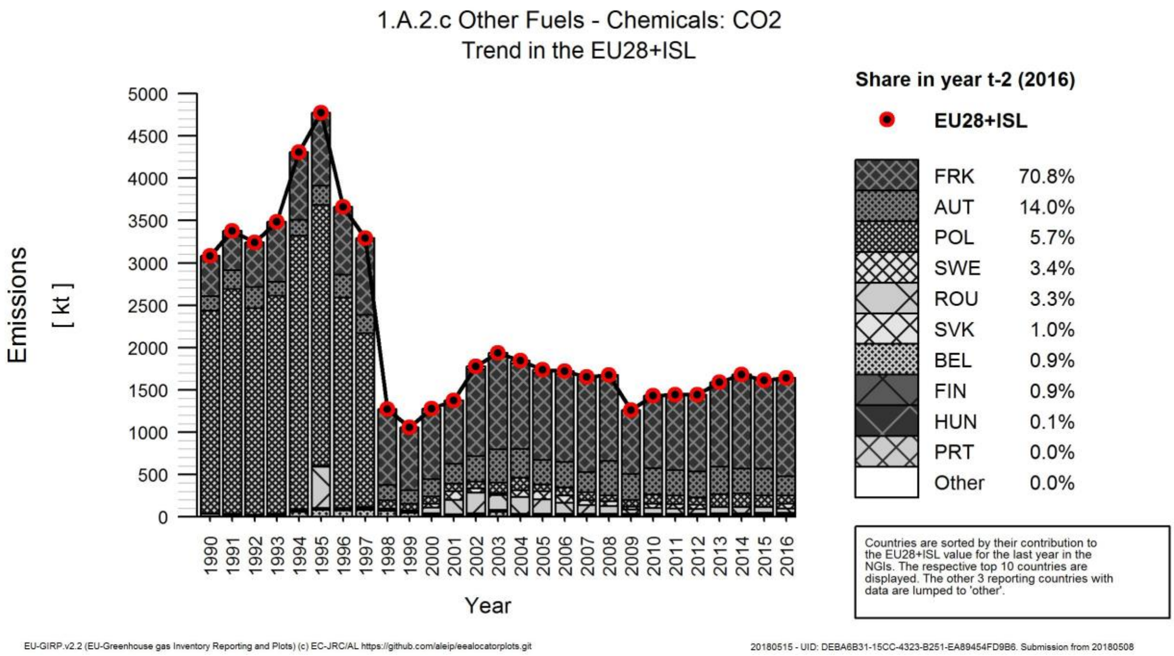


Figure 3.52 1A2c Chemicals, Other fossil fuels: Emission trend and share for CO_2



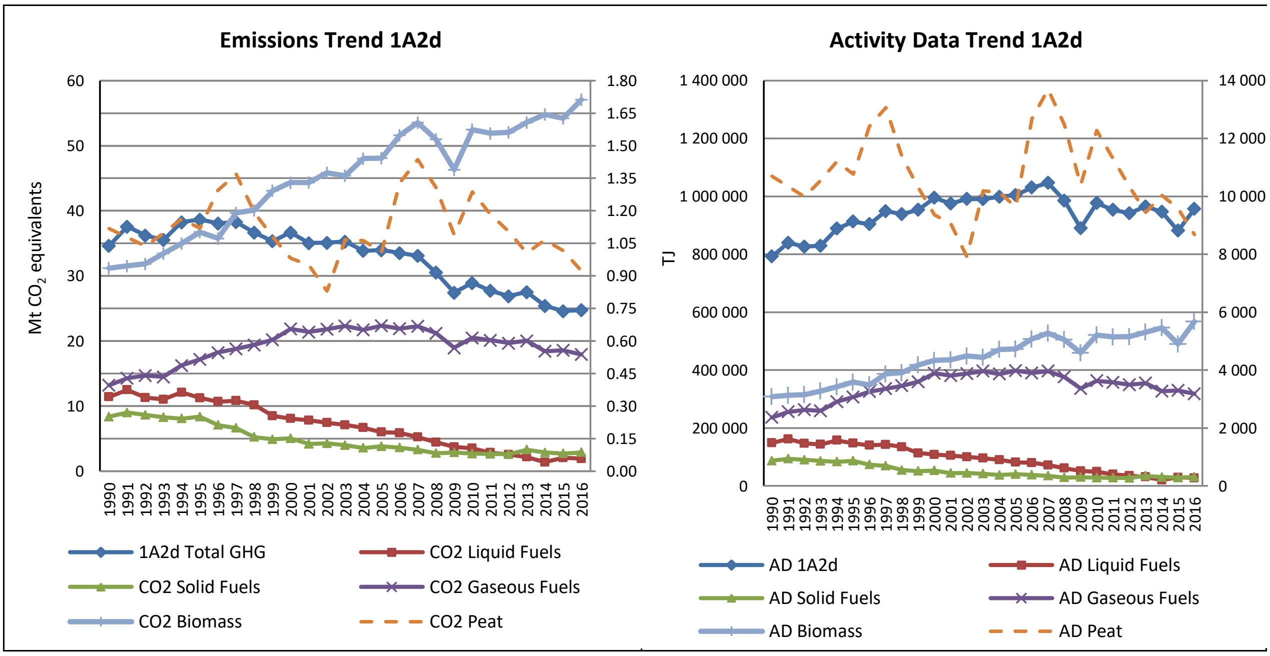
Note: This figure does include Sweden. This also explains the differences between the share of countries in this figure and the table on MS contributions.

3.2.2.4 Pulp, Paper and Print (1A2d)

In this chapter information about emission trends, Member States contribution and activity data is provided for category 1A2d by fuels. GHG emissions from 1A2d Pulp, Paper and Print accounted for 5.2% of 1A2 source category and 0.6% of total GHG emissions in 2016.

Figure 3.53 shows the emission trend within the category 1A2d, which is mainly dominated by CO_2 emissions from gaseous fuels. Total GHG emissions decreased by 29%. The share of gaseous fuels is gradually increasing from 1990 to 2007 and slightly decreasing since the year 2010. This sector includes a high amount of biomass consumption which is also gradually increasing since 1990. The activity data shows a strong switch from liquid and solid fuels to gaseous fuels and biomass.

Figure 3.53 1A2d Pulp, Paper and Print: Total and CO2 emission and activity trends



Data displayed as dashed line refers to the secondary axis.

Note that total CO_2 emissions in the figure on the left hand side do not include CO_2 from biomass whereas total activity data in the figure on the right hand side includes AD biomass.

Between 1990 and 2016, CO_2 emissions from 1A2d Pulp, Paper and Print decreased by 27% (Table 3.36), mainly due to decreases in the Czech Republic, Finland, France, Slovakia and the United Kingdom. Between 2015 and 2016 emissions decreased by 0.6%. Between 1990 and 1999 Luxembourg reported emissions as included elsewhere and between 1990 to 2000 Croatia and from 1990 onwards Malta reported emissions as ‘Included elsewhere’. Sweden reports 2015 emissions as confidential.

Table 3.36 1A2d Pulp, Paper and Print: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016		Method	Emission factor Informa-tion
	1990	2015	2016		kt CO2	%	kt CO2	%		
Austria	2 214	1 834	1 692	7.3%	-522	-24%	-142	-8%	T1,T2	CS,D
Belgium	644	614	609	2.6%	-35	-5%	-6	-1%	T1,T3	D,PS
Bulgaria	16	111	117	0.5%	101	652%	6	5%	T1,T2	CS,D
Croatia	NO,IE	70	105	0.5%	105	∞	35	51%	T1	D
Cyprus	5	3	3	0.0%	-2	-35%	0	0%	T1	D
Czech Republic	2 285	441	404	1.7%	-1 881	-82%	-37	-8%	T1,T2	CS,D
Denmark	337	75	58	0.3%	-278	-83%	-16	-22%	T1,T2,T3	CS,D
Estonia	NO	14	25	0.1%	25	∞	11	82%	T1,T2	CS,D
Finland	5 330	2 680	2 647	11.4%	-2 682	-50%	-33	-1%	T3	CS,D
France	4 661	2 604	2 560	11.0%	-2 100	-45%	-43	-2%	T2	CS
Germany	4	6	4	0.0%	1	21%	-2	-27%	CS	CS
Greece	306	104	80	0.3%	-226	-74%	-25	-24%	T2	CS
Hungary	74	144	424	1.8%	350	471%	280	194%	T1,T3	D,PS
Ireland	28	15	16	0.1%	-12	-43%	1	5%	T2	CS
Italy	3 079	4 662	4 039	17.4%	960	31%	-623	-13%	T2	CS
Latvia	169	6	5	0.0%	-163	-97%	0	-5%	T2	CS
Lithuania	255	22	29	0.1%	-226	-89%	7	33%	T2	CS
Luxembourg	NO,IE	5	6	0.0%	6	∞	1	25%	T2	CS
Malta	NO,IE	NO,IE	NO,IE	-	-	-	-	-	NA	NA
Netherlands	1 669	879	872	3.7%	-797	-48%	-7	-1%	T2	CS
Poland	285	1 587	1 526	6.6%	1 241	435%	-61	-4%	T1,T2	CS,D
Portugal	754	1 109	1 205	5.2%	451	60%	96	9%	T2	CR,D
Romania	NO	156	177	0.8%	177	∞	21	13%	T1,T2	CS,D
Slovakia	2 329	476	402	1.7%	-1 927	-83%	-74	-16%	T2	CS
Slovenia	380	312	306	1.3%	-74	-19%	-6	-2%	T1,T2,T3	CS,D,PS
Spain	2 577	3 698	3 836	16.5%	1 259	49%	138	4%	T2	CS,OTH,PS
Sweden	2 187	C	719	3.1%	-1 468	-67%	719	∞	T2	CS
United Kingdom	4 599	2 357	2 130	9.1%	-2 469	-54%	-228	-10%	T2	CS
EU-28	**31 999**	**23 985**	**23 279**	**100%**	**-8 720**	**-27%**	**-706**	**-3%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	4 599	2 357	2 130	9.1%	-2 469	-54%	-228	-10%	T2	CS
EU-28 + ISL	**31 999**	**23 985**	**23 279**	**100%**	**-8 720**	**-27%**	**-706**	**-3%**	**-**	**-**

From 1990 to 2000 Croatia includes emissions under 1.A.2.g.
Emissions of Luxembourg, Croatia and Malta are included in 1A2g.
EU trends in this table do not include Sweden for confidentiality reasons and to preserve time series consistency for the EU. This also explains the differences between the numbers in this table and the CRF.
Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

1A2d Pulp, Paper and Print – Liquid Fuels (CO_2)

In 2016 CO_2 from liquid fuels had a share of 8% within source category 1A2d (compared to 33% in 1990). Between 1990 and 2016 the emissions decreased by 83% (Table 3.37). Between 1990 and 2016 all Member States reported decreasing CO_2 emissions from this source category except Croatia, Luxembourg (emissions were IE in 1990), Estonia, Romania and Poland. According to the methodology as described in chapter 3.2.2 about 89% of EU-28 emissions are calculated by using higher tier methods in 2016.

Table 3.37 1A2d Pulp, Paper and Print, Liquid fuels: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016		Method	Emission factor Informa-tion
	1990	2015	2016		kt CO2	%	kt CO2	%		
Austria	853	41	24	1.2%	-829	-97%	-17	-42%	T2	CS
Belgium	235	89	53	2.8%	-181	-77%	-36	-40%	T1,T3	D,PS
Bulgaria	16	NO	NO	-	-16	-100%	-	-	NA	NA
Croatia	IE	16	16	0.9%	16	∞	0	0%	T1	D
Cyprus	5	3	3	0.2%	-2	-35%	0	0%	T1	D
Czech Republic	461	14	3	0.2%	-457	-99%	-11	-76%	T1	CS,D
Denmark	86	1	1	0.0%	-86	-99%	0	30%	T1,T2	CS,D
Estonia	NO	1	1	0.1%	1	∞	0	-6%	T1,T2	CS,D
Finland	1 138	333	354	18.6%	-783	-69%	21	6%	T3	CS
France	1 425	168	152	8.0%	-1 273	-89%	-16	-10%	T2	CS
Germany	IE	IE	IE	-	-	-	-	-	NA	NA
Greece	302	60	60	3.2%	-242	-80%	0	0%	T2	CS
Hungary	19	9	6	0.3%	-13	-68%	-3	-34%	T1	D
Ireland	28	8	8	0.4%	-20	-70%	0	3%	T2	CS
Italy	1 017	251	24	1.2%	-993	-98%	-227	-91%	T2	CS
Latvia	16	0	0	0.0%	-15	-97%	0	0%	T2	CS
Lithuania	69	0	0	0.0%	-68	-99%	0	20%	T2	CS
Luxembourg	IE	0	0	0.0%	0	∞	0	9%	T2	CS
Malta	IE	IE	IE	-	-	-	-	-	NA	NA
Netherlands	2	NO	NO	-	-2	-100%	-	-	NA	NA
Poland	105	139	143	7.5%	38	36%	4	3%	T1	D
Portugal	754	217	238	12.5%	-516	-68%	20	9%	T2	CR,D
Romania	NO	NO	3	0.2%	3	∞	3	∞	NA	NA
Slovakia	985	2	4	0.2%	-981	-100%	1	48%	T2	CS
Slovenia	98	4	4	0.2%	-94	-96%	0	10%	T1	D
Spain	1 247	141	223	11.7%	-1 024	-82%	81	57%	T2	CS,PS
Sweden	1 786	554	578	30.3%	-1 207	-68%	24	4%	T2	CS
United Kingdom	769	7	7	0.4%	-762	-99%	0	0%	T2	CS
EU-28	**11 414**	**2 062**	**1 907**	**100%**	**-9 507**	**-83%**	**-155**	**-8%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	769	7	7	0.4%	-762	-99%	0	0%	T2	CS
EU-28 + ISL	**11 414**	**2 062**	**1 907**	**100%**	**-9 507**	**-83%**	**-155**	**-8%**	**-**	**-**

From 1990 to 2000 Croatia includes emissions under 1.A.2.g.
Emissions of Germany, Luxembourg and Malta are included in 1A2g.
Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

Figure 3.54 and Figure 3.55 show CO_2 emissions and implied emission factors for EU-28+ISL as well as the share of the Member States with the highest contributions. The largest contributions are reported by Finland, France, Portugal, Spain and Sweden; together they cause 81% of the CO_2 emissions from liquid fuels in 1A2d. Fuel consumption in the EU-28 decreased by 82% between 1990 and 2016. The CO_2-implied emission factor for liquid fuels was 70.2t/TJ in 2016. The dip of the 2014 implied emission factors is due to the exclusion of Sweden which reports emissions as confidential for this year.

Figure 3.54 1A2d Pulp, Paper and Print, Liquid fuels: Emission trend and share for CO_2

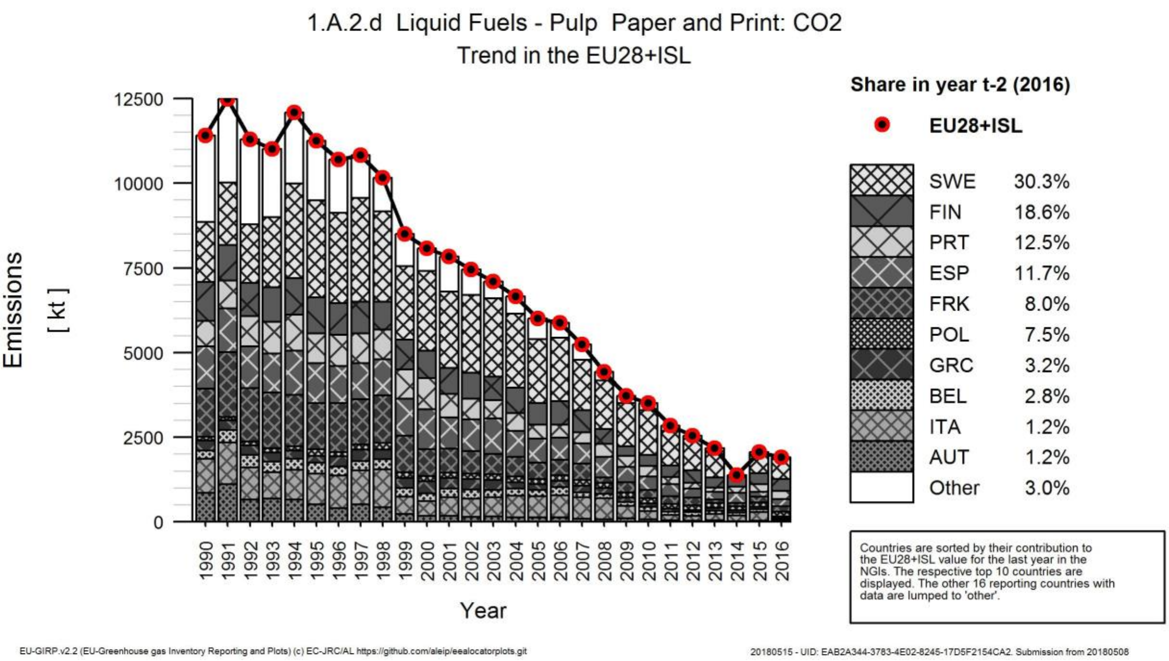
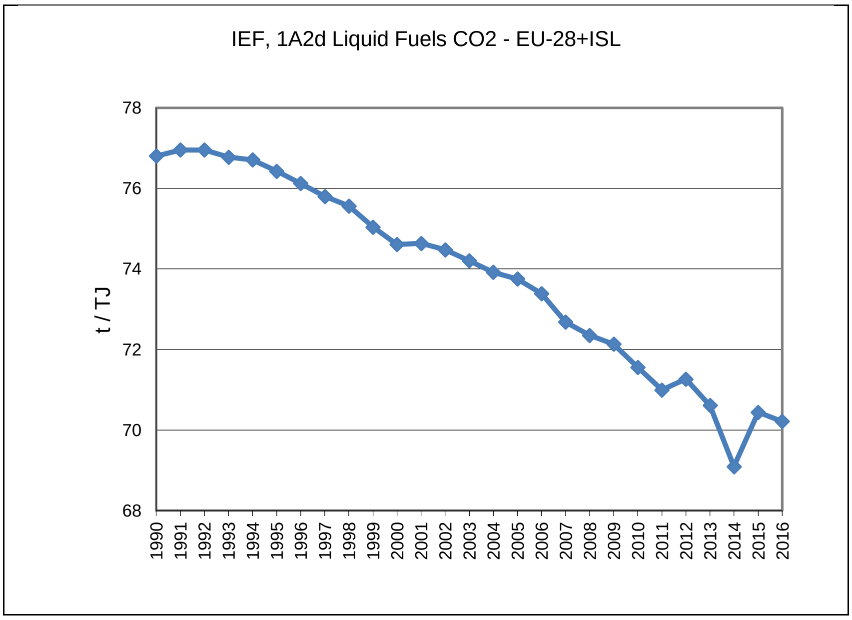
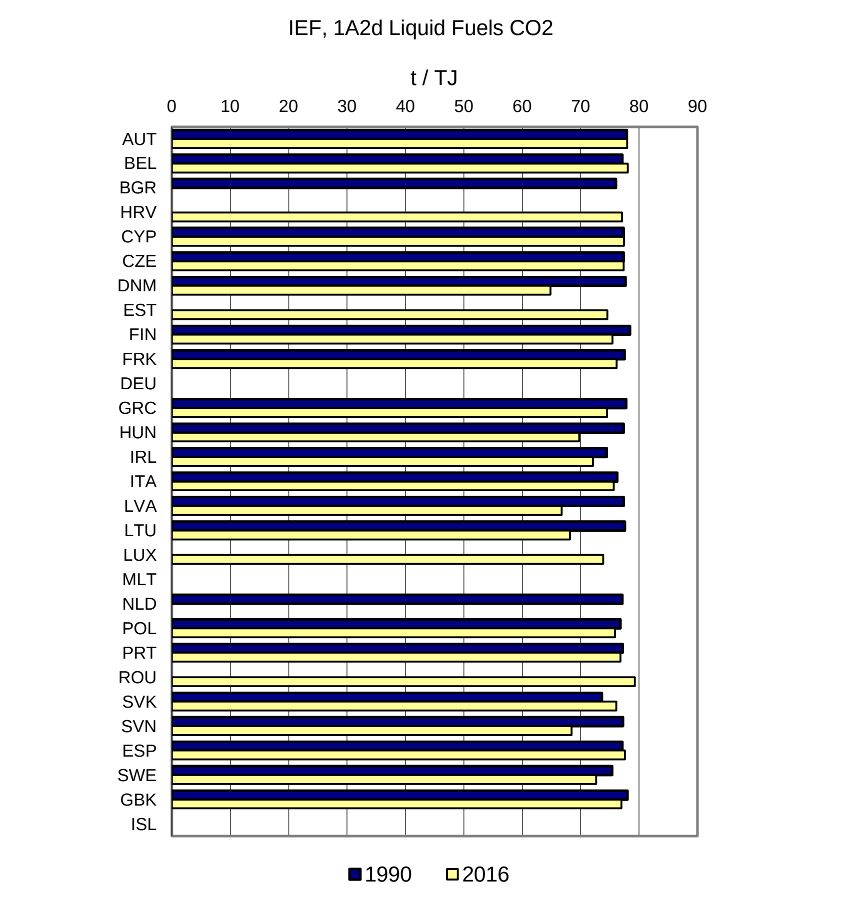


Figure 3.55 1A2d Pulp, Paper and Print, Liquid fuels: Implied Emission Factors for CO_2 (in t/TJ)





1A2d Pulp, Paper and Print - Solid Fuels (CO_2)

In 2016 CO_2 from solid fuels had a share of 12% within source category 1A2d (compared to 24% in 1990). Between 1990 and 2016 CO_2 emissions decreased by 66% (Table 3.38). Only twelve of the EU-28+ISL Member States reported CO_2 emissions from this source category in 2016. All Member States reported decreasing emissions except Poland, Hungary and Bulgaria. Sweden reports 2013 to 2015 emissions as confidential and for other years it reports emissions from peat together with solid fuels (again for confidential reasons). According to the methodology as described in chapter 3.2.2 about 80% of EU-28 emissions are calculated by using higher tier methods in 2016.

Table 3.38 1A2d Pulp, Paper and Print, solid fuels: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016		Method	Emission factor Informa-tion
	1990	2015	2016		kt CO2	%	kt CO2	%		
Austria	398	384	365	12.8%	-33	-8%	-19	-5%	T2	CS
Belgium	128	121	104	3.6%	-24	-19%	-18	-15%	T1	D
Bulgaria	NO	4	7	0.2%	7	∞	3	83%	T1,T2	CS,D
Croatia	NO	NO	NO	-	-	-	-	-	NA	NA
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czech Republic	1 646	146	154	5.4%	-1 492	-91%	7	5%	T2	CS,D
Denmark	125	NO	NO	-	-125	-100%	-	-	NA	NA
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	1 318	153	279	9.8%	-1 038	-79%	126	82%	T3	CS
France	983	130	119	4.2%	-864	-88%	-11	-8%	T2	CS
Germany	IE	IE	IE	-	-	-	-	-	NA	NA
Greece	4	NO	NO	-	-4	-100%	-	-	NA	NA
Hungary	6	NO	288	10.1%	283	5077%	288	∞	T3	PS
Ireland	NO	0	NO	-	-	-	0	-100%	NA	NA
Italy	6	NO	NO	-	-6	-100%	-	-	NA	NA
Latvia	3	NO	0	0.0%	-3	-96%	0	∞	T2	CS
Lithuania	NO	NO	NO	-	-	-	-	-	NA	NA
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	8	NO	NO	-	-8	-100%	-	-	NA	NA
Poland	174	1 034	912	31.9%	737	423%	-122	-12%	T1,T2	CS,D
Portugal	NO	NO	NO	-	-	-	-	-	NA	NA
Romania	NO	NO	NO	-	-	-	-	-	NA	NA
Slovakia	1 142	272	195	6.8%	-947	-83%	-77	-28%	T2	CS
Slovenia	172	121	110	3.8%	-62	-36%	-12	-10%	T3	PS
Spain	277	NO	NO	-	-277	-100%	-	-	NA	NA
Sweden	263	C	22	0.8%	-240	-91%	22	∞	T2	CS
United Kingdom	1 708	335	327	11.4%	-1 381	-81%	-8	-2%	T2	CS
EU-28	**8 096**	**2 700**	**2 859**	**100%**	**-5 237**	**-65%**	**159**	**6%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	1 708	335	327	11.4%	-1 381	-81%	-8	-2%	T2	CS
EU-28 + ISL	**8 096**	**2 700**	**2 859**	**100%**	**-5 237**	**-65%**	**159**	**6%**	**-**	**-**

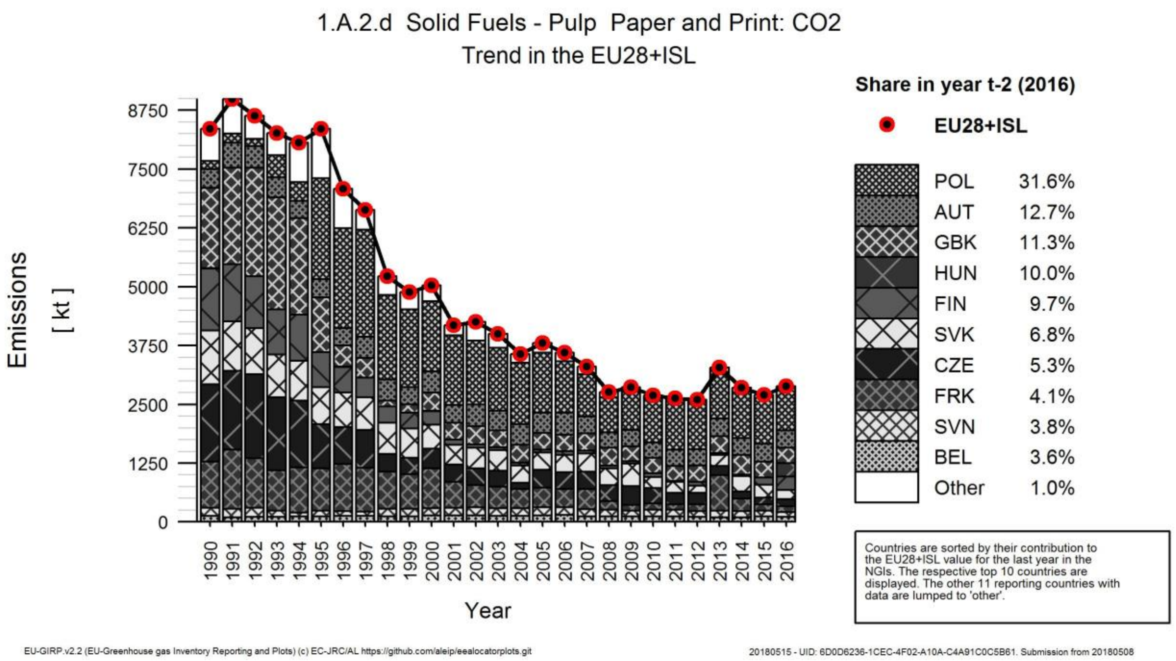
Emissions of Germany are included in 1A2g. Sweden confidential data is included in other solid fuels within the EU inventory.

EU trends in this table do not include Sweden for confidentiality reasons and to preserve time series consistency for the EU. This also explains the differences between the numbers in this table and the CRF.

Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

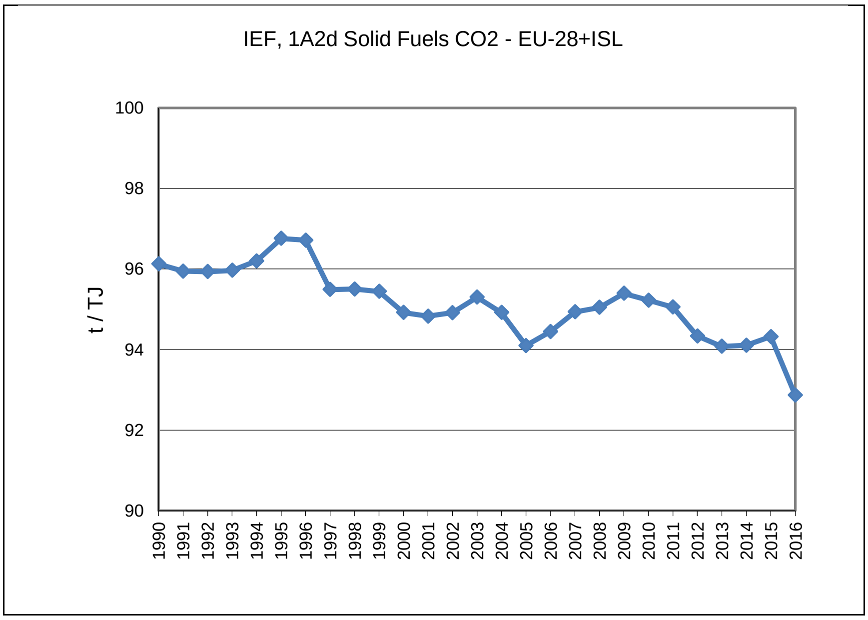
Figure 3.56 and Figure 3.57 1A2d Pulp, Paper and Print, Solid fuels: Implied Emission Factors for CO2 (in t/TJ) show CO_2 emissions and implied emission factors for EU-28+ISL as well as the share of the Member States with the highest contributions. The largest contributions are reported by Austria, Finland, Hungary, Poland and the United Kingdom; together they cause around 75% of CO_2 emissions from solid fuels in 1A2d. Solid fuel consumption decreased by 64% between 1990 and 2016. The CO_2-implied emission factor for solid fuels was 92.9 t/TJ in 2016. The dip in the implied emission factor 2016 is mainly due to Hungary which reports emissions for the years 1990-2001 and 2016 only and which reports a comparatively low implied emission factor for 2016.

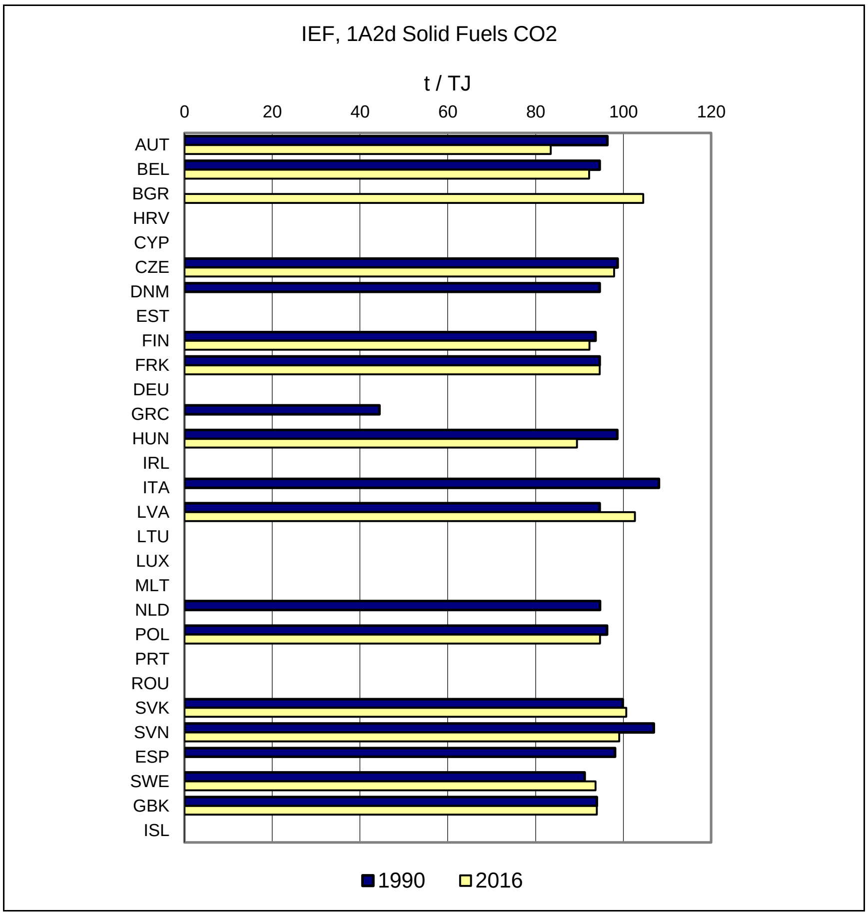
Figure 3.56 1A2d Pulp, Paper and Print, Solid fuels: Emission trend and share for CO_2



Note: This figure does include Sweden. This also explains the differences between the share of countries in this figure and the table on MS contributions.

Figure 3.57 1A2d Pulp, Paper and Print, Solid fuels: Implied Emission Factors for CO_2 (in t/TJ)





1A2d Pulp, Paper and Print - Gaseous Fuels (CO_2)

In 2016, CO_2 from gaseous fuels had a share of 73% within source category 1A2d (compared to 38% in 1990). Between 1990 and 2016, the emissions increased by 36% (Table 3.39). Germany includes emissions in 1A2g. According to the methodology as described in chapter 3.2.2 about 94% of EU-28 emissions are calculated by using higher tier methods in 2016.

Table 3.39 1A2d Pulp, Paper and Print, Gaseous fuels: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016		Method	Emission factor Informa-tion
	1990	2015	2016		kt CO2	%	kt CO2	%		
Austria	943	1 384	1 283	7.1%	340	36%	-101	-7%	T2	CS
Belgium	282	311	358	2.0%	76	27%	47	15%	T1	D
Bulgaria	NO	108	110	0.6%	110	∞	3	3%	T2	CS
Croatia	IE	54	89	0.5%	89	∞	35	66%	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czech Republic	179	281	247	1.4%	68	38%	-33	-12%	T2	CS
Denmark	125	74	58	0.3%	-67	-54%	-16	-22%	T3	CS
Estonia	NO	13	24	0.1%	24	∞	11	89%	T2	CS
Finland	1 757	1 108	1 023	5.7%	-734	-42%	-85	-8%	T3	CS
France	2 253	2 301	2 272	12.7%	19	1%	-29	-1%	T2	CS
Germany	IE	IE	IE	-	-	-	-	-	NA	NA
Greece	NO	44	20	0.1%	20	∞	-25	-56%	T2	CS
Hungary	50	135	98	0.5%	48	96%	-37	-27%	T1	D
Ireland	NO	7	8	0.0%	8	∞	1	8%	T2	CS
Italy	2 056	4 411	4 016	22.4%	1 960	95%	-396	-9%	T2	CS
Latvia	150	5	5	0.0%	-145	-97%	0	-8%	T2	CS
Lithuania	187	21	28	0.2%	-158	-85%	7	33%	T2	CS
Luxembourg	IE	5	6	0.0%	6	∞	1	26%	T2	CS
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	1 659	879	872	4.9%	-787	-47%	-7	-1%	T2	CS
Poland	6	398	444	2.5%	438	7844%	46	11%	T2	CS
Portugal	NO	891	967	5.4%	967	∞	75	8%	T2	CR,D
Romania	NO	155	171	1.0%	171	∞	16	10%	T2	CS
Slovakia	203	186	186	1.0%	-17	-8%	0	0%	T2	CS
Slovenia	110	187	192	1.1%	82	75%	5	3%	T2	CS
Spain	1 053	3 556	3 614	20.1%	2 560	243%	57	2%	T2	CS
Sweden	66	45	64	0.4%	-2	-2%	19	43%	T2	CS
United Kingdom	2 122	2 016	1 796	10.0%	-326	-15%	-220	-11%	T2	CS
EU-28	**13 199**	**18 576**	**17 950**	**100%**	**4 752**	**36%**	**-626**	**-3%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	2 122	2 016	1 796	10.0%	-326	-15%	-220	-11%	T2	CS
EU-28 + ISL	**13 199**	**18 576**	**17 950**	**100%**	**4 752**	**36%**	**-626**	**-3%**	**-**	**-**

From 1990 to 2000 Croatia includes emissions under 1.A.2.g.
Emissions of Germany are included in 1A2g.
Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

Figure 3.58 and Figure 3.59 1A2d Pulp, Paper and Print, Gaseous fuels: Implied Emission Factors for CO2 (in t/TJ)shows CO_2 emissions and implied emission factors for EU-28+ISL as well as the share of the Member States with the highest contributions. The largest emissions are reported by Austria, France, Italy, Spain and the United Kingdom; together they cause 72% of CO_2 emissions from gaseous fuels in 1A2d. Gaseous fuel consumption rose by 33% between 1990 and 2016. The CO_2-implied emission factor for gaseous fuels was 56.5 t/TJ in 2016.

Figure 3.58 1A2d Pulp, Paper and Print, Gaseous fuels: Emission trend and share for CO_2

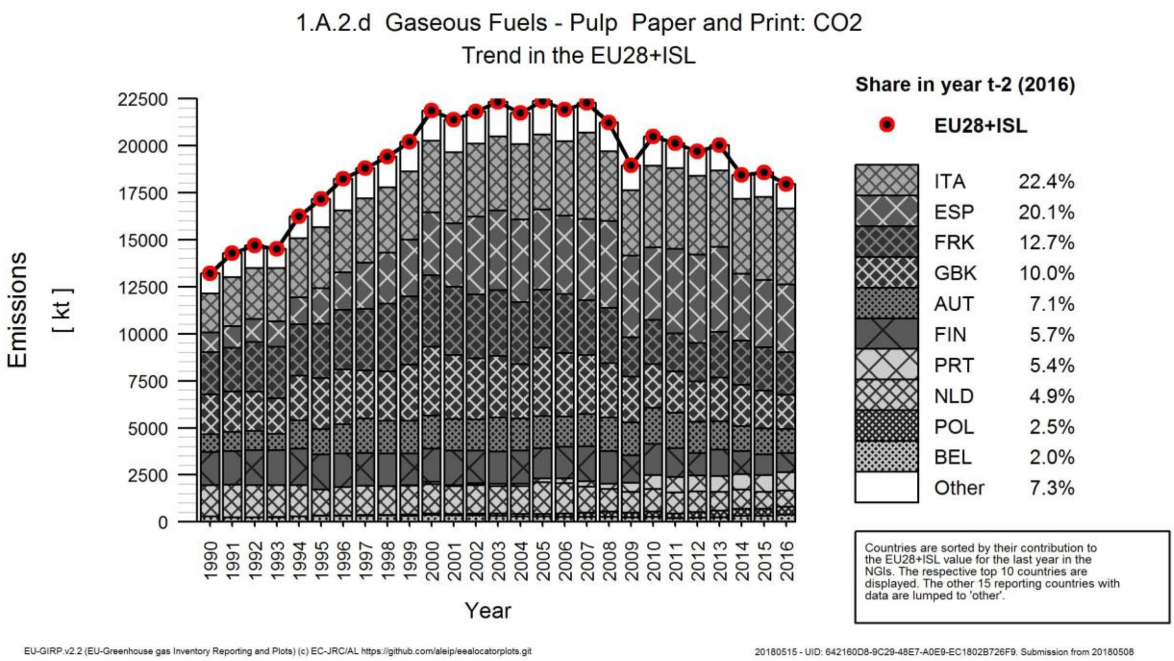
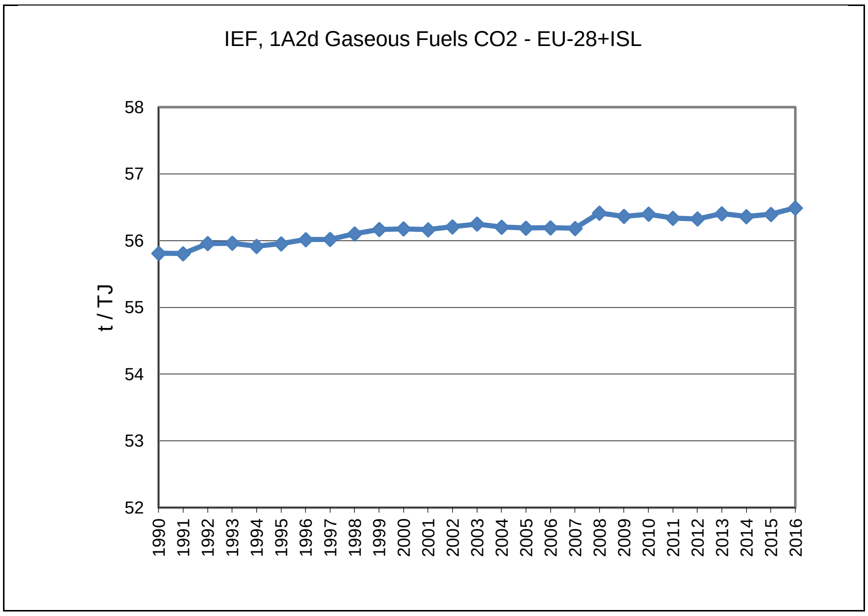
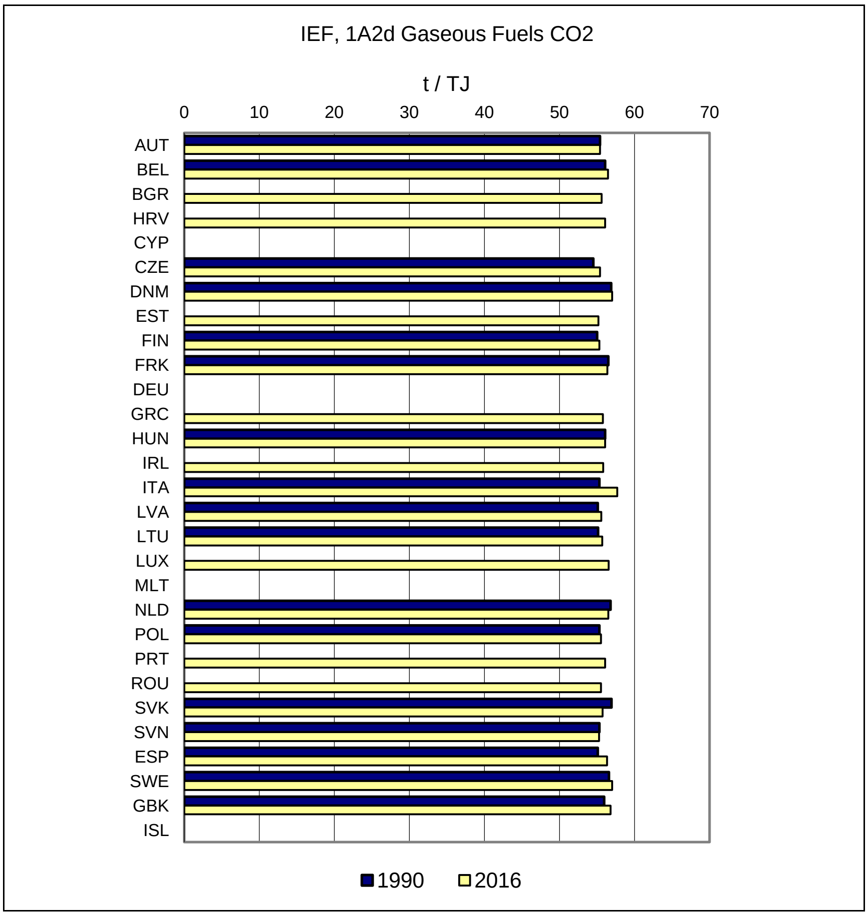


Figure 3.59 1A2d Pulp, Paper and Print, Gaseous fuels: Implied Emission Factors for CO_2 (in t/TJ)



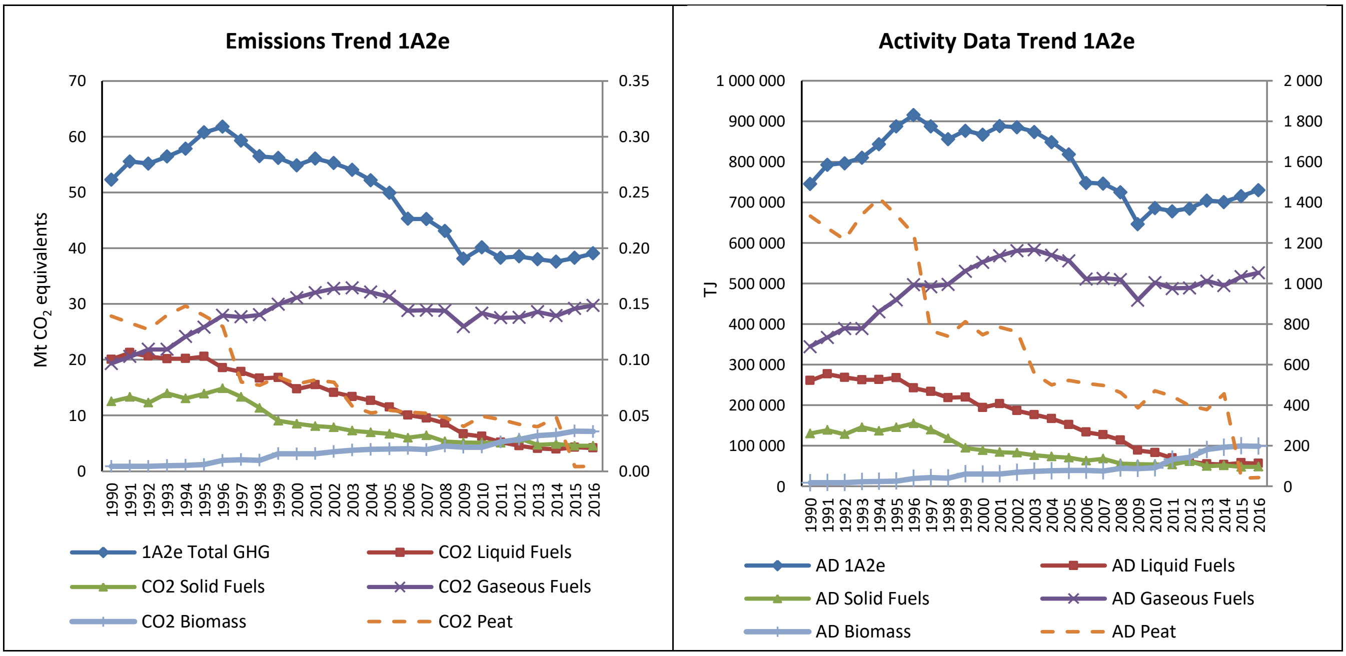


3.2.2.5 Food Processing, Beverages and Tobacco (1A2e)

In this chapter information about emission trends, Member States contribution and activity data is provided for category 1A2e by fuels. GHG emissions from 1A2e Food Processing, Beverages and Tobacco accounted for 8.2% of 1A2 source category and for 0.9% of total GHG emissions in 2016.

Figure 3.60 shows the emission trend within the category 1A2e, which is dominated by CO_2 emissions from gaseous fuels. Total GHG emissions decreased by 25% between 1990 and 2016. Emissions from gaseous fuels increased by 54%, whereas emissions from liquid and solid fuels significantly decreased. The use of biomass is increasing continuously within this category. For confidentiality reasons Germany reports emissions from gaseous fuels under 1A2g. Sweden reports solid fuels for the years 2013 to 2015, other fossil fuels for the year 2015, gaseous fuels for the year 2014 and biomass for the year 2013 as confidential. Within the EU inventory Swedish confidential data has been included in ‘other fossil fuels’.

Figure 3.60 1A2e Food Processing, Beverages and Tobacco: Total and CO_2 emission and activity trends



Data displayed as dashed line refers to the secondary axis.

Between 1990 and 2016, CO_2 emissions from 1A2e Food Processing, Beverages and Tobacco decreased by 25% in the EU-28+ISL (Table 3.40). Between 2015 and 2016 CO_2 emissions increased by 1%. Emissions of Malta are included in 1A2g.

Table 3.40 1A2e Food Processing, Beverages and Tobacco: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016		Method	Emission factor Informa-tion
	1990	2015	2016		kt CO2	%	kt CO2	%		
Austria	868	1 003	990	2.6%	122	14%	-12	-1%	T1,T2	CS,D
Belgium	3 023	2 171	2 277	6.0%	-747	-25%	106	5%	T1,T3	D,PS
Bulgaria	454	259	240	0.6%	-214	-47%	-19	-7%	T1,T2	CS,D
Croatia	NO,IE	351	377	1.0%	377	∞	26	7%	T1	D
Cyprus	73	56	50	0.1%	-23	-32%	-6	-11%	T1	D
Czech Republic	2 988	1 018	1 020	2.7%	-1 968	-66%	2	0%	T1,T2	CS,D
Denmark	1 589	1 012	998	2.6%	-591	-37%	-14	-1%	T1,T2,T3	CS,D
Estonia	457	10	12	0.0%	-445	-97%	2	17%	T1,T2	CS,D
Finland	828	154	168	0.4%	-660	-80%	14	9%	T3	CS,D
France	8 540	7 712	7 460	19.6%	-1 080	-13%	-252	-3%	T2	CS
Germany	2 016	176	179	0.5%	-1 837	-91%	3	2%	CS	CS
Greece	917	620	630	1.7%	-287	-31%	10	2%	T1,T2	CS,D,PS
Hungary	1 888	713	671	1.8%	-1 216	-64%	-41	-6%	T1,T2	CS,D
Ireland	1 017	859	866	2.3%	-152	-15%	6	1%	T1,T2	CS,D
Italy	3 859	3 564	3 473	9.1%	-385	-10%	-91	-3%	T2	CS
Latvia	1 084	111	109	0.3%	-975	-90%	-2	-2%	T1,T2	CS,D
Lithuania	676	239	246	0.6%	-430	-64%	7	3%	T2	CS
Luxembourg	8	18	20	0.1%	12	142%	2	13%	T1,T2	CS,D
Malta	NO,IE	NO,IE	NO,IE	-	-	-	-	-	NA	NA
Netherlands	4 009	3 555	3 621	9.5%	-388	-10%	67	2%	T2	CS
Poland	3 732	3 799	3 975	10.4%	243	6%	176	5%	T1,T2	CS,D
Portugal	830	800	786	2.1%	-45	-5%	-15	-2%	T2	CR,D
Romania	110	840	894	2.3%	784	714%	54	6%	T1,T2	CS,D
Slovakia	1 140	329	320	0.8%	-821	-72%	-9	-3%	T2	CS
Slovenia	221	89	87	0.2%	-133	-60%	-2	-2%	T1,T2	CS,D
Spain	2 990	3 853	4 315	11.3%	1 325	44%	462	12%	T2	CS,OTH
Sweden	948	C	400	1.0%	-549	-58%	400	∞	T2	CS
United Kingdom	7 594	4 345	4 292	11.3%	-3 302	-43%	-53	-1%	T2	CS
EU-28	**50 912**	**37 655**	**38 076**	**100%**	**-12 836**	**-25%**	**421**	**1%**	**-**	**-**
Iceland	128	31	26	0.1%	-102	-80%	-5	-15%	T1	D
United Kingdom (KP)	7 594	4 345	4 292	11.3%	-3 302	-43%	-53	-1%	T2	CS
EU-28 + ISL	**51 040**	**37 686**	**38 102**	**100%**	**-12 938**	**-25%**	**416**	**1%**	**-**	**-**

From 1990 to 2000 Croatia includes emissions under 1.A.2.g.Emissions of Malta are included in 1A2g.

The numbers for 2015 for EU-28 and EU-28 + ISL in this table differ from the numbers in the respective CRF tables because the EU CRF includes CO_2 emissions from liquid and gaseous fuels reported by Sweden. Note that Sweden reports C in 2015 which is reflected in this table. In general, EU trends in this table do not include Sweden to preserve time series consistency for the EU. This also explains the differences between the numbers in this table and the CRF for the years 2013 to 2015.

Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

1A2e Food Processing, Beverages and Tobacco - Liquid Fuels (CO_2)

In 2016 CO_2 from liquid fuels decreased to a share of 11% within source category 1A2e (compared to 38% in 1990). Between 1990 and 2016 CO_2 emissions decreased by 79% (Table 3.41). Between 1990 and 2016 all Member States showed a reduction of emissions except for Romania, Poland and Croatia. Emissions of Malta are included in 1A2g. According to the methodology as described in chapter 3.2.2 about 78% of EU-28 emissions are calculated by using higher tier methods in 2016.

Table 3.41 1A2e Food Processing, Beverages and Tobacco, liquid fuels: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016		Method	Emission factor Informa-tion
	1990	2015	2016		kt CO2	%	kt CO2	%		
Austria	343	176	191	4.6%	-152	-44%	16	9%	T2	CS
Belgium	1 689	85	97	2.3%	-1 592	-94%	12	14%	T1	D
Bulgaria	409	34	33	0.8%	-376	-92%	0	-1%	T1	D
Croatia	IE	60	61	1.5%	61	∞	1	2%	T1	D
Cyprus	73	56	50	1.2%	-23	-32%	-6	-11%	T1	D
Czech Republic	472	23	22	0.5%	-450	-95%	-1	-3%	T1	CS,D
Denmark	720	174	180	4.3%	-540	-75%	6	3%	T1,T2	CS,D
Estonia	437	2	3	0.1%	-435	-99%	0	13%	T1,T2	CS,D
Finland	365	72	72	1.7%	-293	-80%	0	0%	T3	CS
France	3 024	481	335	8.0%	-2 689	-89%	-146	-30%	T2	CS
Germany	908	20	10	0.2%	-898	-99%	-9	-48%	CS	CS
Greece	863	464	476	11.4%	-386	-45%	12	3%	T2	CS
Hungary	463	24	23	0.6%	-440	-95%	0	-2%	T1	D
Ireland	433	376	387	9.3%	-46	-11%	11	3%	T1,T2	CS,D
Italy	1 424	344	56	1.3%	-1 367	-96%	-288	-84%	T2	CS
Latvia	806	18	21	0.5%	-785	-97%	3	15%	T2	CS
Lithuania	174	42	40	1.0%	-135	-77%	-3	-6%	T2	CS
Luxembourg	4	3	3	0.1%	-1	-33%	0	9%	T1,T2	CS,D
Malta	IE	IE	IE	-	-	-	-	-	NA	NA
Netherlands	165	NO	NO	-	-165	-100%	-	-	NA	NA
Poland	231	203	237	5.7%	5	2%	34	17%	T1	D
Portugal	829	261	236	5.7%	-593	-72%	-24	-9%	T2	CR,D
Romania	NO	102	150	3.6%	150	∞	48	47%	T1,T2	CS,D
Slovakia	359	0	0	0.0%	-358	-100%	0	-9%	T2	CS
Slovenia	146	28	26	0.6%	-119	-82%	-1	-5%	T1	D
Spain	2 251	744	1 035	24.8%	-1 216	-54%	291	39%	T2	CS
Sweden	596	167	158	3.8%	-439	-74%	-9	-6%	T2	CS
United Kingdom	2 735	307	243	5.8%	-2 493	-91%	-64	-21%	T2	CS
EU-28	**19 919**	**4 266**	**4 146**	**99%**	**-15 773**	**-79%**	**-120**	**-3%**	**-**	**-**
Iceland	128	31	26	0.6%	-102	-80%	-5	-15%	T1	D
United Kingdom (KP)	2 735	307	243	5.8%	-2 493	-91%	-64	-21%	T2	CS
EU-28 + ISL	**20 047**	**4 297**	**4 172**	**100%**	**-15 875**	**-79%**	**-124**	**-3%**	**-**	**-**

From 1990 to 2000 Croatia includes emissions under 1.A.2.g.
Emissions of Malta are included in 1A2g
Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

Figure 3.61 and Figure **3.61** show CO_2 emissions and implied emission factors for EU-28+ISL as well as the share of the Member States with the highest contributions. The largest emissions are reported by France, Spain, Greece, the United Kingdom and Ireland; together they cause 62% of CO_2 emissions from liquid fuels in 1A2e. Fuel consumption decreased by 78% between 1990 and 2016. The CO_2-implied emission factor for liquid fuels was 74.0 t/TJ in 2016.

Figure 3.61 1A2e Food Processing, Beverages and Tobacco, Liquid fuels: Emission trend and share for CO_2

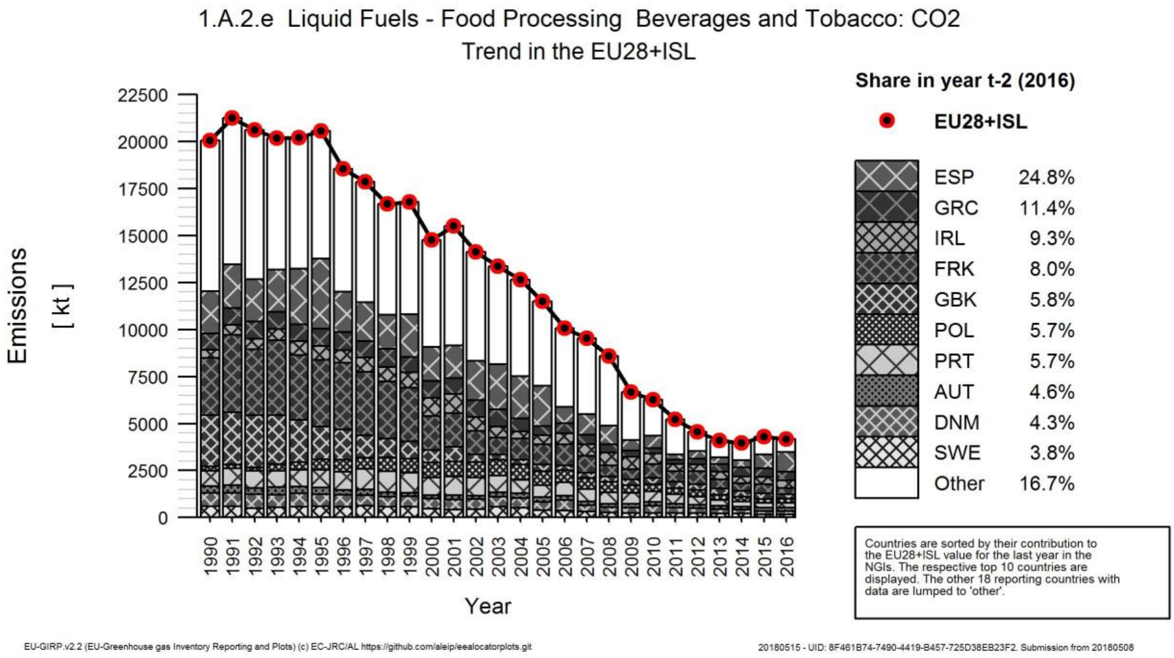
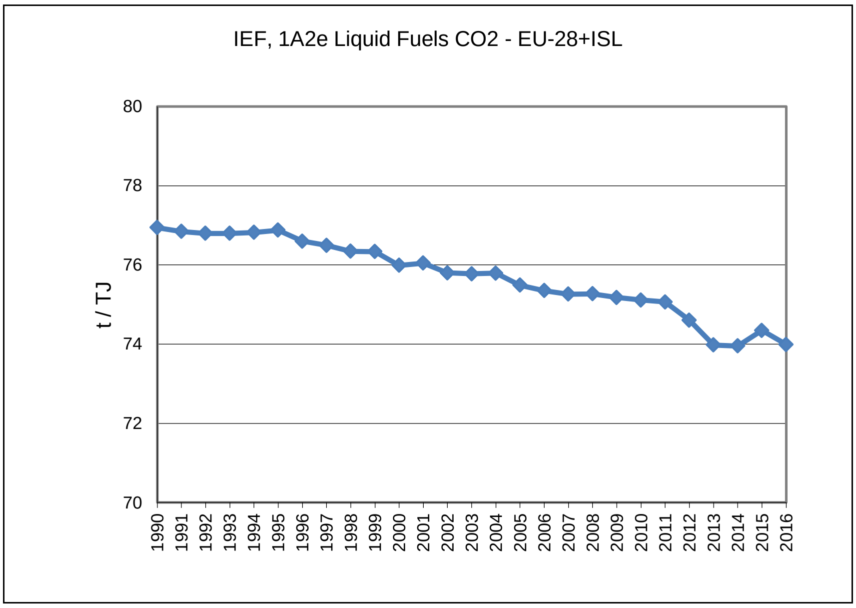
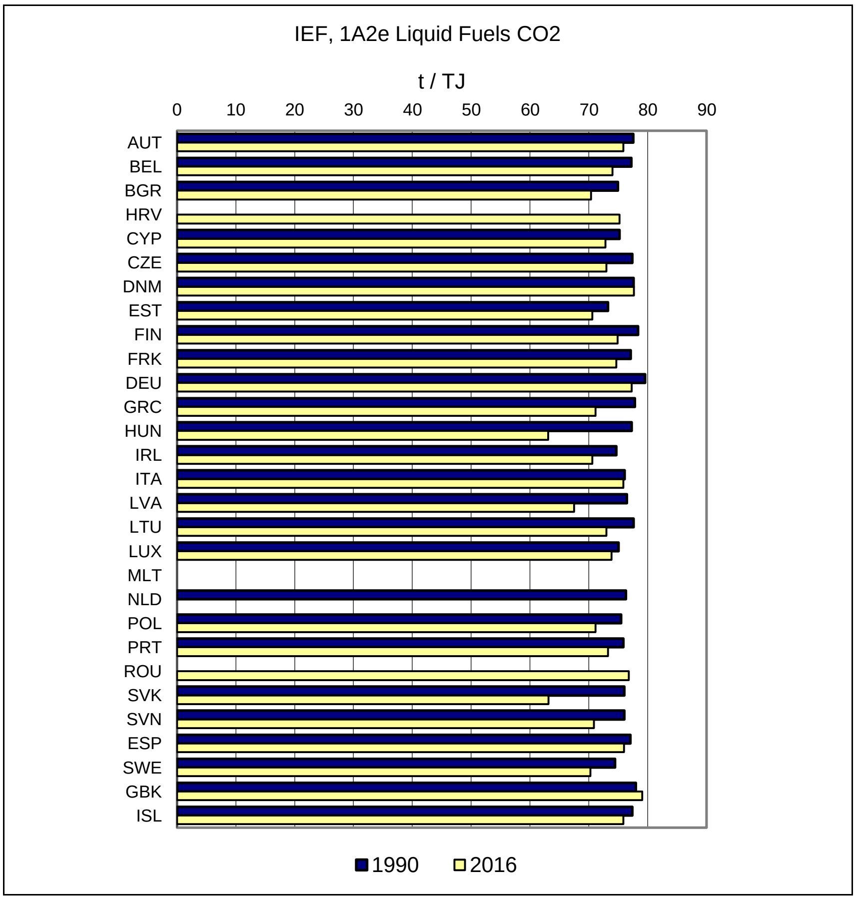


Figure 3.62 1A2e Food Processing, Beverages and Tobacco, Liquid fuels: Implied Emission Factors for CO_2 (in t/TJ)





1A2e Food Processing Beverages and Tobacco - Solid Fuels (CO_2)

In 2016 solid fuels had a share of 12% within source category 1A2e (compared to 24% in 1990). Between 1990 and 2016 CO_2 emissions decreased by 63% (Table 3.42) and all Member States reported decreasing CO_2 emissions from this source category. Sweden reports 2013 to 2015 emissions from solid fuels as confidential. According to the methodology as described in chapter 3.2.2 about 69% of EU-28 emissions are calculated by using higher tier methods in 2016.

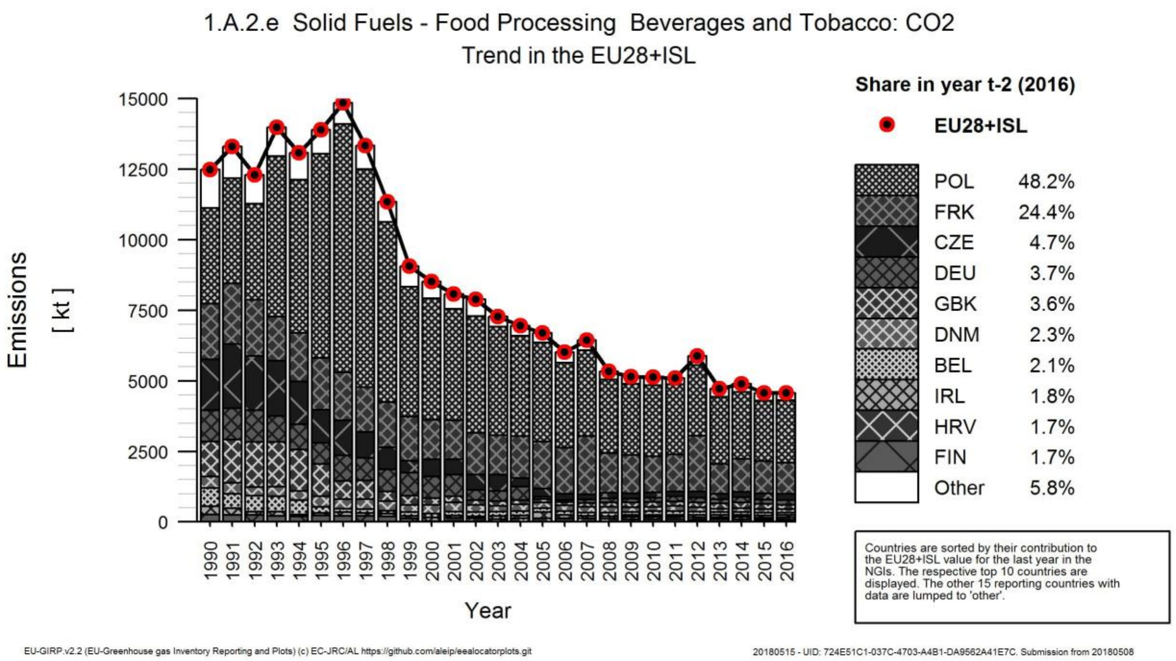
Table 3.42 1A2e Food Processing, Beverages and Tobacco, Solid fuels: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016		Method	Emission factor Informa-tion
	1990	2015	2016		kt CO2	%	kt CO2	%		
Austria	18	23	16	0.4%	-2	-9%	-7	-30%	T2	CS
Belgium	651	105	95	2.1%	-556	-85%	-11	-10%	T1	D
Bulgaria	33	7	3	0.1%	-30	-92%	-5	-66%	T1,T2	CS,D
Croatia	IE	68	79	1.7%	79	∞	11	16%	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czech Republic	1 789	219	214	4.7%	-1 575	-88%	-5	-2%	T2	CS,D
Denmark	402	117	107	2.4%	-294	-73%	-10	-8%	T1	D
Estonia	5	NO	0	0.0%	-4	-94%	0	∞	T1,T2	CS,D
Finland	257	69	79	1.7%	-178	-69%	10	14%	T3	CS
France	1 982	1 142	1 114	24.5%	-868	-44%	-28	-2%	T2	CS
Germany	1 108	156	168	3.7%	-939	-85%	12	8%	CS	CS
Greece	54	4	4	0.1%	-50	-93%	0	-2%	T2	PS
Hungary	185	6	6	0.1%	-178	-97%	0	2%	T1,T2	CS,D
Ireland	292	87	82	1.8%	-210	-72%	-5	-6%	T2	CS
Italy	87	11	12	0.3%	-75	-86%	1	11%	T2	CS
Latvia	103	2	5	0.1%	-98	-95%	2	108%	T2	CS
Lithuania	33	8	10	0.2%	-24	-71%	1	16%	T2	CS
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	227	74	78	1.7%	-150	-66%	4	5%	T2	CS
Poland	3 392	2 151	2 206	48.4%	-1 186	-35%	55	3%	T1,T2	CS,D
Portugal	1	NO	NO	-	-1	-100%	-	-	NA	NA
Romania	110	39	45	1.0%	-65	-59%	6	15%	T1	D
Slovakia	312	53	40	0.9%	-272	-87%	-13	-25%	T2	CS
Slovenia	9	NO	NO	-	-9	-100%	-	-	NA	NA
Spain	94	32	28	0.6%	-66	-70%	-4	-13%	T2	CS
Sweden	90	C	19	0.4%	-71	-79%	19	∞	T2	CS
United Kingdom	1 254	186	162	3.6%	-1 091	-87%	-24	-13%	T2	CS
EU-28	**12 396**	**4 562**	**4 553**	**100%**	**-7 843**	**-63%**	**-9**	**0%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	1 254	186	162	3.6%	-1 091	-87%	-24	-13%	T2	CS
EU-28 + ISL	**12 396**	**4 562**	**4 553**	**100%**	**-7 843**	**-63%**	**-9**	**0%**	**-**	**-**

From 1990 to 2000 Croatia includes emissions under 1.A.2.g.
EU trends in this table do not include Sweden for confidentiality reasons and to preserve time series consistency for the EU. This also explains the differences between the numbers in this table and the CRF.
Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

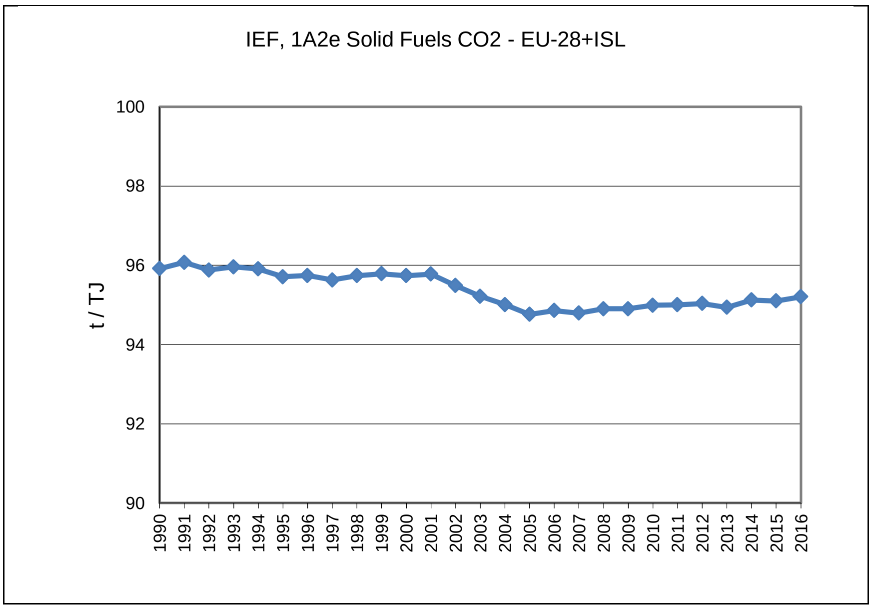
Figure 3.63 and Figure 3.64 show CO_2 emissions and implied emission factors for EU-28+ISL as well as the share of the Member States with the highest contributions. The largest emissions are reported by Poland and France which contribute 73% of the CO_2 emissions from solid fuels in 1A2e. Fuel consumption decreased by 63% between 1990 and 2016.The CO_2-implied emission factor for solid fuels was 95.2 t/TJ in 2016.

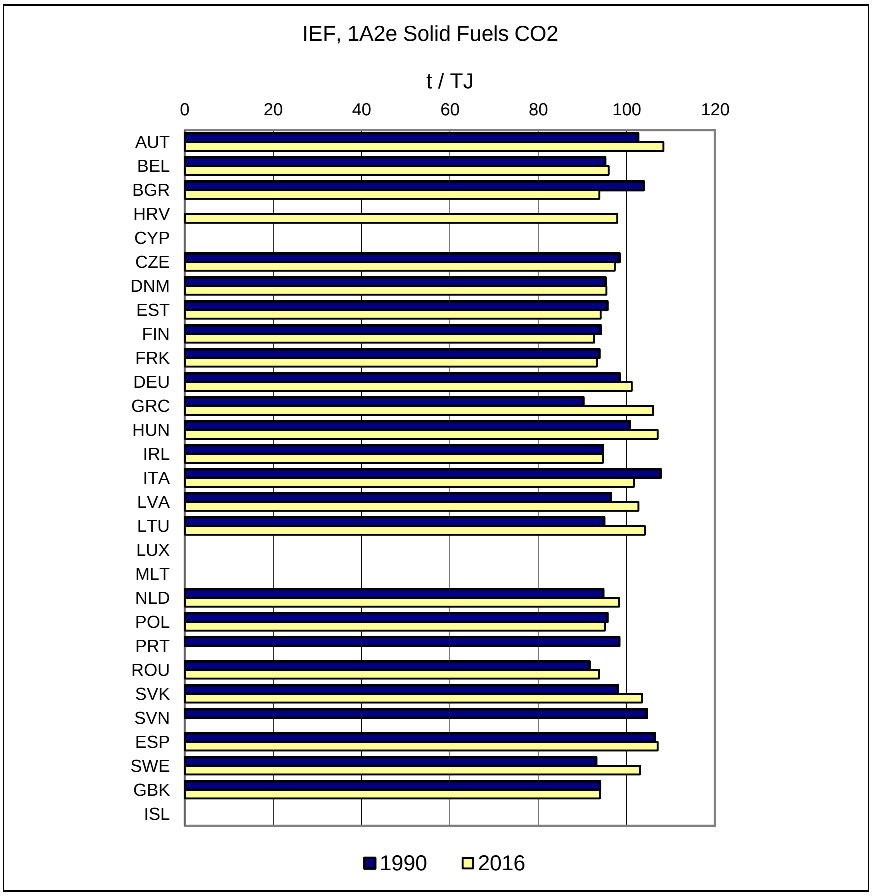
Figure 3.63 1A2e Food Processing, Beverages and Tobacco, solid fuels: Emission trend and share for CO_2



Note: This figure does include Sweden. This also explains the differences between the share of countries in this figure and the table on MS contributions.

Figure 3.64 1A2e Food Processing, Beverages and Tobacco, Solid fuels: Implied Emission Factors for CO_2 (in t/TJ)





1A2e Food Processing Beverages and Tobacco - Gaseous Fuels (CO_2)

In 2016 CO_2 from gaseous fuels had a share of 76% within source category 1A2e (compared to 37% in 1990). Between 1990 and 2016 CO_2 emissions increased by 54% (Table 3.43). Between 1990 and 2016 most Member States reported increasing CO_2 emissions from this source category. Major absolute increases occurred in Belgium, France, Poland and Spain. For confidentiality reasons Germany reports emissions in 1A2g. Emissions of Malta are included in 1A2g. Sweden reports 2014 emissions as confidential. According to the methodology as described in chapter 3.2.2 about 88% of EU-28 emissions are calculated by using higher tier methods in 2016.

Table 3.43 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	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016		Method	Emission factor Informa-tion
	1990	2015	2016		kt CO2	%	kt CO2	%		
Austria	507	804	783	2.6%	276	54%	-21	-3%	T2	CS
Belgium	684	1 980	2 085	7.0%	1 401	205%	105	5%	T1,T3	D,PS
Bulgaria	11	218	204	0.7%	193	1685%	-14	-6%	T2	CS
Croatia	IE	223	236	0.8%	236	∞	13	6%	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czech Republic	727	776	784	2.6%	57	8%	8	1%	T2	CS
Denmark	468	720	711	2.4%	243	52%	-9	-1%	T3	CS
Estonia	15	8	9	0.0%	-6	-41%	1	15%	T2	CS
Finland	67	12	17	0.1%	-50	-74%	5	40%	T3	CS
France	3 534	6 088	6 011	20.2%	2 476	70%	-78	-1%	T2	CS
Germany	IE	IE	IE	-	-	-	-	-	NA	NA
Greece	NO	152	150	0.5%	150	∞	-2	-1%	T2	CS
Hungary	1 239	683	642	2.2%	-598	-48%	-41	-6%	T1	D
Ireland	293	393	394	1.3%	100	34%	1	0%	T2	CS
Italy	2 348	3 208	3 405	11.5%	1 057	45%	196	6%	T2	CS
Latvia	175	89	82	0.3%	-93	-53%	-7	-8%	T2	CS
Lithuania	469	188	196	0.7%	-273	-58%	8	4%	T2	CS
Luxembourg	4	15	17	0.1%	13	344%	2	13%	T2	CS
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	3 617	3 481	3 544	11.9%	-74	-2%	63	2%	T2	CS
Poland	109	1 445	1 532	5.2%	1 423	1306%	87	6%	T2	CS
Portugal	NO	540	549	1.8%	549	∞	9	2%	T2	CR,D
Romania	NO	673	684	2.3%	684	∞	12	2%	T2	CS
Slovakia	470	276	280	0.9%	-190	-40%	4	1%	T2	CS
Slovenia	65	61	61	0.2%	-5	-7%	0	-1%	T2	CS
Spain	646	3 077	3 253	10.9%	2 607	404%	176	6%	T2	CS
Sweden	254	202	214	0.7%	-39	-16%	13	6%	T2	CS
United Kingdom	3 605	3 852	3 887	13.1%	282	8%	35	1%	T2	CS
EU-28	**19 307**	**29 163**	**29 728**	**100%**	**10 421**	**54%**	**565**	**2%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	3 605	3 852	3 887	13.1%	282	8%	35	1%	T2	CS
EU-28 + ISL	**19 307**	**29 163**	**29 728**	**100%**	**10 421**	**54%**	**565**	**2%**	**-**	**-**

From 1990 to 2000 Croatia includes emissions under 1.A.2.g.
Emissions of Germany included in 1A2g.
Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

Figure 3.65 and Figure 3.66 show CO_2 emissions and implied emission factors for EU-28+ISL as well as the share of the Member States with the highest contributions. The largest emissions are reported by France, Italy, the Netherlands, Spain and the United Kingdom; together they cause about 68% of CO_2 emissions from gaseous fuels in 1A2e. Fuel consumption rose by 53% between 1990 and 2016. The CO_2-implied emission factor for gaseous fuels was 56.4 t/TJ in 2016.

Figure 3.65 1A2e Food Processing, Beverages and Tobacco, Gaseous fuels: Emission trend and share for CO_2

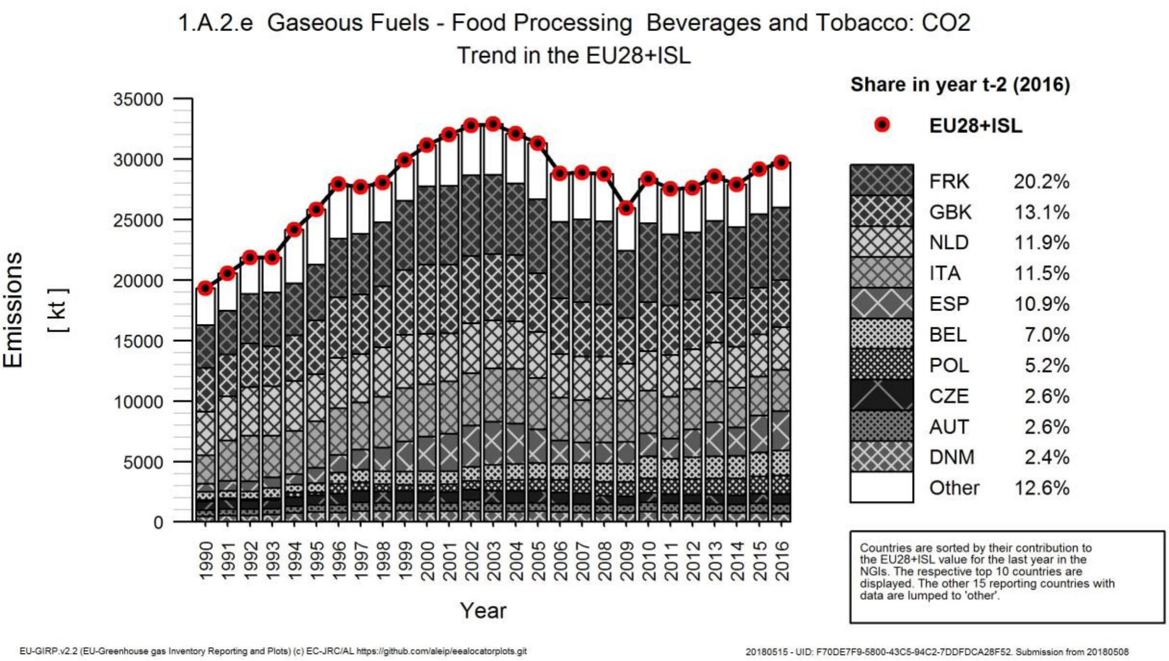
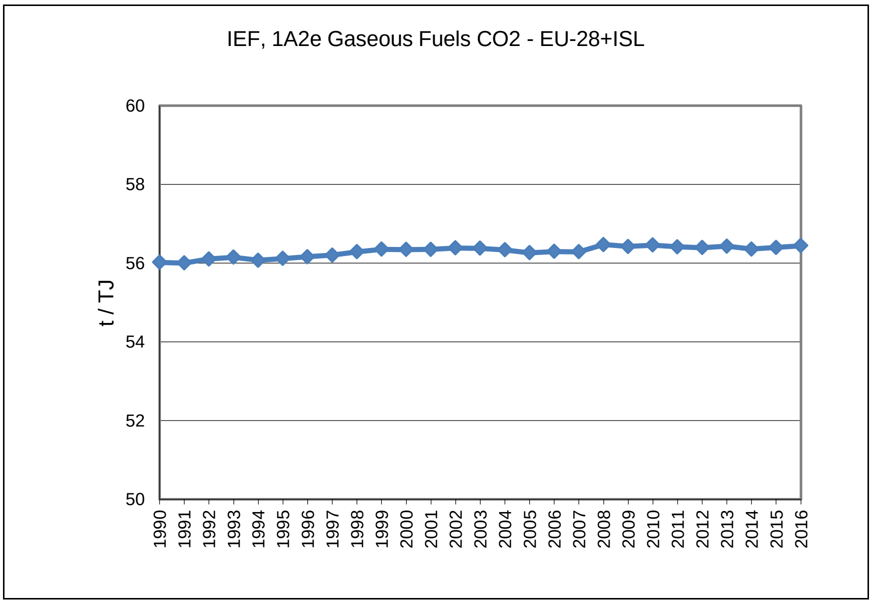
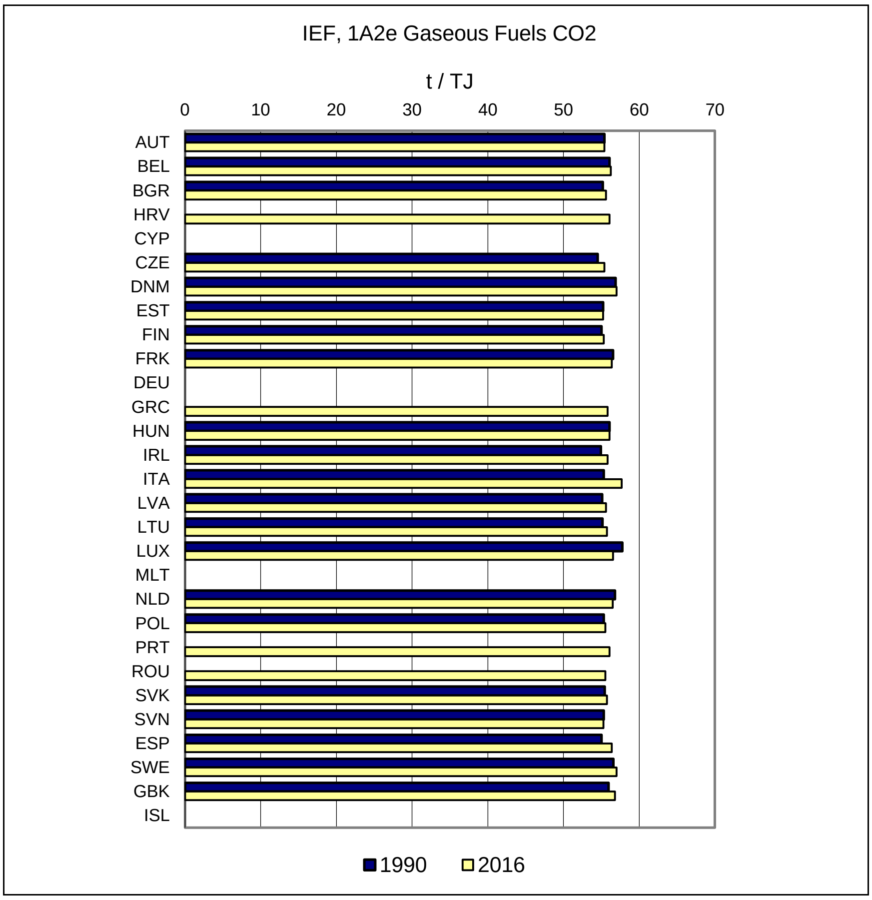


Figure 3.66 1A2e Food Processing, Beverages and Tobacco, Gaseous fuels: Implied Emission Factors for CO_2 (in t/TJ)



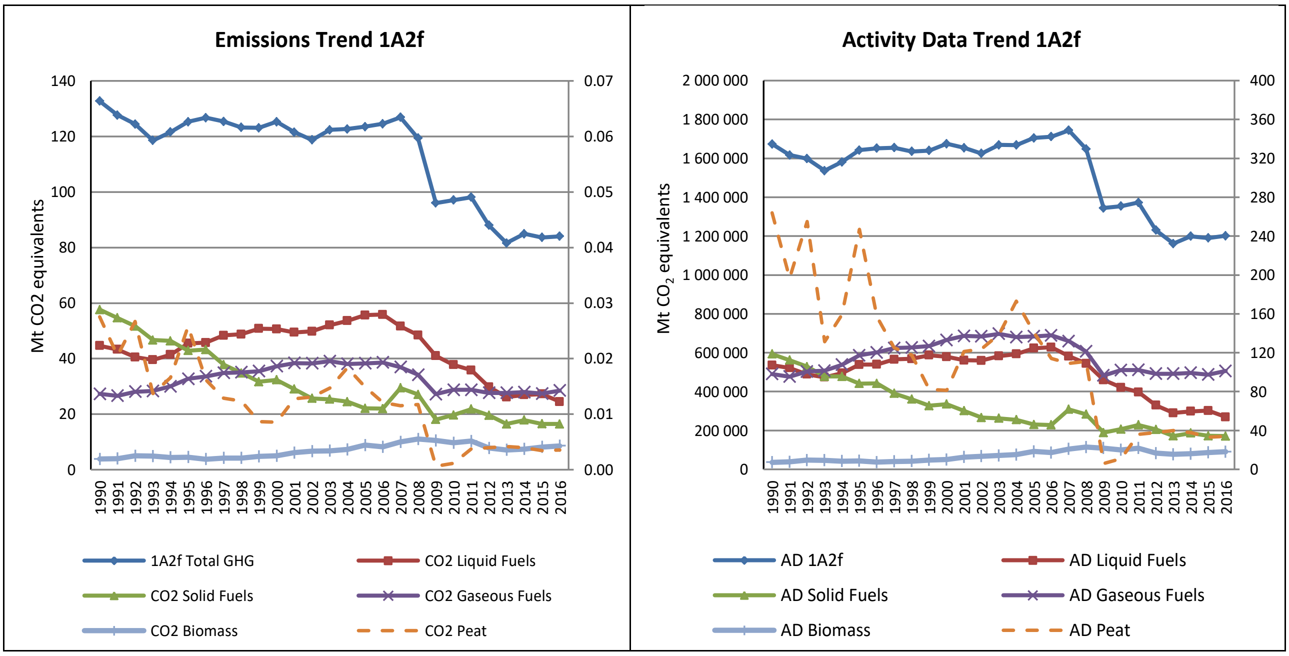


3.2.2.6 Non-metallic Minerals (1A2f)

In this chapter information about emission trends, Member States contribution and activity data is provided for category 1A2f by fuels. GHG emissions from 1A2f Non-metallic Minerals accounted for 17.7 % for 1A2 source category and for 1.9% of total GHG emissions in 2016.

Figure 3.67 shows the emission trend within the category 1A2f, which is mainly dominated by CO_2 emissions from liquid and gaseous fuels. The decrease of emissions from 2008 to 2009 by -20% was due to a decline of production data (cement production decreased by 19%) in all Member states due to the economic recession. Between 1990 and 2016 total GHG emissions decreased by 37%, mainly due to decreases in CO_2 emissions from solid (-71%) and liquid (-45%) fuels while CO_2 emissions from other fossil fuels (non-renewable waste) increased by 782% and emissions of biomass (mostly renewable waste) increased by 123%.

Figure 3.67 1A2f Non-metallic Minerals: Activity data and CO_2 emission trends



Data displayed as dashed line refers to the secondary axis.

Between 1990 and 2016, CO_2 emissions from 1A2f Non-metallic Minerals decreased by 37% in the EU-28+ISL (Table 3.44), showing significant decreases for almost all Member States except for Romania which reports a significant increase. Malta includes emissions in category 1A2g. Sweden reports liquid fuels for 2016, solid fuels for 2013 and 2016 and biomass for 2013 as confidential. Within the EU inventory Swedish confidential data has been included in 'other fossil fuels'.. Greece includes emissions from 1A2g under this category.

Table 3.44 1A2f Non-metallic Minerals : Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016		Method	Emission factor Informa-tion
	1990	2015	2016		kt CO2	%	kt CO2	%		
Austria	1 669	1 605	1 630	2.0%	-39	-2%	25	2%	T1,T2	CS,D
Belgium	5 525	3 475	3 469	4.2%	-2 057	-37%	-6	0%	T1,T3	D,PS
Bulgaria	2 646	1 228	1 233	1.5%	-1 413	-53%	5	0%	T1,T2	CS,D
Croatia	NO,IE	82	110	0.1%	110	∞	29	35%	T1	D
Cyprus	380	488	480	0.6%	100	26%	-7	-2%	CS,T1	CS,D
Czech Republic	4 527	2 347	2 438	2.9%	-2 089	-46%	91	4%	T1,T2	CS,D
Denmark	1 310	1 170	1 319	1.6%	8	1%	148	13%	T1,T2,T3	CS,D,PS
Estonia	952	270	253	0.3%	-699	-73%	-17	-6%	T1,T2,T3	CS,D,PS
Finland	1 368	588	642	0.8%	-726	-53%	54	9%	T3	CS,D
France	14 176	8 754	8 449	10.2%	-5 727	-40%	-304	-3%	T2,T3	CS,PS
Germany	18 507	13 176	13 775	16.6%	-4 732	-26%	599	5%	CS	CS
Greece	6 278	3 346	3 807	4.6%	-2 471	-39%	461	14%	T1,T2	CS,D,PS
Hungary	2 326	1 031	1 121	1.4%	-1 205	-52%	90	9%	T1,T2,T3	CS,D,PS
Ireland	819	1 177	1 231	1.5%	412	50%	54	5%	T1,T2,T3	CS,D,PS
Italy	20 980	13 174	11 458	13.8%	-9 522	-45%	-1 716	-13%	T2	CS
Latvia	609	284	240	0.3%	-369	-61%	-44	-15%	T1,T2,T3	CS,D,PS
Lithuania	3 210	440	408	0.5%	-2 801	-87%	-31	-7%	T2	CS
Luxembourg	537	362	374	0.5%	-162	-30%	13	4%	T1,T2	CS,D,PS
Malta	NO,IE	NO,IE	NO,IE	-	-	-	-	-	NA	NA
Netherlands	2 298	1 174	1 219	1.5%	-1 078	-47%	45	4%	T2	CS
Poland	10 414	7 330	7 973	9.6%	-2 440	-23%	643	9%	T1,T2	CS,D
Portugal	3 283	2 982	2 589	3.1%	-694	-21%	-393	-13%	T2,T3	CR,D,PS
Romania	265	2 443	2 542	3.1%	2 277	861%	98	4%	T1,T2	CS,D
Slovakia	3 408	1 235	1 349	1.6%	-2 059	-60%	115	9%	T2	CS
Slovenia	296	399	408	0.5%	112	38%	9	2%	T1,T2,T3	CS,D,PS
Spain	16 341	10 091	10 569	12.7%	-5 771	-35%	478	5%	T2	CS,M,OTH,PS
Sweden	1 826	1 239	1 226	1.5%	-600	-33%	-13	-1%	T1,T2	CS
United Kingdom	7 049	2 592	2 600	3.1%	-4 449	-63%	8	0%	T2	CS
EU-28	**130 998**	**82 481**	**82 912**	**100%**	**-48 086**	**-37%**	**431**	**1%**	**-**	**-**
Iceland	50	0	0	0.0%	-50	-99%	0	-3%	T1	D
United Kingdom (KP)	7 049	2 592	2 600	3.1%	-4 449	-63%	8	0%	T2	CS
EU-28 + ISL	**131 048**	**82 481**	**82 913**	**100%**	**-48 136**	**-37%**	**431**	**1%**	**-**	**-**

From 1990 to 2000 Croatia includes emissions under 1.A.2.g.
Malta includes emissions under 1A2g.
Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

1A2f Non-metallic Minerals - Liquid Fuels (CO_2)

In 2016 CO_2 emissions from liquid fuels had a share of 29% within source category 1A2f (compared to 34% in 1990). Between 1990 and 2016 CO_2 emissions decreased by 44% (Table 3.45). Between 1990 and 2016 the highest absolute decreases were achieved by France, Italy, Lithuania and Spain. Romania is the only member state which reports a significant increase in emissions from this source. Sweden reports 2016 emissions as confidential. According to the methodology as described in chapter 3.2.2 about 90% of EU-28 emissions are calculated by using higher tier methods in 2016.

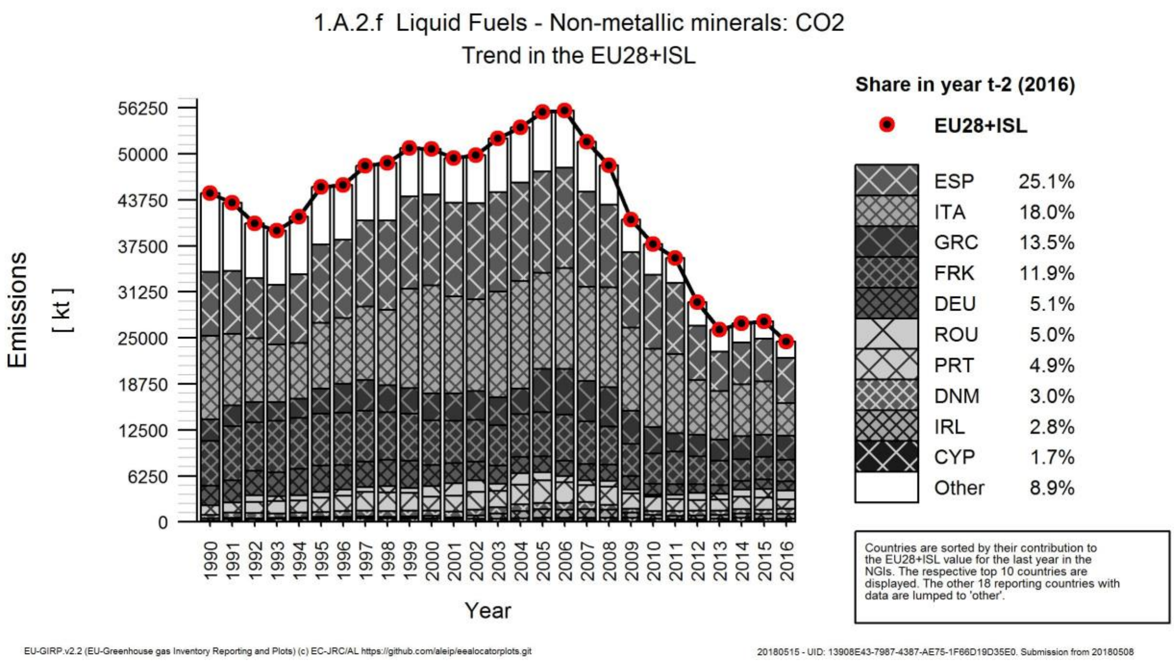
Table 3.45 1A2f Non-metallic Minerals , liquid fuels: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016		Method	Emission factor Information
	1990	2015	2016		kt CO2	%	kt CO2	%		
Austria	508	159	165	0.7%	-343	-68%	6	4%	T2	CS
Belgium	1 509	291	232	0.9%	-1 277	-85%	-59	-20%	T1,T3	D,PS
Bulgaria	666	354	370	1.5%	-296	-44%	16	5%	T1	D
Croatia	IE	1	17	0.1%	17	∞	16	2758%	T1	D
Cyprus	148	414	413	1.7%	264	179%	-2	0%	CS	CS
Czech Republic	1 029	44	44	0.2%	-985	-96%	1	2%	T1	CS,D
Denmark	498	633	732	3.0%	234	47%	100	16%	T1,T2	CS,D
Estonia	140	2	2	0.0%	-138	-99%	-1	-30%	T1,T2	CS,D
Finland	437	230	248	1.0%	-189	-43%	18	8%	T3	CS
France	6 068	3 034	2 914	11.9%	-3 154	-52%	-120	-4%	T2,T3	CS,PS
Germany	2 663	1 310	1 251	5.1%	-1 412	-53%	-59	-4%	CS	CS
Greece	2 914	3 011	3 306	13.5%	393	13%	295	10%	T2	PS
Hungary	423	306	368	1.5%	-55	-13%	62	20%	T1,T2	CS,D
Ireland	312	634	676	2.8%	364	117%	42	7%	T1,T2	CS,D
Italy	11 375	7 222	4 412	18.0%	-6 963	-61%	-2 810	-39%	T2	CS
Latvia	276	21	31	0.1%	-245	-89%	10	48%	T1,T2	CS,D
Lithuania	2 750	10	7	0.0%	-2 744	-100%	-3	-32%	T2	CS
Luxembourg	23	4	3	0.0%	-20	-87%	-1	-20%	T2	CS
Malta	IE	IE	IE	-	-	-	-	-	NA	NA
Netherlands	468	15	15	0.1%	-453	-97%	0	0%	T2	CS
Poland	392	143	222	0.9%	-170	-43%	78	55%	T1	D
Portugal	1 313	1 588	1 204	4.9%	-109	-8%	-384	-24%	T2,T3	CR,D,PS
Romania	NO	1 197	1 223	5.0%	1 223	∞	25	2%	T1,T2	CS,D
Slovakia	1 219	180	226	0.9%	-993	-81%	46	26%	T2	CS
Slovenia	63	99	96	0.4%	33	52%	-3	-3%	T1	D
Spain	8 686	5 826	6 154	25.1%	-2 532	-29%	328	6%	T2	CS,M
Sweden	625	346	C	-	-625	-100%	-346	-100%	T1	CS
United Kingdom	127	174	143	0.6%	16	12%	-31	-18%	T2	CS
EU-28	**44 008**	**26 902**	**24 474**	**100%**	**-19 534**	**-44%**	**-2 428**	**-9%**	**-**	**-**
Iceland	2	0	0	0.0%	-2	-84%	0	-3%	T1	D
United Kingdom (KP)	127	174	143	0.6%	16	12%	-31	-18%	T2	CS
EU-28 + ISL	**44 010**	**26 902**	**24 475**	**100%**	**-19 535**	**-44%**	**-2 428**	**-9%**	**-**	**-**

From 1990 to 2000 Croatia includes emissions under 1.A.2.g.
Malta includes emissions under 1A2g.
EU trends in this table do not include Sweden for confidentiality reasons and to preserve time series consistency for the EU. This also explains the differences between the numbers in this table and the CRF.
Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

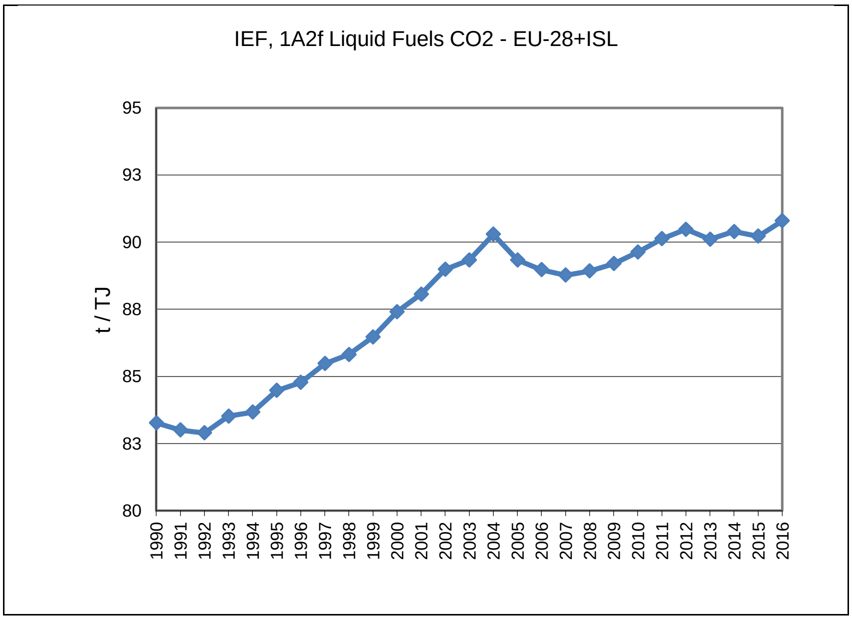
Figure 3.68 and Figure 3.69 show CO_2 emissions and implied emission factors for EU-28+ISL as well as the share of the Member States with the highest contributions. The largest emissions are reported by France, Greece, Spain and Italy; together they cause 69% of the CO_2 emissions from liquid fuels in 1A2f. Fuel consumption decreased by 50% between 1990 and 2016. The CO_2-implied emission factor for liquid fuels was 90.8 t/TJ in 2016. The high IEF is mainly due to the consumption of petrol coke in cement kilns.

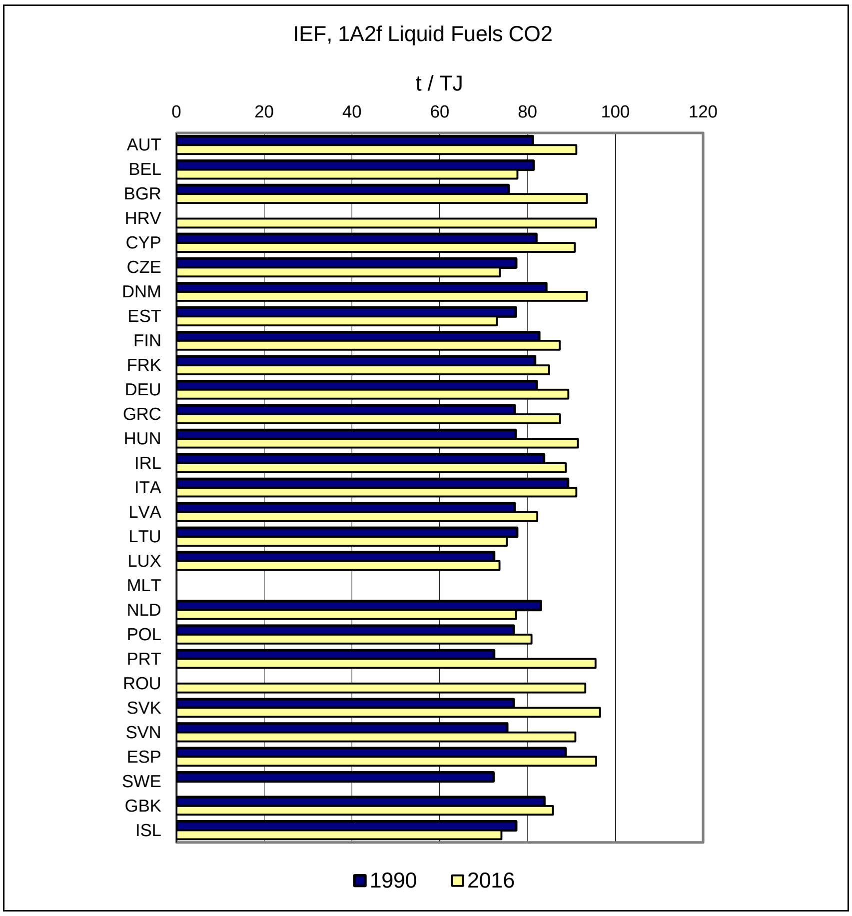
Figure 3.68 1A2f Non-metallic Minerals, liquid fuels: Emission trend and share for CO_2



Note: This figure does include Sweden. This also explains the differences between the share of countries in this figure and the table on MS contributions.

Figure 3.69 1A2f Non-metallic Minerals, liquid fuels: Implied Emission Factors for CO_2 (in t/TJ)





1A2f Non-metallic Minerals - Solid Fuels (CO_2)

In 2016 CO_2 from solid fuels had a share of 20% within source category 1A2f (compared to 43% in 1990). Between 1990 and 2016 CO_2 emissions decreased by 71% (Table 3.46). Between 1990 and 2016 almost all Member States reported decreases of emissions; the highest absolute decreases were reported by Germany, Poland, Spain and the UK. Between 2015 and 2016 emissions increased by 4%. Sweden reports 2013 and 2016 emissions as confidential. According to the methodology as described in chapter 3.2.2 about 85% of EU-28 emissions are calculated by using higher tier methods in 2016.

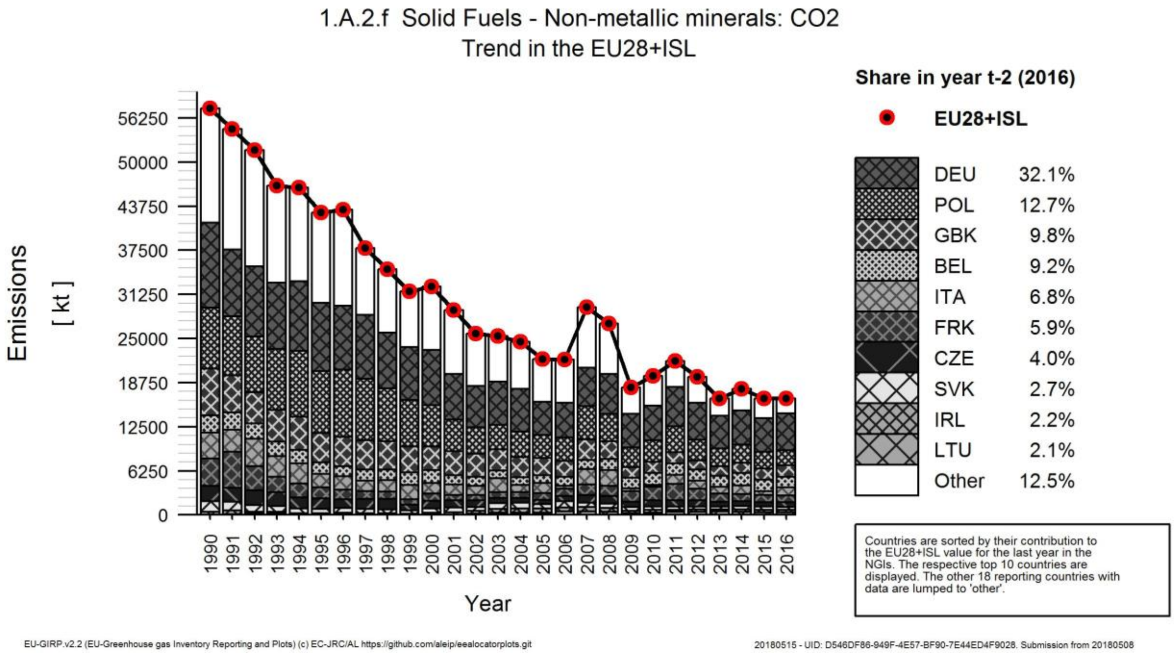
Table 3.46 1A2f Non-metallic Minerals, solid fuels: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016		Method	Emission factor Informa-tion
	1990	2015	2016		kt CO2	%	kt CO2	%		
Austria	535	266	221	1.3%	-314	-59%	-45	-17%	T2	CS
Belgium	2 466	1 632	1 520	9.2%	-946	-38%	-111	-7%	T1,T3	D,PS
Bulgaria	295	286	241	1.5%	-54	-18%	-45	-16%	T1,T2	CS,D
Croatia	IE	NO	NO	-	-	-	-	-	NA	NA
Cyprus	232	15	2	0.0%	-230	-99%	-13	-87%	CS	CS
Czech Republic	2 209	615	663	4.0%	-1 546	-70%	48	8%	T2	CS,D
Denmark	574	145	171	1.0%	-403	-70%	26	18%	T1,T3	D,PS
Estonia	756	124	93	0.6%	-663	-88%	-31	-25%	T1,T2	CS,D
Finland	806	251	281	1.7%	-525	-65%	30	12%	T3	CS
France	3 854	1 010	979	5.9%	-2 875	-75%	-32	-3%	T2,T3	CS,PS
Germany	12 053	4 721	5 287	32.1%	-6 766	-56%	566	12%	CS	CS
Greece	3 364	183	128	0.8%	-3 236	-96%	-55	-30%	T2	PS
Hungary	230	136	116	0.7%	-114	-50%	-20	-15%	T1,T2	D,PS
Ireland	375	333	354	2.2%	-20	-5%	21	6%	T2	CS
Italy	3 690	546	1 124	6.8%	-2 566	-70%	577	106%	T2	CS
Latvia	16	91	67	0.4%	50	306%	-24	-26%	T2	CS
Lithuania	60	374	339	2.1%	280	469%	-35	-9%	T2	CS
Luxembourg	312	144	161	1.0%	-152	-49%	16	11%	T1	D
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	346	150	157	1.0%	-189	-55%	6	4%	T2	CS
Poland	8 653	2 412	2 092	12.7%	-6 561	-76%	-320	-13%	T1,T2	CS,D
Portugal	1 958	NO	NO	-	-1 958	-100%	-	-	NA	NA
Romania	265	230	238	1.4%	-27	-10%	8	4%	T1,T2	CS,D
Slovakia	1 474	498	451	2.7%	-1 024	-69%	-48	-10%	T2	CS
Slovenia	113	51	44	0.3%	-69	-61%	-7	-13%	T1,T3	D,PS
Spain	5 221	125	141	0.9%	-5 080	-97%	15	12%	T2	CS
Sweden	1 135	641	C	-	-1 135	-100%	-641	-100%	T2	CS
United Kingdom	6 601	1 551	1 608	9.8%	-4 993	-76%	57	4%	T2	CS
EU-28	**56 458**	**15 892**	**16 478**	**100%**	**-39 980**	**-71%**	**586**	**4%**	**-**	**-**
Iceland	48	NO	NO	-	-48	-100%	-	-	NA	NA
United Kingdom (KP)	6 601	1 551	1 608	9.8%	-4 993	-76%	57	4%	T2	CS
EU-28 + ISL	**56 506**	**15 892**	**16 478**	**100%**	**-40 028**	**-71%**	**586**	**4%**	**-**	**-**

From 1990 to 2000 Croatia includes emissions under 1.A.2.g.
EU trends in this table do not include Sweden for confidentiality reasons and to preserve time series consistency for the EU. This also explains the differences between the numbers in this table and the CRF.
Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

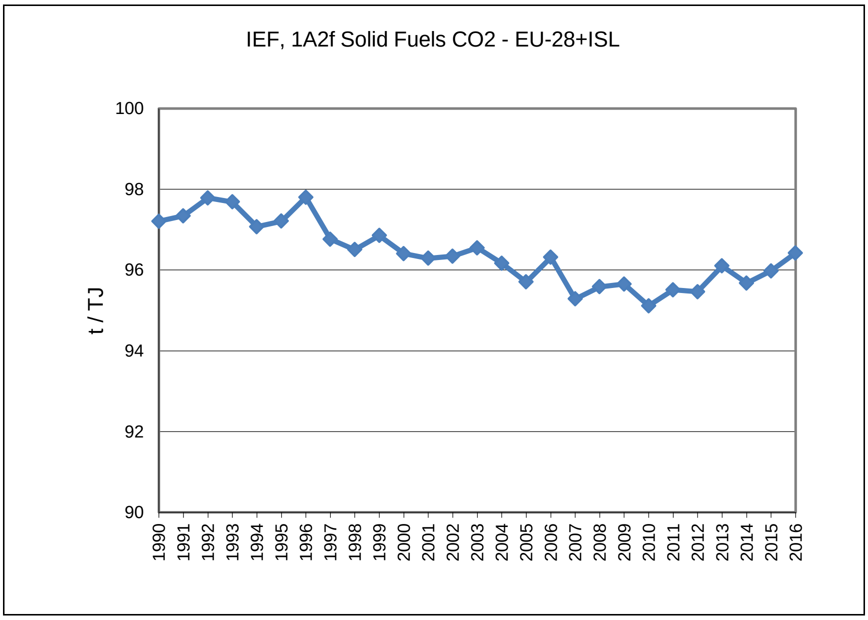
Figure 3.70 and Figure 3.71 show CO_2 emissions and implied emission factors for EU-28+ISL as well as the share of the Member States with the highest contributions. The largest emissions are reported by Germany, Poland, Belgium and the United Kingdom; together they cause about 64% of the CO_2 emissions from solid fuels in 1A2f. Fuel consumption decreased by 71% between 1990 and 2016. The CO_2-implied emission factor for solid fuels was 96.4 t/TJ in 2016. The comparatively high implied emission factor of Finland for 2016 is due to the use of CO waste gas from a steel plant.

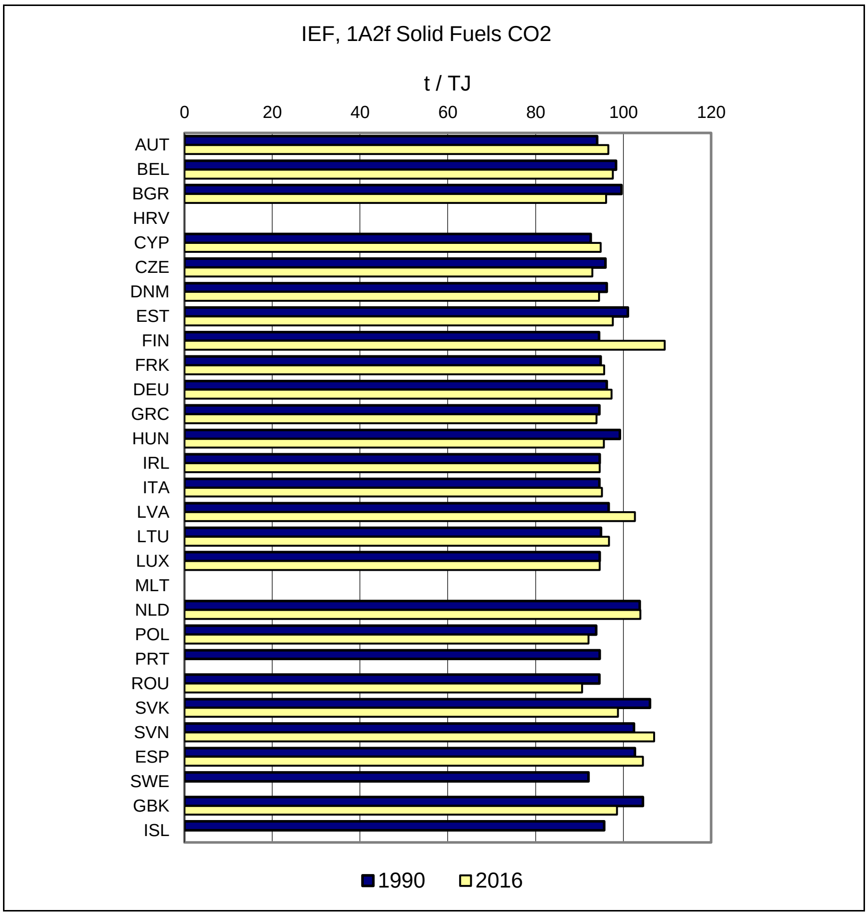
Figure 3.70 1A2f Non-metallic Minerals, solid fuels: Emission trend and share for CO_2



Note: This figure does include Sweden. This also explains the differences between the share of countries in this figure and the table on MS contributions.

Figure 3.71 1A2f Non-metallic Minerals, solid fuels: Implied Emission Factors for CO_2 (in t/TJ)





1A2f Non-metallic Minerals - Gaseous Fuels (CO_2)

In 2016 CO_2 from gaseous fuels had a share of 34% within source category 1A2f (compared to 21% in 1990). Between 1990 and 2016, the emissions increased by 4% (Table 3.47). Between 1990 and 2016 Hungary and Bulgaria showed the highest absolute decreases while Germany, Poland, Portugal and Spain showed the highest absolute increases. According to the methodology as described in chapter 3.2.2 about 87% of EU-28 emissions are calculated by using higher tier methods in 2016.

Table 3.47 1A2f Non-metallic Minerals, gaseous fuels: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016		Method	Emission factor Informa-tion
	1990	2015	2016		kt CO2	%	kt CO2	%		
Austria	559	625	645	2.3%	86	15%	20	3%	T2	CS
Belgium	1 364	1 169	1 292	4.5%	-72	-5%	123	10%	T1,T3	D,PS
Bulgaria	1 684	588	622	2.2%	-1 062	-63%	34	6%	T2	CS
Croatia	IE	81	93	0.3%	93	∞	12	15%	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czech Republic	1 289	1 301	1 278	4.5%	-12	-1%	-23	-2%	T2	CS
Denmark	238	269	270	0.9%	31	13%	1	0%	T3	CS
Estonia	46	29	32	0.1%	-14	-30%	4	13%	T2	CS
Finland	126	53	50	0.2%	-75	-60%	-3	-6%	T3	CS
France	3 931	3 529	3 277	11.5%	-654	-17%	-252	-7%	T2,T3	CS,PS
Germany	3 265	4 510	4 650	16.3%	1 385	42%	140	3%	CS	CS
Greece	NO	114	329	1.2%	329	∞	215	189%	T2	CS
Hungary	1 673	424	474	1.7%	-1 199	-72%	50	12%	T1	D
Ireland	132	36	39	0.1%	-94	-71%	3	8%	T2	CS
Italy	5 915	5 027	5 514	19.3%	-401	-7%	487	10%	T2	CS
Latvia	316	66	66	0.2%	-250	-79%	0	0%	T2	CS
Lithuania	382	52	59	0.2%	-324	-85%	6	12%	T2	CS
Luxembourg	201	167	169	0.6%	-32	-16%	2	1%	T2	CS
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	1 484	1 009	1 047	3.7%	-436	-29%	38	4%	T2	CS
Poland	1 359	2 252	2 443	8.6%	1 084	80%	191	9%	T2	CS
Portugal	NO	1 100	1 106	3.9%	1 106	∞	5	0%	T2,T3	CR,D,PS
Romania	NO	572	608	2.1%	608	∞	36	6%	T2	CS
Slovakia	542	359	373	1.3%	-169	-31%	14	4%	T2	CS
Slovenia	115	162	174	0.6%	59	51%	11	7%	T2	CS
Spain	2 314	3 538	3 515	12.3%	1 201	52%	-23	-1%	T2	CS
Sweden	65	110	114	0.4%	49	75%	4	3%	T1	CS
United Kingdom	320	281	266	0.9%	-53	-17%	-15	-5%	T2	CS
EU-28	**27 322**	**27 422**	**28 503**	**100%**	**1 181**	**4%**	**1 081**	**4%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	320	281	266	0.9%	-53	-17%	-15	-5%	T2	CS
EU-28 + ISL	**27 322**	**27 422**	**28 503**	**100%**	**1 181**	**4%**	**1 081**	**4%**	**-**	**-**

From 1990 to 2000 Croatia includes emissions under 1.A.2.g.
Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

Figure 3.72 and Figure 3.73 show CO_2 emissions and implied emission factors for EU-28+ISL as well as the share of the Member States with the highest contributions. The largest emissions are reported by Germany, Italy, Spain and France; together they cause 59% of the CO_2 emissions from gaseous fuels in 1A2f. Fuel combustion increased by 3% between 1990 and 2016. The CO_2-implied emission factor for gaseous fuels was 56.3 t/TJ in 2016.

Figure 3.72 1A2f Non-metallic Minerals, gaseous fuels: Emission trend and share for CO_2

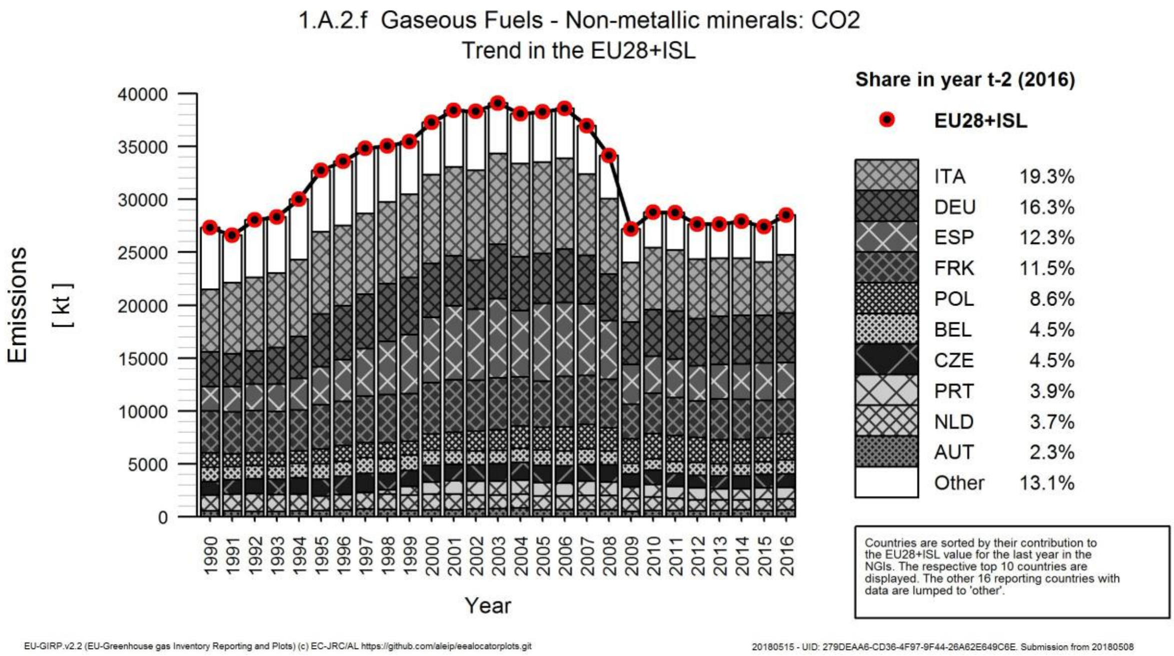
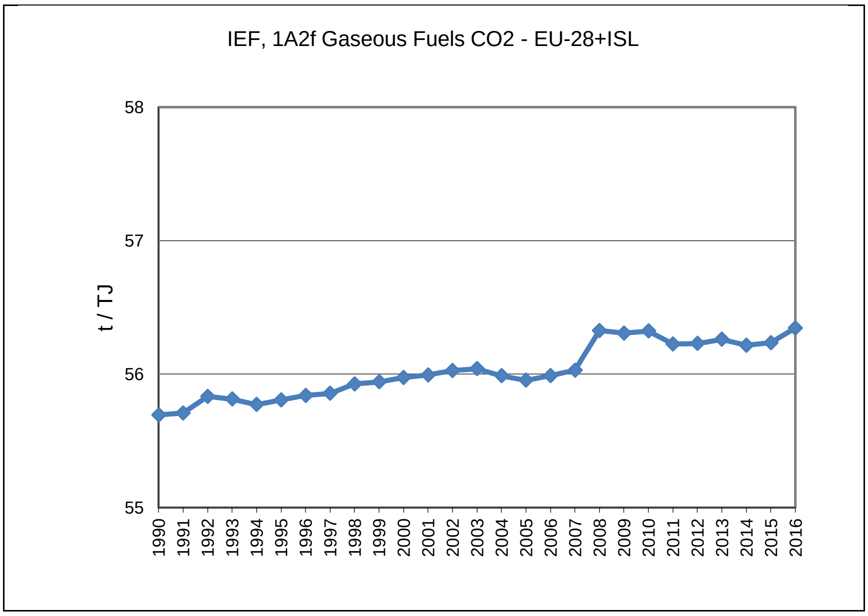
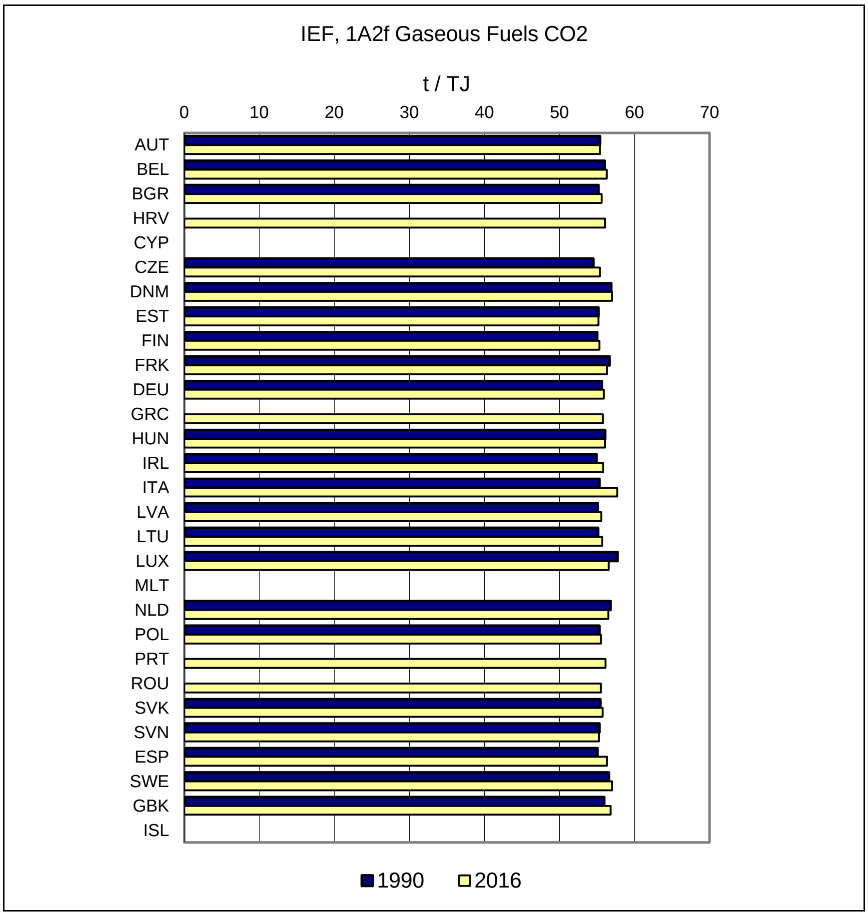


Figure 3.73 1A2f Non-metallic Minerals, gaseous fuels: Implied Emission Factors for CO_2 (in t/TJ)





1A2f Non-metallic Minerals – Other Fossil Fuels (CO_2)

In 2016 CO_2 from other fossil fuels had a share of 15% within source category 1A2f (compared to 1% in 1990). Between 1990 and 2016, the emissions increased by 782% (Table 3.48). Between 1990 and 2016 Germany and Poland showed the highest absolute increases. Most member states report emissions from industrial waste (co-) incineration and particularly incineration of municipal waste (e.g. Spain) under this category, especially from cement kilns. Examples of industrial wastes are: waste tyres, waste oil/lubricants, solvents, plastics waste and paper waste. According to the methodology as described in chapter 3.2.2 about 72% of EU-28 emissions are calculated by using higher tier methods in 2016.

Table 3.48 1A2f Non-metallic Minerals, other fossil fuels: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016		Method	Emission factor Informa-tion
	1990	2015	2016		kt CO2	%	kt CO2	%		
Austria	67	555	600	4.8%	532	792%	44	8%	T2	CS
Belgium	186	382	424	3.4%	238	128%	42	11%	T1,T3	D,PS
Bulgaria	NO	NO	NO	-	-	-	-	-	NA	NA
Croatia	NO	NO	NO	-	-	-	-	-	NA	NA
Cyprus	NO	59	66	0.5%	66	∞	7	12%	T1	D
Czech Republic	NO	387	453	3.6%	453	∞	66	17%	T2	CS
Denmark	NO	124	145	1.2%	145	∞	22	17%	T2	CS
Estonia	NO	115	126	1.0%	126	∞	11	9%	T3	PS
Finland	NO	54	63	0.5%	63	∞	9	16%	T3	CS
France	323	1 181	1 279	10.2%	956	296%	99	8%	T2,T3	CS,PS
Germany	526	2 635	2 587	20.6%	2 061	392%	-48	-2%	CS	CS
Greece	NO	38	43	0.3%	43	∞	6	15%	T2	PS
Hungary	NO	164	162	1.3%	162	∞	-2	-1%	T3	PS
Ireland	NO	175	162	1.3%	162	∞	-13	-7%	T3	PS
Italy	NO	379	409	3.3%	409	∞	30	8%	T2	CS
Latvia	NO	106	76	0.6%	76	∞	-30	-28%	T3	PS
Lithuania	NO	NO	NO	-	-	-	-	-	NA	NA
Luxembourg	NO	46	42	0.3%	42	∞	-4	-10%	T1,T2	D,PS
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	NO	NO	NO	-	-	-	-	-	NA	NA
Poland	10	2 523	3 217	25.6%	3 207	32979%	694	28%	T1	D
Portugal	12	294	279	2.2%	267	2185%	-15	-5%	T2,T3	CR,D,PS
Romania	NO	445	473	3.8%	473	∞	28	6%	T2	CS
Slovakia	173	198	300	2.4%	127	73%	102	52%	T2	CS
Slovenia	5	86	94	0.7%	89	1904%	7	9%	T1,T3	D,PS
Spain	120	602	760	6.1%	640	536%	158	26%	T2	CS,PS
Sweden	NO	142	202	1.6%	202	∞	59	42%	T2	CS
United Kingdom	1	585	582	4.6%	581	54059%	-3	-1%	T2	CS
EU-28	**1 422**	**11 275**	**12 543**	**100%**	**11 121**	**782%**	**1 268**	**11%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	1	585	582	4.6%	581	54059%	-3	-1%	T2	CS
EU-28 + ISL	**1 422**	**11 275**	**12 543**	**100%**	**11 121**	**782%**	**1 268**	**11%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

Figure 3.74 and Figure 3.75 show CO_2 emissions and implied emission factors for EU-28+ISL as well as the share of the Member States with the highest contributions. The largest emissions are reported by Germany, France and Poland; they cause 56% of the CO_2 emissions from other fossil fuels in 1A2f. The CO_2-implied emission factor for other fossil fuels was 81.3 t/TJ in 2016. Poland applies the default IPCC default CO_2 emission factor (or a factor which is closed to it) which is significantly higher than the country specific values used by almost all other countries.

Figure 3.74 1A2f Non-metallic Minerals, other fossil fuels: Emission trend and share for CO_2

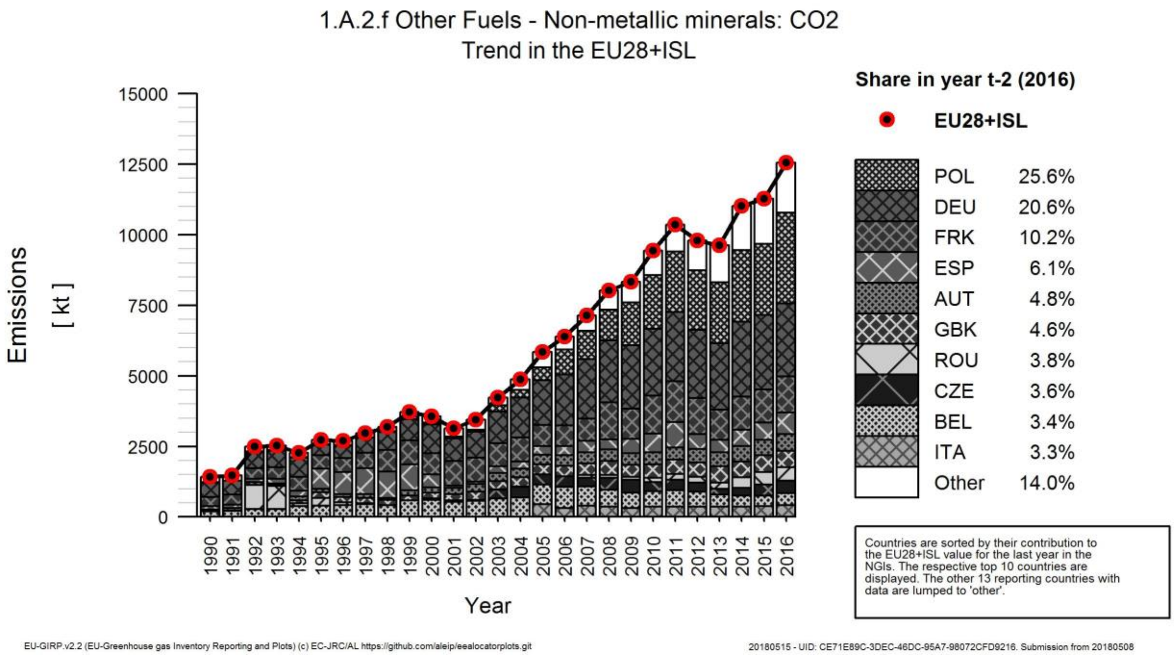
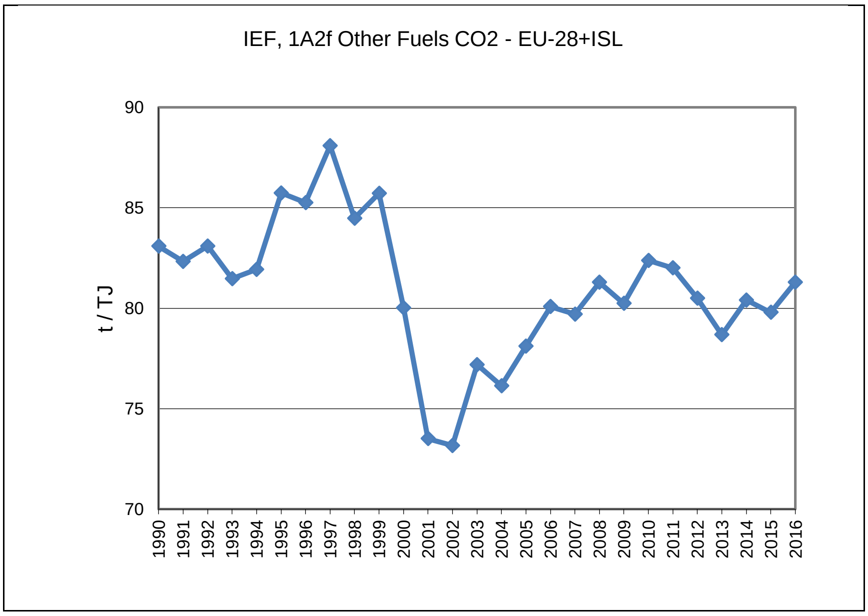
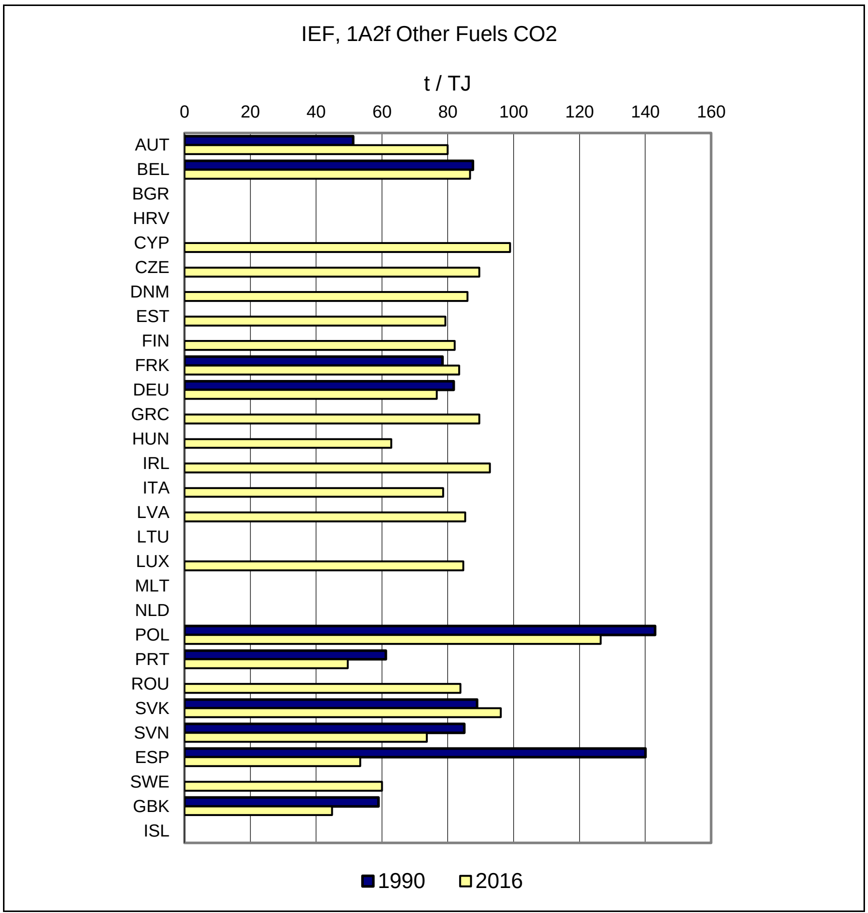


Figure 3.75 1A2f Non-metallic Minerals, other fossil fuels: Implied Emission Factors for CO_2 (in t/TJ)





3.2.2.7 Other (1A2g)

In this chapter information about emission trends, Member States contribution and activity data is provided for category 1A2g by fuels. GHG emissions from 1A2g Other accounted for 33.3% for 1A2 source category and for 3.6% of total GHG emissions in 2016.

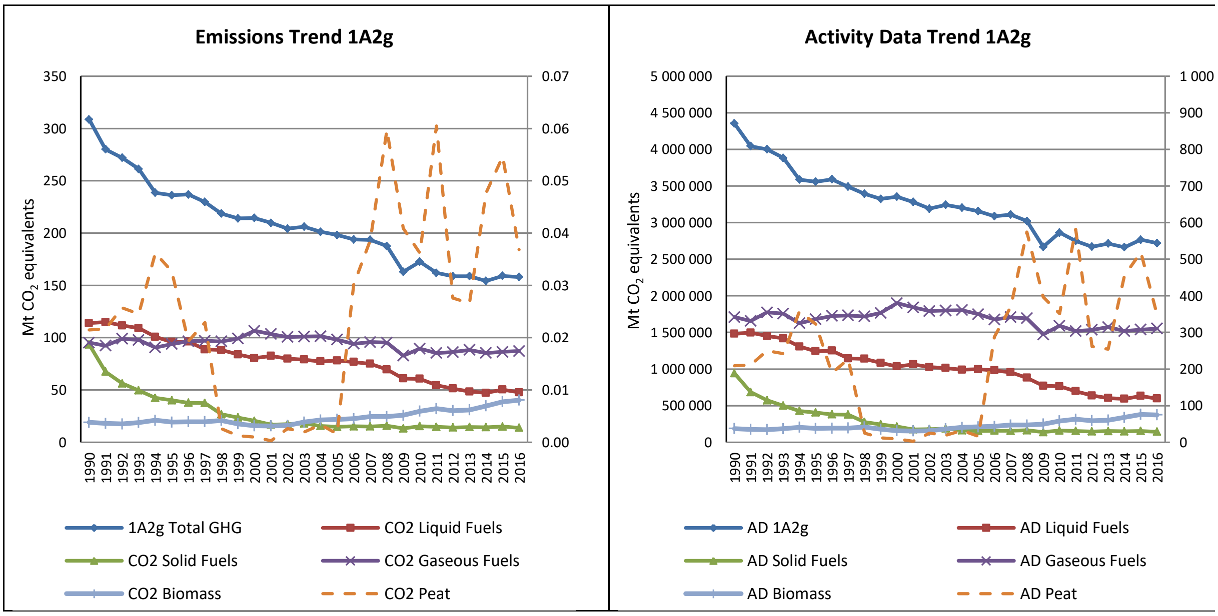
This category includes emissions from stationary combustion but also may include emissions from mobile sources (e.g. construction machinery). Some Member States use this category to report emissions which cannot be allocated to the categories 1A2a to 1A2f due to lack of detailed data, e.g. IEA data provides fuel consumption of Industrial Auto-producers (Electricity, CHP, Heat) for total industry only. Some Member States are reporting/hiding confidential data under this category. The following Table 3.49 presents 1A2g GHG emissions and the share of mobile machinery (off road vehicles) by Member State. Most Member States are reporting emissions from off road vehicles separately. Greece reports emissions of 1A2g together with category 1A2f. Portugal includes emissions from 1A2gvii mobile sources together with 1A2gviii stationary sources and Slovakia includes it together with agricultural mobile sources in category 1A4cii while Ireland presumably includes it in the transport sector (1A3). Sweden reports solid fuels for the years 2013 to 2016, other fossil fuels for the year 2015, gaseous fuels for the years 2013 to 2015 and biomass for the years 2013 and 2016 as confidential. Within the EU inventory Swedish confidential data has been included in ‘other fossil fuels’.

Table 3.49: 1A2g Other: CO_2, CH_4 and N_2O emissions

Member State		Emissions in kt		
		CO2	CH4	N2O
AUT	g. Other	3 195	0.405	0.287
	1.A.2.g.vii Off-road vehicles and other machinery	1 079	0.022	0.149
BEL	g. Other	2 074	0.350	0.061
	1.A.2.g.vii Off-road vehicles and other machinery	491	0.083	0.038
BGR	g. Other	625	0.140	0.040
	1.A.2.g.vii Off-road vehicles and other machinery	56	0.003	0.022
HRV	g. Other	1 274	0.086	0.014
	1.A.2.g.vii Off-road vehicles and other machinery	289	0.012	0.002
CYP	g. Other	54	0.002	0.000
	1.A.2.g.vii Off-road vehicles and other machinery			
CZE	g. Other	2 208	0.362	0.048
	1.A.2.g.vii Off-road vehicles and other machinery			
DNM	g. Other	1 058	0.164	0.069
	1.A.2.g.vii Off-road vehicles and other machinery	675	0.028	0.031
EST	g. Other	213	0.041	0.006
	1.A.2.g.vii Off-road vehicles and other machinery			
FIN	g. Other	1 741	0.544	0.052
	1.A.2.g.vii Off-road vehicles and other machinery	1 284	0.100	0.022
FRK	g. Other	6 980	1.088	0.918
	1.A.2.g.vii Off-road vehicles and other machinery			
DEU	g. Other	74 038	7.978	1.915
	1.A.2.g.vii Off-road vehicles and other machinery	3 288	0.120	0.130
GRC	g. Other	IE	IE	IE
	1.A.2.g.vii Off-road vehicles and other machinery	IE	IE	IE
HUN	g. Other	1 709	0.097	0.035
	1.A.2.g.vii Off-road vehicles and other machinery	557	0.007	0.024
IRL	g. Other	739	0.159	0.021
	1.A.2.g.vii Off-road vehicles and other machinery	NO,IE	NO,IE	NO,IE
ITA	g. Other	7 865	0.169	0.471
	1.A.2.g.vii Off-road vehicles and other machinery			
LVA	g. Other	192	0.416	0.055
	1.A.2.g.vii Off-road vehicles and other machinery	3	0.003	0.000
LTU	g. Other	193	0.086	0.027
	1.A.2.g.vii Off-road vehicles and other machinery	41	0.003	0.016
LUX	g. Other	232	0.030	0.023
	1.A.2.g.vii Off-road vehicles and other machinery	153	0.003	0.019
MLT	g. Other	33	0.001	0.000
	1.A.2.g.vii Off-road vehicles and other machinery			
NLD	g. Other	3 006	0.592	0.072
	1.A.2.g.vii Off-road vehicles and other machinery	1 506	0.033	0.018
POL	g. Other	2 649	1.019	0.138
	1.A.2.g.vii Off-road vehicles and other machinery			
PRT	g. Other	1 571	0.099	0.041
	1.A.2.g.vii Off-road vehicles and other machinery	IE	IE	IE
ROU	g. Other	4 771	0.398	0.016
	1.A.2.g.vii Off-road vehicles and other machinery			
SVK	g. Other	1 189	0.105	0.013
	1.A.2.g.vii Off-road vehicles and other machinery	IE	IE	IE
SVN	g. Other	393	0.073	0.038
	1.A.2.g.vii Off-road vehicles and other machinery	76	0.005	0.029
ESP	g. Other	8 012	8.452	0.193
	1.A.2.g.vii Off-road vehicles and other machinery			
SWE	g. Other	2 489	0.314	0.169
	1.A.2.g.vii Off-road vehicles and other machinery	1 280	0.092	0.059
GBK	g. Other	26 518	3.404	2.552
	1.A.2.g.vii Off-road vehicles and other machinery	5 779	0.915	2.209
ISL	g. Other	152	0.008	0.042
	1.A.2.g.vii Off-road vehicles and other machinery	108.690	0.006	0.042

Figure 3.47 shows the emission trend within the category 1A2g, which is mainly dominated by CO_2 emissions from gaseous, liquid and solid fuels; the decrease in the early 1990s was mainly due to a decline of solid fuel consumption. Total GHG emissions decreased by 49%, mainly due to decreases in CO_2 emissions from solid (-85%) and liquid (-58%) fuels.

Figure 3.76 1A2g Other: Activity data and CO_2 emission trends



Data displayed as dashed line refers to the secondary axis.

Between 1990 and 2016, CO_2 emissions from 1A2g Other decreased by 49% in the EU-28+ISL (Table 3.50). Romania, Germany, the Czech Republic, Bulgaria, Italy and the United Kingdom report significant decreases of GHG emissions while Austria reports the highest increases since 1990.

Malta reports almost all emissions from categories 1A2a to 1A2f under this category. Croatia reports emissions from 1A2a-1A2f for the years 1990 to 2000 under this category.

Table 3.50 1A2g Other: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016		Method	Emission factor Informa-tion
	1990	2015	2016		kt CO2	%	kt CO2	%		
Austria	1 972	2 923	3 195	2.1%	1 223	62%	271	9%	T1,T2,T3	CS,D
Belgium	2 816	2 385	2 074	1.3%	-742	-26%	-311	-13%	CS,T1,T3	D
Bulgaria	10 585	614	625	0.4%	-9 960	-94%	11	2%	T1,T2	CS,D
Croatia	5 502	1 363	1 274	0.8%	-4 228	-77%	-90	-7%	T1	D
Cyprus	48	47	54	0.0%	6	12%	6	13%	T1	D
Czech Republic	23 171	2 381	2 208	1.4%	-20 963	-90%	-173	-7%	T1,T2	CS,D
Denmark	1 679	1 063	1 058	0.7%	-621	-37%	-6	-1%	CR,M,T1,T2,T3	CS,D
Estonia	280	162	213	0.1%	-67	-24%	51	31%	T1,T2	CS,D
Finland	1 872	1 702	1 741	1.1%	-131	-7%	39	2%	CS,M,T2,T3	CS,D
France	11 144	6 902	6 980	4.5%	-4 164	-37%	78	1%	T2	CS
Germany	127 935	72 261	74 038	47.7%	-53 897	-42%	1 777	2%	CS	CS,D
Greece	IE	IE	IE	-	-	-	-	-	NA	NA
Hungary	5 180	1 606	1 709	1.1%	-3 471	-67%	103	6%	T1,T2	CS,D
Ireland	684	695	739	0.5%	55	8%	43	6%	T1,T2	CS,D
Italy	19 255	10 019	7 865	5.1%	-11 390	-59%	-2 154	-22%	T2	CS
Latvia	1 358	185	192	0.1%	-1 166	-86%	7	4%	T1,T2	CS,D
Lithuania	1 567	164	193	0.1%	-1 374	-88%	29	18%	T1,T2	CS,D
Luxembourg	103	224	232	0.1%	129	126%	9	4%	T1,T2	CS,D
Malta	53	30	33	0.0%	-19	-37%	3	11%	T1	D
Netherlands	3 393	2 865	3 006	1.9%	-388	-11%	141	5%	T2	CS
Poland	7 049	2 653	2 649	1.7%	-4 400	-62%	-4	0%	T1,T2	CS,D
Portugal	2 189	1 676	1 571	1.0%	-618	-28%	-105	-6%	T2	D,OTH
Romania	23 761	5 244	4 771	3.1%	-18 990	-80%	-473	-9%	T1,T2	CS,D
Slovakia	2 560	1 187	1 189	0.8%	-1 371	-54%	2	0%	T2	CS
Slovenia	1 153	401	393	0.3%	-760	-66%	-8	-2%	T1,T2	CS,D
Spain	7 857	7 560	8 012	5.2%	155	2%	452	6%	T2	CS,M,OTH,PS
Sweden	3 240	2 444	2 489	1.6%	-751	-23%	46	2%	T1,T2	CS
United Kingdom	38 430	27 152	26 371	17.0%	-12 059	-31%	-780	-3%	T1,T2,T3	CS,D
EU-28	**304 833**	**155 909**	**154 873**	**100%**	**-149 960**	**-49%**	**-1 037**	**-1%**	**-**	**-**
Iceland	162	123	152	0.1%	-10	-6%	29	23%	T1	D
United Kingdom (KP)	38 539	27 292	26 518	17.1%	-12 021	-31%	-774	-3%	T1,T2,T3	CS,D
EU-28 + ISL	**305 103**	**156 173**	**155 171**	**100%**	**-149 932**	**-49%**	**-1 001**	**-1%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.
Greece includes emissions of 1A2g in category 1A2f

1A2g Other – Liquid Fuels (CO_2)

In 2016 CO_2 from liquid fuels decreased to a share of 30% within source category 1A2g (compared to 37% in 1990). Between 1990 and 2016, CO_2 emissions decreased by 57% (Table 3.51). Between 1990 and 2016 all Member States showed a reduction of emissions except for Austria, Cyprus and Luxembourg. Fuel consumption decreased by 60% between 1990 and 2016. Sweden reports 2016 emissions as confidential. According to the methodology as described in chapter 3.2.2 about 91% of EU-28 emissions are calculated by using higher tier methods in 2016.

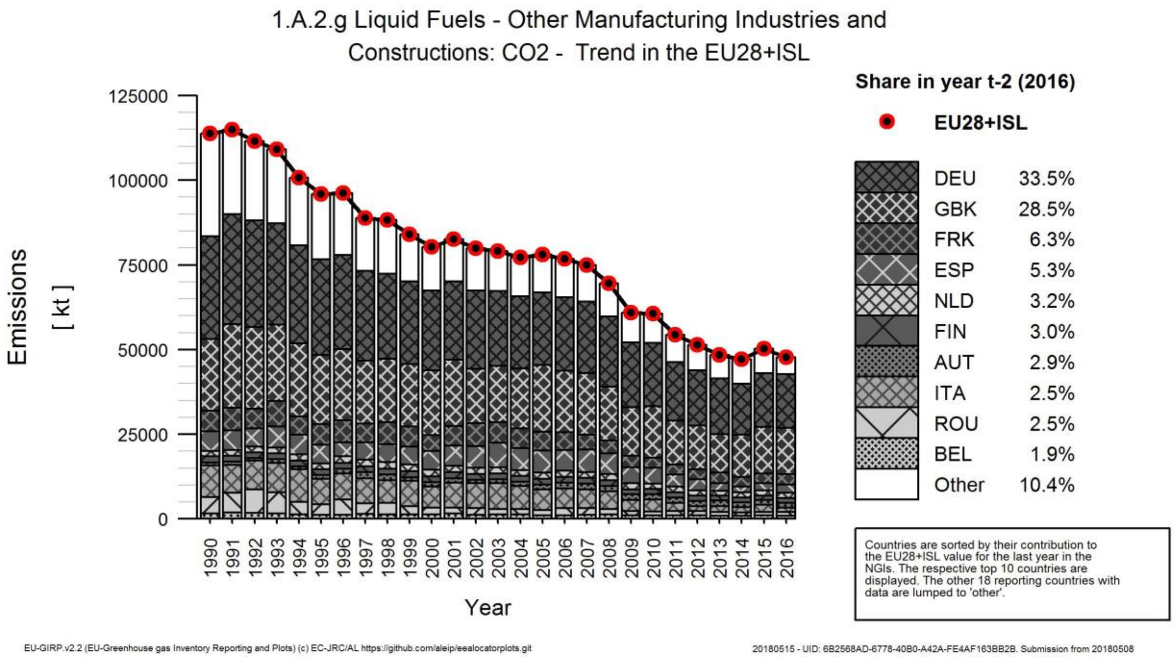
Table 3.51 1A2g Other, liquid fuels: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016	
	1990	2015	2016		kt CO2	%	kt CO2	%
Austria	862	1 395	1 408	2.9%	545	63%	13	1%
Belgium	1 579	992	914	1.9%	-665	-42%	-78	-8%
Bulgaria	8 638	157	144	0.3%	-8 494	-98%	-13	-9%
Croatia	2 158	885	857	1.8%	-1 301	-60%	-29	-3%
Cyprus	48	47	54	0.1%	6	12%	6	13%
Czech Republic	7 041	595	198	0.4%	-6 843	-97%	-397	-67%
Denmark	1 068	689	684	1.4%	-384	-36%	-6	-1%
Estonia	188	129	167	0.4%	-21	-11%	38	29%
Finland	1 713	1 393	1 451	3.0%	-262	-15%	57	4%
France	6 097	2 824	3 010	6.3%	-3 087	-51%	186	7%
Germany	30 317	15 883	15 981	33.5%	-14 336	-47%	98	1%
Greece	IE	IE	IE	-	-	-	-	-
Hungary	1 900	558	612	1.3%	-1 288	-68%	54	10%
Ireland	512	361	379	0.8%	-133	-26%	18	5%
Italy	9 470	2 033	1 206	2.5%	-8 264	-87%	-827	-41%
Latvia	804	97	100	0.2%	-704	-88%	3	3%
Lithuania	812	63	59	0.1%	-753	-93%	-4	-7%
Luxembourg	59	159	165	0.3%	105	178%	5	3%
Malta	53	30	33	0.1%	-19	-37%	3	11%
Netherlands	1 642	1 501	1 506	3.2%	-136	-8%	5	0%
Poland	1 026	629	617	1.3%	-410	-40%	-13	-2%
Portugal	2 139	695	574	1.2%	-1 565	-73%	-121	-17%
Romania	4 805	1 123	1 174	2.5%	-3 632	-76%	51	5%
Slovakia	66	9	12	0.0%	-54	-81%	3	38%
Slovenia	647	137	137	0.3%	-510	-79%	0	0%
Spain	5 788	2 112	2 522	5.3%	-3 266	-56%	410	19%
Sweden	3 033	1 930	C	-	-3 033	-100%	-1 930	-100%
United Kingdom	21 100	13 588	13 470	28.2%	-7 631	-36%	-118	-1%
EU-28	**110 533**	**48 088**	**47 432**	**99%**	**-63 101**	**-57%**	**-656**	**-1%**
Iceland	162	123	152	0.3%	-10	-6%	29	23%
United Kingdom (KP)	21 208	13 728	13 616	28.5%	-7 592	-36%	-111	-1%
EU-28 + ISL	**110 803**	**48 351**	**47 730**	**100%**	**-63 073**	**-57%**	**-621**	**-1%**

Greece includes emissions of 1A2g in category 1A2f
EU trends in this table do not include Sweden for confidentiality reasons and to preserve time series consistency for the EU. This also explains the differences between the numbers in this table and the CRF.
Note: The information on methodologies and emission factors is not available from the CRF/XML on fuels level.
Abbreviations explained in the Chapter 'Units and abbreviations'.

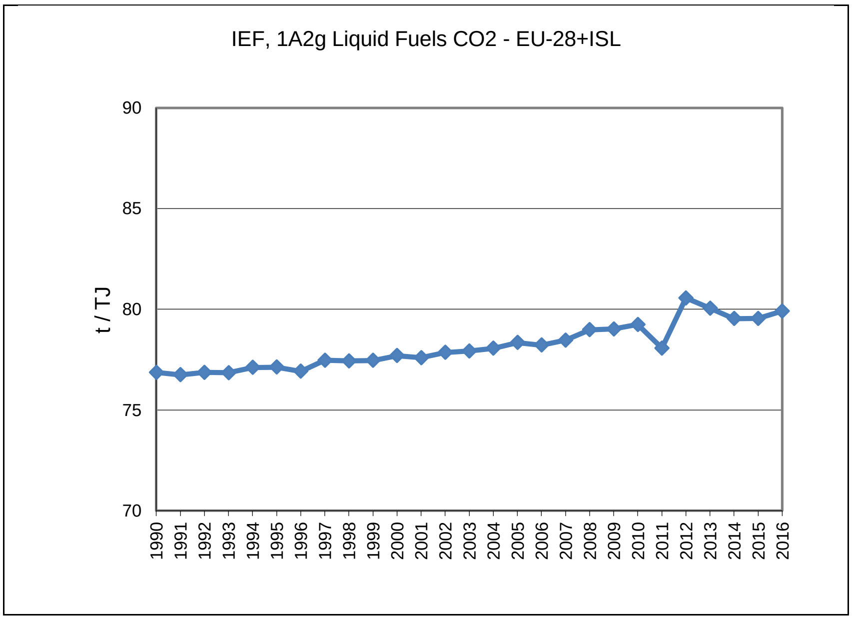
Figure 3.77 and Figure 3.78 show CO_2 emissions and implied emission factors for EU-28+ISL as well as the share of the Member States with the highest contributions. The largest emissions are reported by Germany and the United Kingdom; together they cause 62% of the CO_2 emissions from liquid fuels in 1A2g. The CO_2 implied emission factor for liquid fuels was 79.9 t/TJ in 2016. The high IEF of Germany is due to inclusion of residual gases of chemical industry.

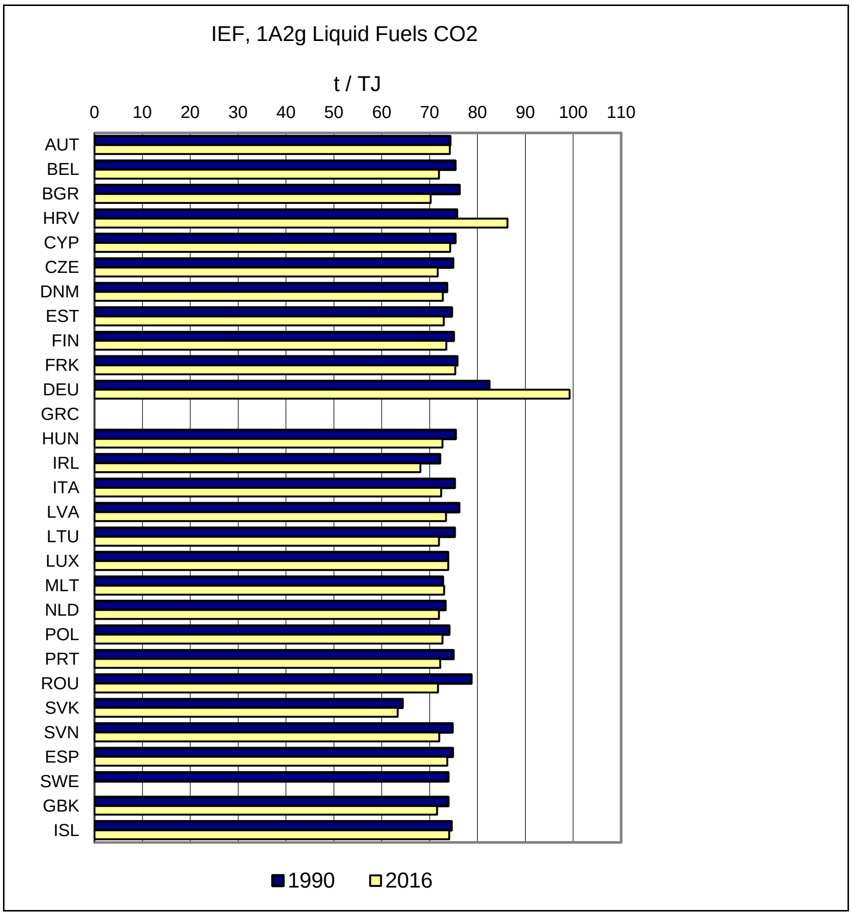
Figure 3.77 1A2g Other, liquid fuels: Emission trend and share for CO_2



Note: This figure does include Sweden. This also explains the differences between the share of countries in this figure and the table on MS contributions.

Figure 3.78 1A2g Other, liquid fuels: Implied Emission Factors for CO_2 (in t/TJ)





1A2g Other – Solid Fuels (CO_2)

In 2016 CO_2 from solid fuels decreased to a share of 9% within source category 1A2g (compared to 30% in 1990). Between 1990 and 2016, CO_2 emissions decreased by 85% (Table 3.52). Between 1990 and 2016 all Member States showed a reduction of emissions except for the Netherlands. Fuel consumption decreased by 85% between 1990 and 2016. Sweden reports 2013 to 2016 emissions as confidential. According to the methodology as described in chapter 3.2.2 about 95% of EU-28 emissions are calculated by using higher tier methods in 2016.

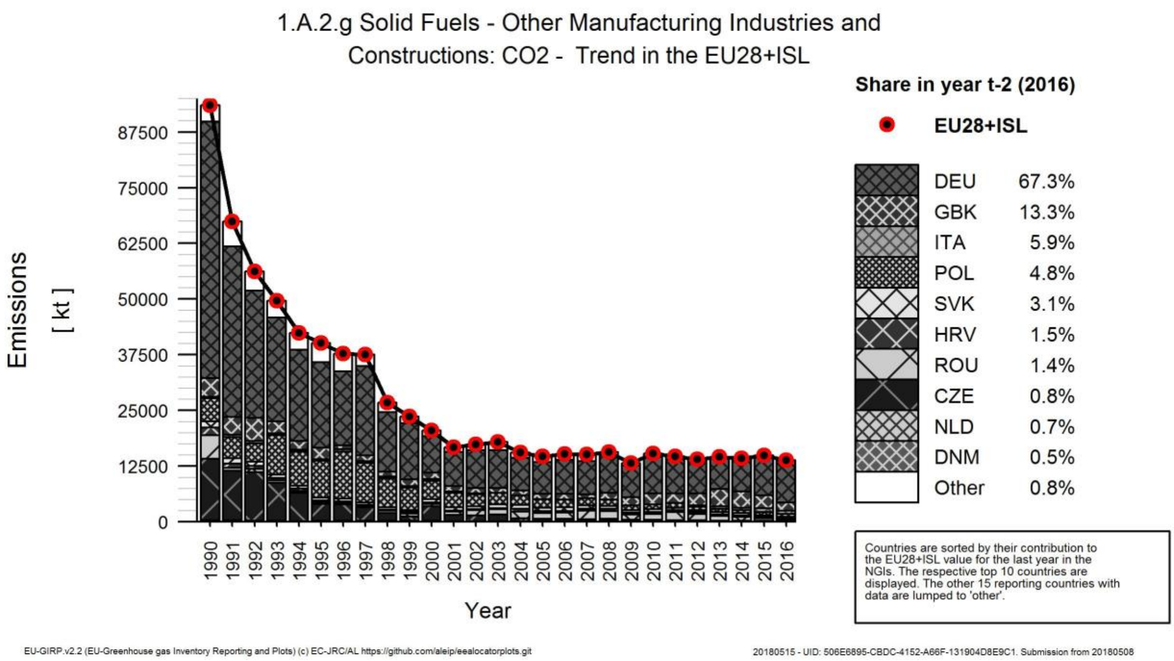
Table 3.52 1A2g Other, solid fuels: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016	
	1990	2015	2016		kt CO2	%	kt CO2	%
Austria	91	4	0	0.0%	-91	-100%	-4	-93%
Belgium	33	13	14	0.1%	-19	-57%	1	6%
Bulgaria	1 858	16	13	0.1%	-1 845	-99%	-3	-16%
Croatia	1 703	258	200	1.5%	-1 502	-88%	-57	-22%
Cyprus	NO	NO	NO	-	-	-	-	-
Czech Republic	13 750	115	113	0.8%	-13 637	-99%	-2	-2%
Denmark	326	70	66	0.5%	-260	-80%	-4	-6%
Estonia	38	0	0	0.0%	-37	-99%	0	400%
Finland	8	0	NO	-	-8	-100%	0	-100%
France	371	75	4	0.0%	-367	-99%	-71	-94%
Germany	57 580	8 798	9 282	67.3%	-48 299	-84%	484	5%
Greece	IE	IE	IE	-	-	-	-	-
Hungary	677	30	30	0.2%	-648	-96%	0	-1%
Ireland	14	0	NO	-	-14	-100%	0	-100%
Italy	397	896	808	5.9%	411	104%	-88	-10%
Latvia	27	3	3	0.0%	-24	-89%	0	-2%
Lithuania	79	5	5	0.0%	-74	-94%	0	4%
Luxembourg	20	18	15	0.1%	-5	-25%	-3	-18%
Malta	NO	NO	NO	-	-	-	-	-
Netherlands	42	52	92	0.7%	50	120%	40	76%
Poland	5 154	753	667	4.8%	-4 488	-87%	-86	-11%
Portugal	49	19	22	0.2%	-28	-56%	3	17%
Romania	5 313	518	190	1.4%	-5 123	-96%	-329	-63%
Slovakia	1 422	419	428	3.1%	-994	-70%	9	2%
Slovenia	89	0	0	0.0%	-88	-100%	0	54%
Spain	248	NO	NO	-	-248	-100%	-	-
Sweden	94	C	C	-	-94	-100%	-	-
United Kingdom	4 118	2 861	1 841	13.3%	-2 277	-55%	-1 020	-36%
EU-28	**93 407**	**14 923**	**13 793**	**100%**	**-79 614**	**-85%**	**-1 130**	**-8%**
Iceland	NO	NO	NO	-	-	-	-	-
United Kingdom (KP)	4 118	2 861	1 841	13.3%	-2 277	-55%	-1 020	-36%
EU-28 + ISL	**93 407**	**14 923**	**13 793**	**100%**	**-79 614**	**-85%**	**-1 130**	**-8%**

EU trends in this table do not include Sweden for confidentiality reasons and to preserve time series consistency for the EU. This also explains the differences between the numbers in this table and the CRF.
Note: The information on methodologies and emission factors is not available from the CRF/XML on fuels level.
Abbreviations explained in the Chapter 'Units and abbreviations'.
Greece includes emissions of 1A2g in category 1A2f

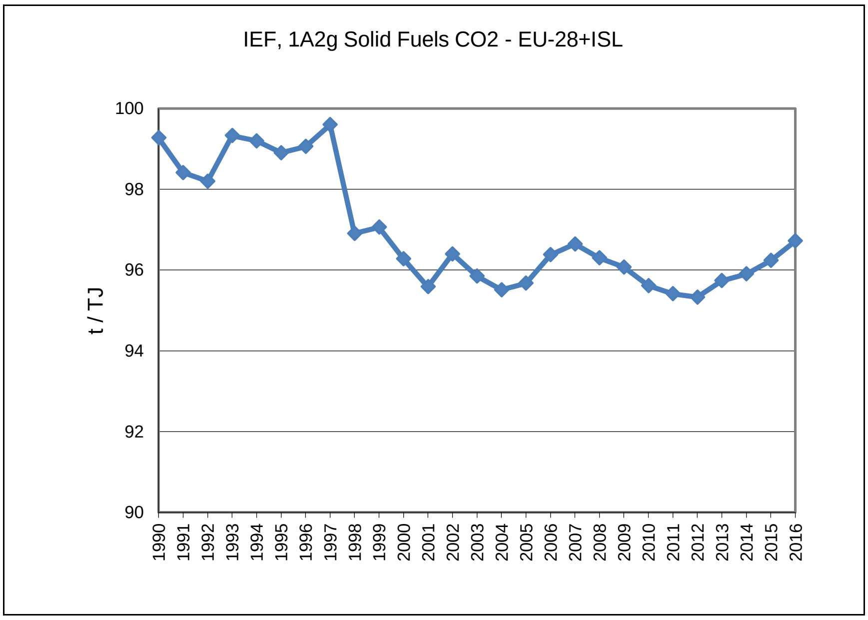
Figure 3.79 and Figure 3.80 show CO_2 emissions and implied emission factors for EU-28+ISLand the Member States as well as the share of the Member States with the highest contributions. The largest emissions are reported by Germany and the United Kingdom; together they cause 81% of the CO_2 emissions from liquid fuels in 1A2g. The CO_2-implied emission factor for solid fuels was 96.7 t/TJ in 2016.

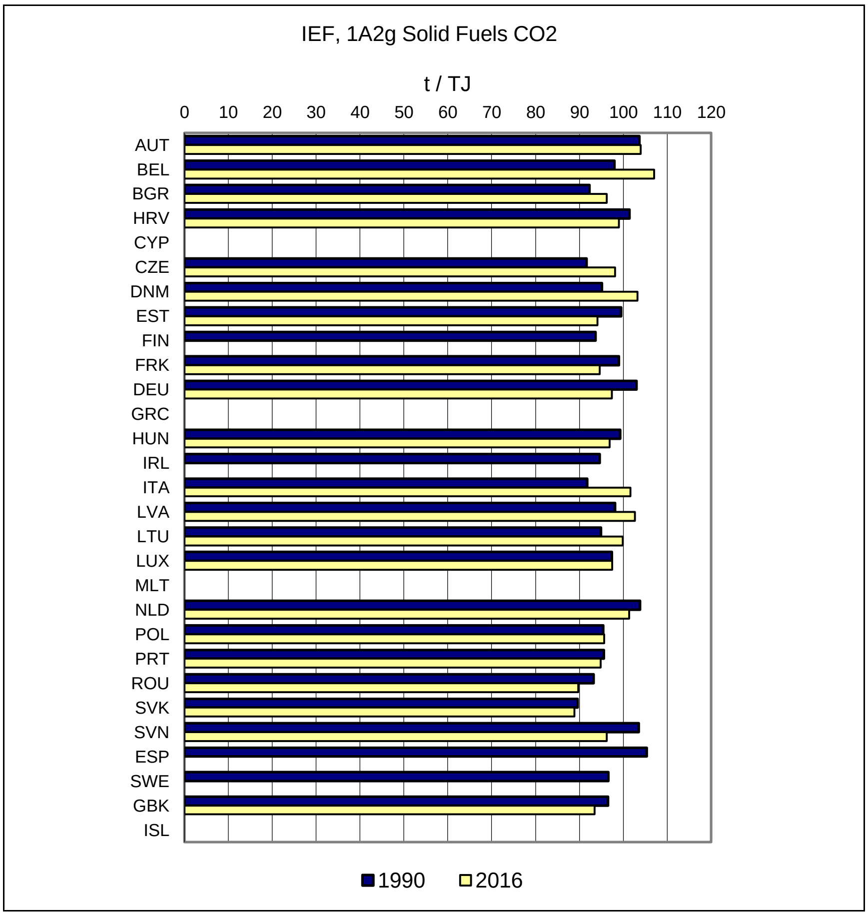
Figure 3.79 1A2g Other, solid fuels: Emission trend and share for CO_2



Note: This figure does include Sweden. This also explains the differences between the share of countries in this figure and the table on MS contributions.

Figure 3.80 1A2g Other, solid fuels: Implied Emission Factors for CO_2 (in t/TJ)





1A2g Other – Gaseous Fuels (CO_2)

In 2016 CO_2 from gaseous fuels increased to a share of 55% within source category 1A2g (compared to 31% in 1990). Between 1990 and 2016, the emissions decreased by 8% (Table 3.53). Between 1990 and 2016 Romania shows the most significant decrease (-75%) while Germany (+20%) and Spain (+201%) show the most significant increase of emissions. Sweden reports 2013 to 2015 emissions as confidential. According to the methodology as described in chapter 3.2.2 about 96% of EU-28 emissions are calculated by using higher tier methods in 2016.

Table 3.53 1A2g Other, gaseous fuels: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016	
	1990	2015	2016		kt CO2	%	kt CO2	%
Austria	1 014	1 497	1 758	2.0%	745	73%	261	17%
Belgium	1 204	1 339	1 108	1.3%	-96	-8%	-230	-17%
Bulgaria	89	373	365	0.4%	276	310%	-8	-2%
Croatia	1 641	165	158	0.2%	-1 483	-90%	-7	-4%
Cyprus	NO	NO	NO	-	-	-	-	-
Czech Republic	2 379	1 671	1 896	2.2%	-483	-20%	225	13%
Denmark	284	304	308	0.4%	24	8%	4	1%
Estonia	54	33	45	0.1%	-9	-16%	12	38%
Finland	41	33	32	0.0%	-9	-22%	-1	-2%
France	4 667	3 992	3 951	4.5%	-716	-15%	-41	-1%
Germany	37 693	44 113	45 309	52.0%	7 615	20%	1 195	3%
Greece	IE	IE	IE	-	-	-	-	-
Hungary	2 603	1 018	1 067	1.2%	-1 536	-59%	49	5%
Ireland	158	334	360	0.4%	202	128%	26	8%
Italy	9 388	7 090	5 850	6.7%	-3 537	-38%	-1 240	-17%
Latvia	527	84	85	0.1%	-441	-84%	1	2%
Lithuania	677	94	122	0.1%	-555	-82%	28	29%
Luxembourg	24	46	53	0.1%	29	122%	7	16%
Malta	NO	NO	NO	-	-	-	-	-
Netherlands	1 710	1 312	1 408	1.6%	-302	-18%	96	7%
Poland	865	1 264	1 360	1.6%	495	57%	96	8%
Portugal	NO,IE	956	971	1.1%	971	∞	14	2%
Romania	13 643	3 601	3 407	3.9%	-10 236	-75%	-194	-5%
Slovakia	1 071	759	749	0.9%	-322	-30%	-11	-1%
Slovenia	417	256	250	0.3%	-167	-40%	-6	-2%
Spain	1 821	5 448	5 490	6.3%	3 669	201%	42	1%
Sweden	113	NO,C	97	0.1%	-16	-14%	97	∞
United Kingdom	13 136	10 647	11 030	12.7%	-2 106	-16%	383	4%
EU-28	**95 105**	**86 429**	**87 133**	**100%**	**-7 971**	**-8%**	**704**	**1%**
Iceland	NO	NO	NO	-	-	-	-	-
United Kingdom (KP)	13 136	10 647	11 030	12.7%	-2 106	-16%	383	4%
EU-28 + ISL	**95 105**	**86 429**	**87 133**	**100%**	**-7 971**	**-8%**	**704**	**1%**

Abbreviations explained in the Chapter 'Units and abbreviations'.
Greece includes emissions of 1A2g in category 1A2f
Note: The information on methodologies and emission factors is not available from the CRF/XML on fuels level.
EU trends in this table do not include Sweden for confidentiality reasons and to preserve time series consistency for the EU. This also explains the differences between the numbers in this table and the CRF.

Figure 3.81 and Figure 3.82 show CO_2 emissions and implied emission factors for EU-28+ISL as well as the share of the Member States with the highest contributions. The largest emissions are reported by Germany, Italy, Spain and the United Kingdom; together they cause 78% of the CO_2 emissions from gaseous fuels in 1A2g. Fuel consumption decreased by 9% between 1990 and 2016. The CO_2 implied emission factor for gaseous fuels was 56.2 t/TJ in 2016.

Figure 3.81 1A2g Other, gaseous fuels: Emission trend and share for CO_2

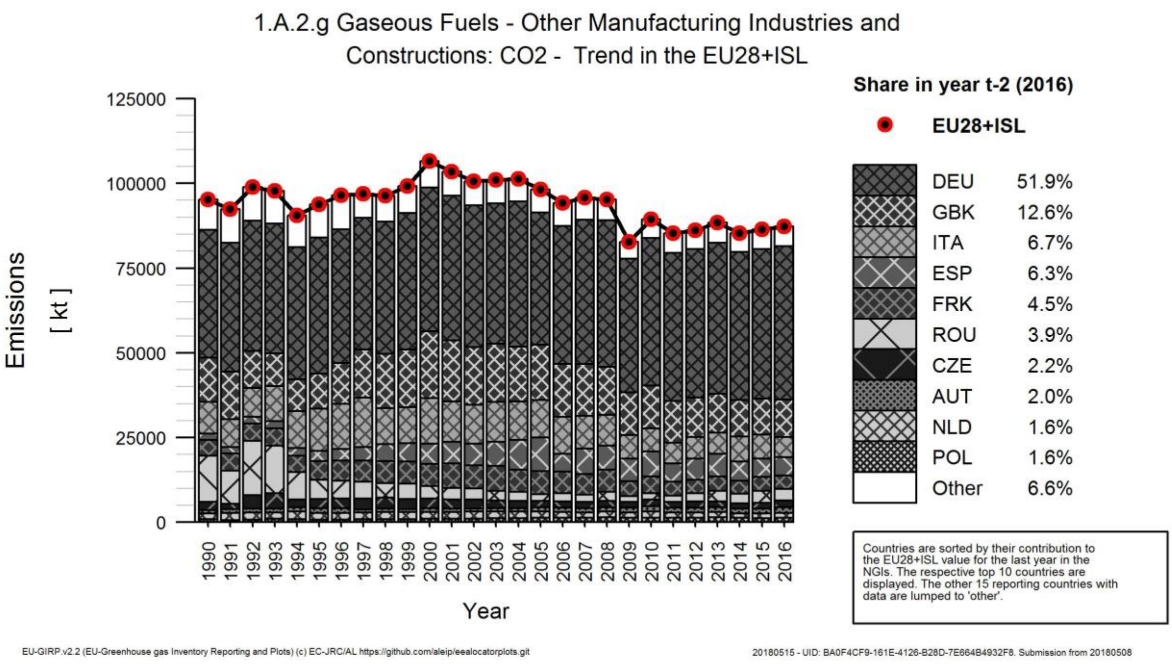
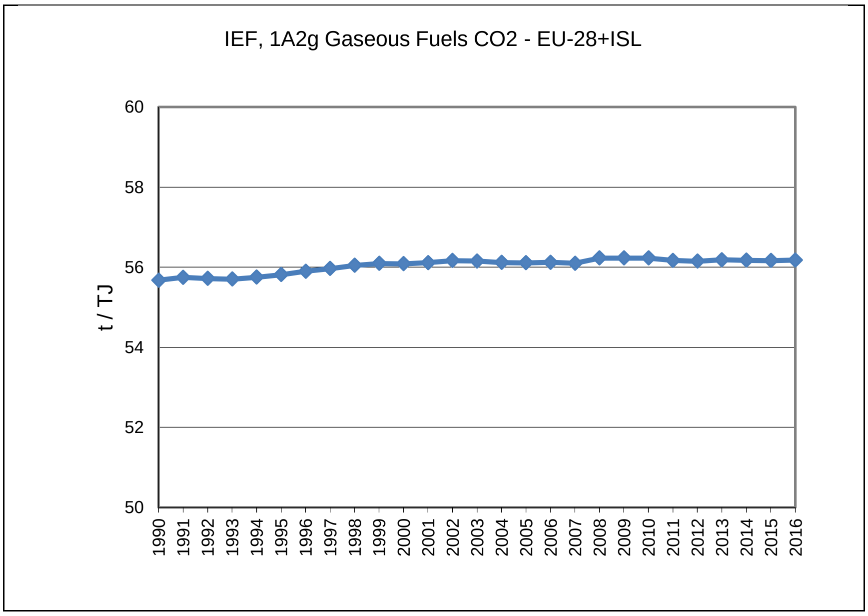
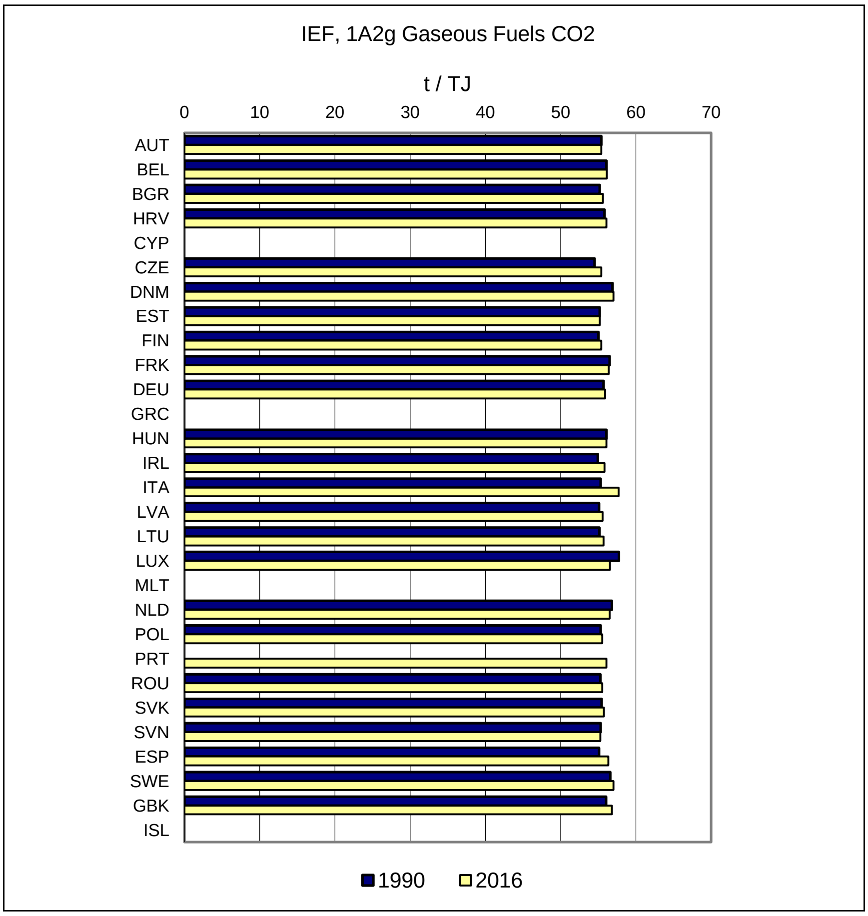


Figure 3.82 1A2g Other, gaseous fuels: Implied Emission Factors for CO_2 (in t/TJ)





1A2g Other – Other fossil fuels (CO_2)

In 2016 CO_2 from other fossil fuels increased to a share of 3% within source category 1A2g (compared to 1% in 1990). Between 1990 and 2016, CO_2 emissions increased by 58% (Table 3.54). Only 14 Member States reported emissions from this source and almost all of these Member States also reported an increase of emissions between 1990 and 2016. The trend and absolute values of emissions are dominated by Germany. Deviating to the methodology as described in chapter 3.2.2 about 90% of EU-28 emissions are assumed to be calculated by using higher tier methods in 2016 which is approximately the share of Germany.

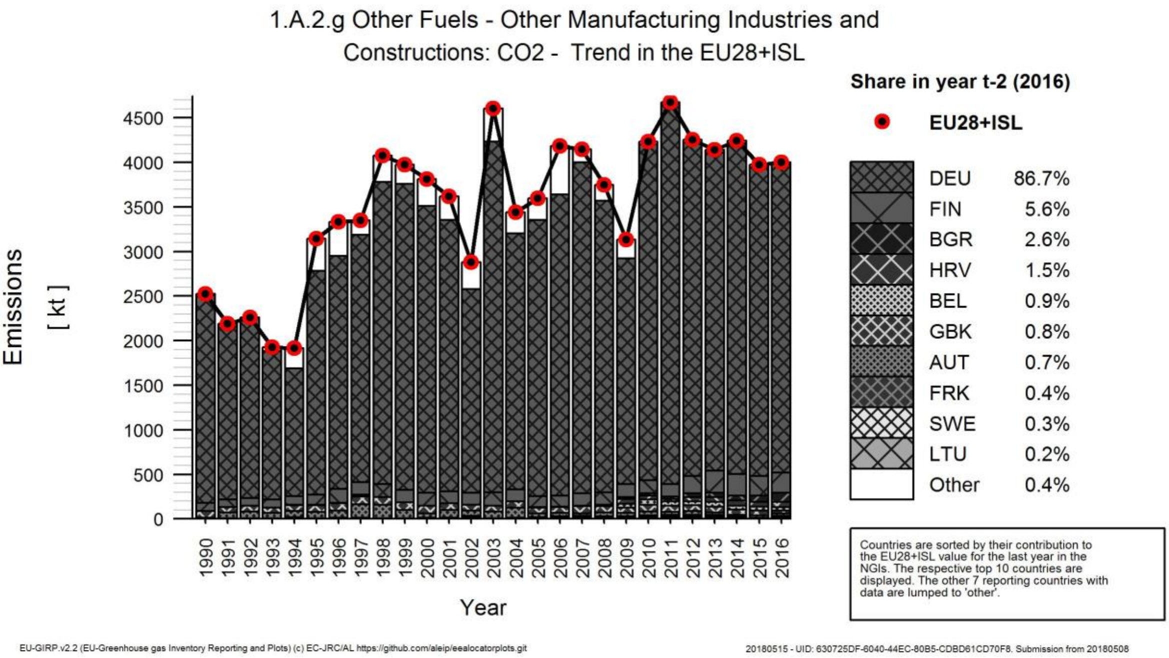
Table 3.54 1A2g Other, other fossil fuels: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016	
	1990	2015	2016		kt CO2	%	kt CO2	%
Austria	5	28	29	0.7%	24	498%	1	4%
Belgium	NO	41	37	0.9%	37	∞	-3	-8%
Bulgaria	0	68	103	2.6%	103	100%	35	51%
Croatia	NO	56	59	1.5%	59	∞	3	6%
Cyprus	NO	NO	NO	-	-	-	-	-
Czech Republic	NO	NO	NO	-	-	-	-	-
Denmark	1	NO	NO	-	-1	-100%	-	-
Estonia	NO	NO	NO	-	-	-	-	-
Finland	88	223	225	5.6%	137	156%	3	1%
France	10	10	15	0.4%	5	52%	4	41%
Germany	2 344	3 466	3 467	86.9%	1 122	48%	0	0%
Greece	-	-	-	-	-	-	-	-
Hungary	NO	NO	NO	-	-	-	-	-
Ireland	NO	NO	NO	-	-	-	-	-
Italy	NO	NO	NO	-	-	-	-	-
Latvia	NO	NO	NO	-	-	-	-	-
Lithuania	NO	1	7	0.2%	7	∞	6	454%
Luxembourg	NO	NO	NO	-	-	-	-	-
Malta	NO	NO	NO	-	-	-	-	-
Netherlands	NO	NO	NO	-	-	-	-	-
Poland	3	6	5	0.1%	2	68%	-1	-18%
Portugal	NO,IE	6	5	0.1%	5	∞	-2	-26%
Romania	NO	1	1	0.0%	1	∞	-1	-45%
Slovakia	NO	NO	NO	-	-	-	-	-
Slovenia	NO	8	6	0.1%	6	∞	-3	-31%
Spain	NO	NO	NO	-	-	-	-	-
Sweden	NO	NO,C	12	0.3%	12	∞	12	∞
United Kingdom	76	56	30	0.8%	-46	-60%	-25	-46%
EU-28	**2 527**	**3 971**	**3 989**	**100%**	**1 462**	**58%**	**18**	**0%**
Iceland	NO	NO	NO	-	-	-	-	-
United Kingdom (KP)	76	56	30	0.8%	-46	-60%	-25	-46%
EU-28 + ISL	**2 527**	**3 971**	**3 989**	**100%**	**1 462**	**58%**	**18**	**0%**

Abbreviations explained in the Chapter 'Units and abbreviations'.
Note: The information on methodologies and emission factors is not available from the CRF/XML on fuels level.
EU trends in this table do not include Sweden for confidentiality reasons and to preserve time series consistency for the EU. This also explains the differences between the numbers in this table and the CRF.

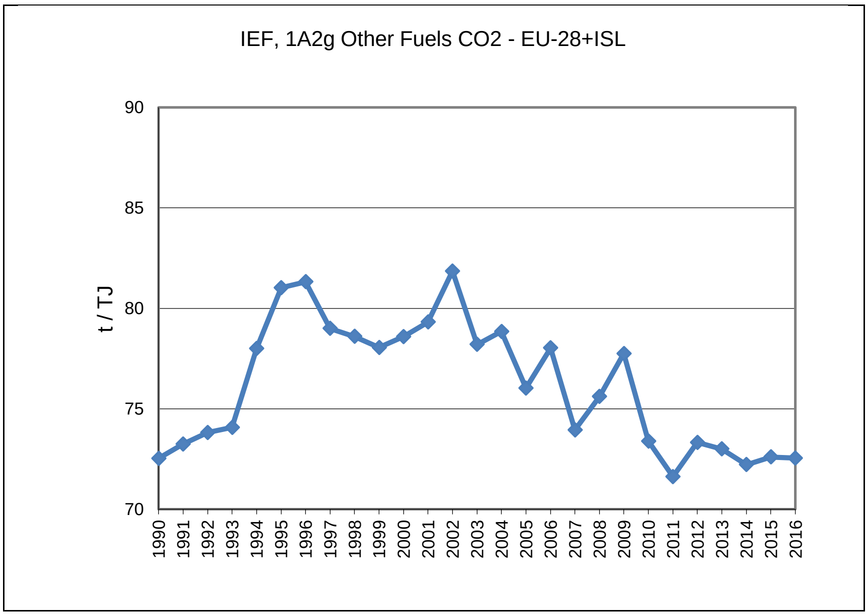
Figure 3.83 and Figure 3.84 show CO_2 emissions and implied emission factors for EU-28+ISL and the Member States as well as the share of the Member States with the highest contributions. The emission level is dominated by Germany which covers 87% of the CO_2 emissions from other fossil fuels in 1A2g. Fuel consumption in the EU-28 increased by 58% between 1990 and 2016. The CO_2-implied emission factor for other fossil fuels was 72.5 t/TJ in 2016. The comparatively low implied emission factor of Austria is mainly due to reporting of wood waste with a high biomass content.

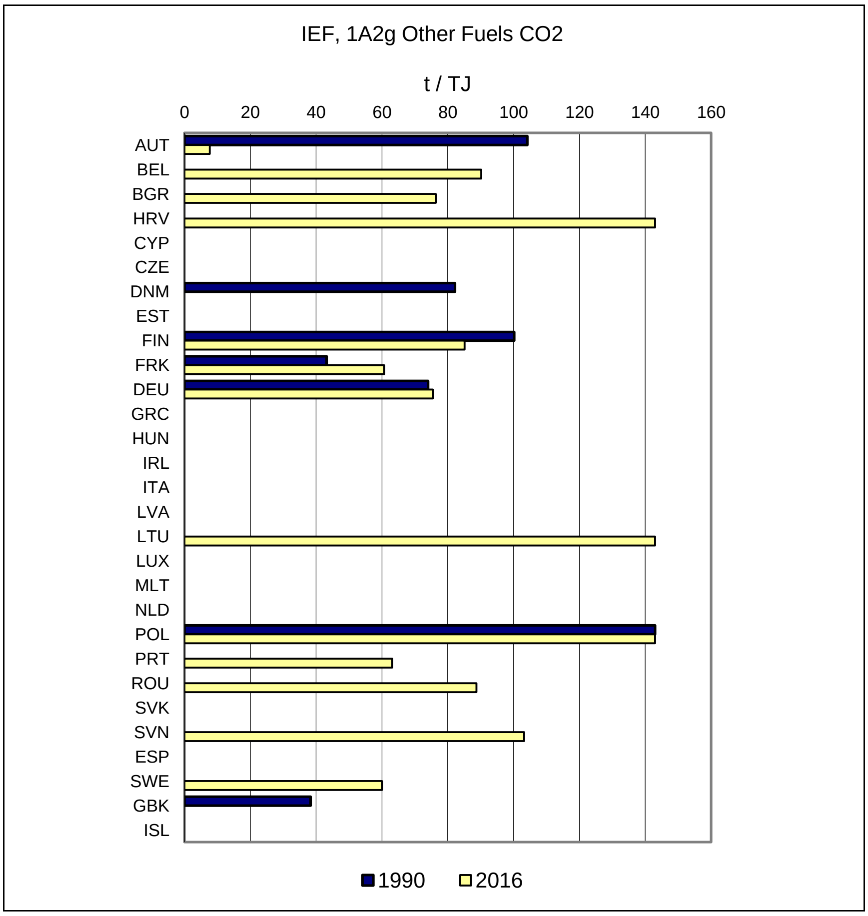
Figure 3.83 1A2g Other, other fossil fuels: Emission trend and share for CO_2



Note: This figure does include Sweden. This also explains the differences between the share of countries in this figure and the table on MS contributions.

Figure 3.84 1A2g Other, other fossil fuels: Implied Emission Factors for CO_2 (in t/TJ)

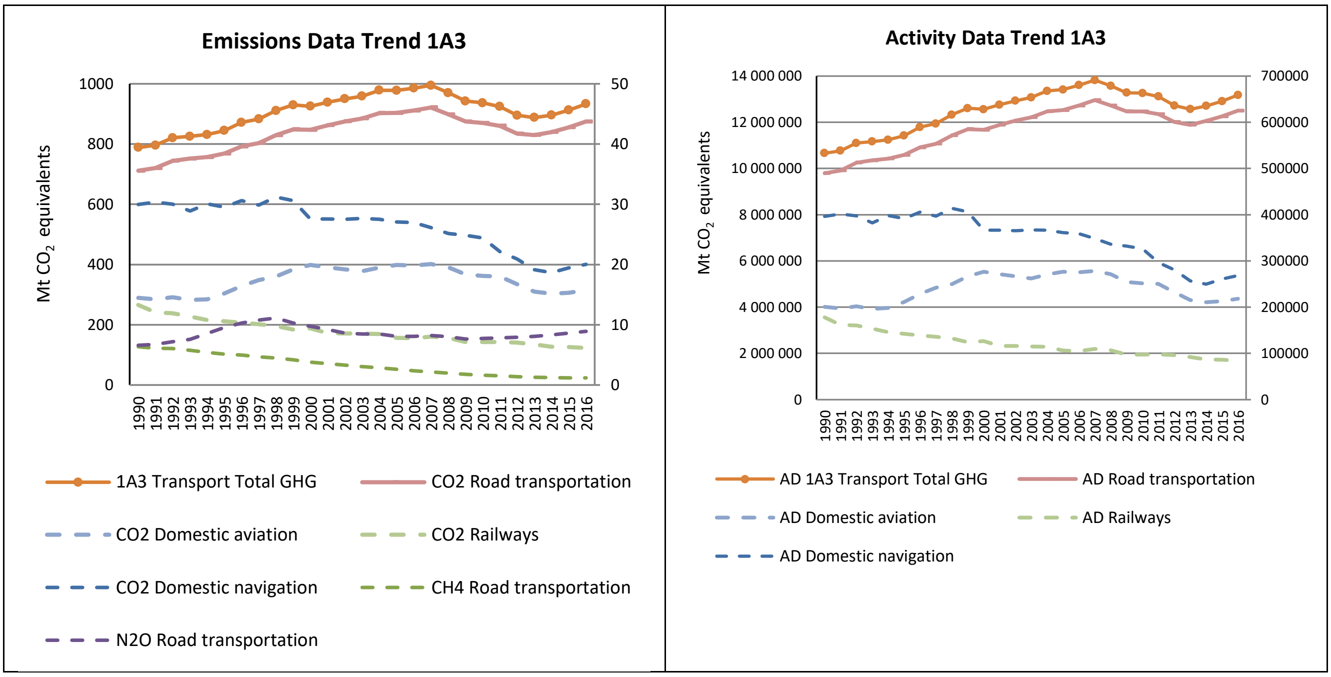



IEF, 1A2g Other Fuels CO2
t / TJ
0 20 40 60 80 100 120 140 160
AUT
BEL
BGR
HRV
CYP
CZE
DNM
EST
FIN
FRK
DEU
GRC
HUN
IRL
ITA
LVA
LTU
LUX
MLT
NLD
POL
PRT
ROU
SVK
SVN
ESP
SWE
GBK
ISL
1990
2016

3.2.3 Transport (CRF Source Category 1A3) (EU-28+ISL)

Greenhouse gas emissions from 1A3 Transport are shown in Figure 3.85. CO_2 emissions from this source category account for 21%, CH_4 for 0.03 %, N_2O for 0.2 % of total GHG emissions (without LULUCF). Between 1990 and 2016, GHG from transport increased by 18 % in the EU-28+ISL.

Figure 3.85 1A3 Transport: Greenhouse gas emissions in CO_2 equivalents (Mt) and Activity Data in TJ



Data displayed as dashed line refers to the secondary axis.

Table **3.60** summarizes the share of MS using higher tier methods for calculating emissions for the key categories of the transport categories. As presented, most MSs use higher tiers, whereas the lower percentage is observed for 1A3c Railways, where most MS use T1 method for calculating corresponding emissions. It should be mentioned that as high tiers methods are categorised all used methods expect for the cases where only T1 method was used.

Table 3.55: Key category analysis for the EU (1A3 sector excerpt): Key source categories for level and trend analyses and share of MS emissions using higher tier methods

Source category gas	kt CO_2 equ.		Trend	Level		share of higher Tier
	1990	2016		1990	2016	
1.A.3.a Domestic Aviation: Jet Kerosene (CO_2)	13755	15517	T	L	L	92.3 %
1.A.3.b Road Transportation: Diesel Oil (CO_2)	297957	623282	T	L	L	86.5 %
1.A.3.b Road Transportation: Diesel Oil (N_2O)	1799	7360	T	0	L	99.2 %
1.A.3.b Road Transportation: Gaseous Fuels (CO_2)	504	3778	T	0	0	82.9 %
1.A.3.b Road Transportation: Gasoline (CH_4)	5756	837	T	0	0	98.5 %
1.A.3.b Road Transportation: Gasoline (CO_2)	404900	231331	T	L	L	90.3 %
1.A.3.b Road Transportation: Liquefied Petroleum Gases (LPG) (CO_2)	7338	16108	T	0	L	95.9 %
1.A.3.c Railways: Liquid Fuels (CO_2)	12845	6086	T	L	L	74.6 %
1.A.3.d Domestic Navigation: Gas/Diesel Oil (CO_2)	17868	13682	0	L	L	80.4 %
1.A.3.d Domestic Navigation: Residual Fuel Oil (CO_2)	10448	4548	T	L	0	82.5 %

Table 3.56 shows total GHG, CO_2, CH_4 and N_2O emissions from 1A3 Transport.

Table 3.56 1A3 Transport: Member States' contributions to CO_2 emissions, CH_4 and N_2O emissions

Member State	GHG emissions in 1990 (kt CO2 equivalents)	GHG emissions in 2016 (kt CO2 equivalents)	CO2 emissions in 1990 (kt)	CO2 emissions in 2016 (kt)	N2O emissions in 1990 (kt CO2 equivalents)	N2O emissions in 2016 (kt CO2 equivalents)	CH4 emissions in 1990 (kt CO2 equivalents)	CH4 emissions in 2016 (kt CO2 equivalents)
Austria	13 973	23 488	13 777	23 274	128	203	68	11
Belgium	20 892	26 390	20 553	26 093	218	280	121	17
Bulgaria	6 605	9 350	6 426	9 239	107	85	71	26
Croatia	3 881	6 173	3 787	6 101	53	60	41	12
Cyprus	1 229	2 022	1 196	1 959	28	52	5	11
Czech Republic	7 284	18 450	7 032	18 028	214	395	39	27
Denmark	10 775	12 987	10 617	12 835	101	141	58	11
Estonia	2 477	2 377	2 416	2 347	38	26	23	4
Finland	12 101	12 612	11 827	12 512	161	80	113	20
France	120 665	132 848	118 713	131 121	949	1 580	1 003	148
Germany	164 404	166 815	161 882	165 046	1 193	1 623	1 329	145
Greece	14 507	17 439	14 124	17 132	272	233	110	73
Hungary	8 876	12 480	8 685	12 318	127	137	63	26
Ireland	5 137	12 294	5 022	12 149	66	131	49	14
Italy	102 100	104 505	100 240	103 379	953	908	907	218
Latvia	3 042	3 198	2 941	3 147	81	47	20	4
Lithuania	5 838	5 496	5 706	5 432	80	51	52	13
Luxembourg	2 585	5 480	2 556	5 431	18	48	11	1
Malta	331	633	326	628	1	3	3	2
Netherlands	28 031	30 509	27 731	30 202	105	247	196	61
Poland	20 496	53 415	19 985	52 777	331	526	180	112
Portugal	10 229	16 677	10 046	16 491	98	160	84	25
Romania	12 439	16 828	12 059	16 588	285	205	94	36
Slovakia	6 824	6 747	6 693	6 665	100	73	30	9
Slovenia	2 728	5 734	2 666	5 664	36	65	26	6
Spain	59 199	86 131	58 288	85 145	527	896	384	89
Sweden	19 107	16 891	18 772	16 721	180	150	155	19
United Kingdom	121 321	123 528	118 609	122 185	1 465	1 233	1 246	110
EU-28	**787 074**	**931 496**	**772 675**	**920 611**	**7 917**	**9 637**	**6 481**	**1 248**
Iceland	620	974	600	934	16	36	4	3
United Kingdom (KP)	122 130	124 321	119 403	122 970	1 473	1 239	1 254	112
EU-28 + ISL	**788 503**	**933 263**	**774 069**	**922 330**	**7 941**	**9 680**	**6 493**	**1 253**

Abbreviations explained in the Chapter 'Units and abbreviations'.

Table 3.57 provides information on the contribution of Member States to EU-28+ISL recalculations in CO_2 from 1A3 Transport for 1990 and 2015 and main explanations for the largest recalculations in absolute terms.

Table 3.57 1A3 Transport: Contribution of MS to EU-28+ISL recalculations in CO_2 for 1990 and 2015 (difference between latest submission and previous submission in kt of CO_2 equivalents and percent)

	1990		2015		Main explanations
	kt CO_2	%	kt CO_2	%	
Austria	0	0.0	5	0.0	Update of the aviation emission model for calculating emissions of 2016 including the newest EMEP/EEA 2016 (Annex 5) emission factors. Flight movement data and the calculation of distances between airport pairs have been improved. Refined calibration of specific CO_2 emissions of newly registered PCs and LDVs registrations of all years by taking into account the special characteristics of fuels used in the type approval process.
Belgium	234	1.2	206	0.8	Beside recalculations linked to using COPERT 4 vs. 11.4 instead of 11.3 before and optimization of mobility data, this is mainly due to new EF CO_2 in the last update (June 2017) from EMEP/EEA air pollutant emission inventory guidebook 2016-table 3.29
Bulgaria	30	0.5	-125	-1.4	Updated vehicle fleet matrix and updated COPERT model resulted in updated emission estimates for all gases.
Croatia	-	-	-	-	NA
Cyprus	15	1.3	0	0.0	For aviation source categories the recalculations have been caused by a revision of the methodology use to estimate fuel consumption. For Domestic water-borne navigation (1A3d ii) the recalculations have been caused by availability of new data from the Statistical Service for the years 2014 and 2015.
Czech Republic	-	-	-3	-0.0	Activity data for Diesel oil consumption was updated for year 2015.
Denmark	40	0.4	357	2.9	Small changes in the list of aircraft types – representative aircraft types have been made in the model used for calculating civil aviation emissions. The gasoline fuel consumption for road transport has been somewhat changed for gasoline, due to a large revision of the emission inventory for gasoline fuelled household and gardening machinery. A structural revision of the emission inventories for national sea transport has been made. The methodology has shifted from being bottom up activity based to fuel sold based.
Estonia	-	-	-	-	NA
Finland	-	-	-2	-0.0	Updated aviation fuel consumption data from Eurostat taken into account.
France	7	0.0	-93	-0.1	1A3b: Update of the CNG and overseas gasoline / diesel energy balance. Update of the unit consumption reduction coefficients of VP of the LPGs.
Germany	-	-	1 984	1.2	amongst others: revised models (especially 1.A.3.b, 1.A.3.d)
Greece	-	-	-0	-0.0	Diesel consumption and the corresponding emissions of PCs and HDVs for 2015 were recalculated.
Hungary	7	0.1	3	0.0	New version of COPERT (v5.1) model was used with somewhat updated fleet data; revised Eurocontrol data
Ireland	-0	-0.0	-20	-0.2	New COPERT 5 model
Italy	-531	-0.5	1	0.0	Update of activity data (energy conversion factor from TOE to TJ)
Latvia	10	0.4	88	2.8	Difference due to corrected country specific CO_2 EF for diesel oil and switch from COPERT IV model version to COPERT 5 model version in road transport.

	1990		2015		Main explanations
	kt CO_2	%	kt CO_2	%	
Lithuania	-	-	-0	-0.0	Application of new CO_2 EF for CNG (natural gas) from road transportation (according to 2016 study).
Luxembourg	-0	-0.0	-42	-0.7	energy balance revised, error correction
Malta	13	4.1	31	5.0	Rcalculations were made following changes in key parameters including: 1) revisions of database on the stock of vehicles as provided by the NSO, 2) changes in fuels used for road transportation and 3) the inclusion of national parameters in the COPERT model.
Netherlands	-107	-0.4	-809	-2.6	Recalculation with new EF's and changed diesel use
Poland	-1	-0.0	259	0.6	AD update in domestic aviation sector
Portugal	163	1.6	147	0.9	Implementation of the COPERT V (Version 5.1.0 – December 2017) and review of the vehicle stock and mean activity. Update and correction of the Sines Port data
Romania	-	-	12	0.1	CO_2 emissions were recalculated for 2015 year taking into account the final data associated to the CS EF (CRF 1A3d category).
Slovakia	-	-	114	1.7	New COPERT model calculation in category 1.A.3.b
Slovenia	-0	-0.0	0	0.0	New version of COPERT 4 model and updated AD in railways and road transport.
Spain	238	0.4	-198	-0.2	Methodological change for aviation gasoline emission estimates and updated methodology aligned with Eurocontol fuel consumption and emission estimates.
Sweden	-225	-1.2	-291	-1.6	Updated data on consumption of diesel and gasoline and improved allocation of fuel consumption between source categories.
United Kingdom	5 377	4.7	3 263	2.8	1A3a: A number of smaller aircraft type now use FCs and EFs from 2016 EMEP/EEA guidebook, rather than from the local inventories. This is to reduce the reliance on surrogate data. This has a disproportional impact on piston aircraft, which use AS; 1A3b: revision to the VOC evaporatives methodology, revision to the cat fail calcs for petrol LGVs; 1A3d: Revisions to OECD household expenditure statistics. Introduction of the BEIS shipping improvements model from 2017 which resulted in a revision to both activity and emission factors
EU28	5 271	0.7	4 887	0.5	
Iceland	1	0.2	0	0.1	Minor corrections
United Kingdom (KP)	5 151	4.5	3 178	2.7	1A3a: A number of smaller aircraft type now use FCs and EFs from 2016 EMEP/EEA guidebook, rather than from the local inventories. This is to reduce the reliance on surrogate data. This has a disproportional impact on piston aircraft, which use AS; 1A3b: revision to the VOC evaporatives methodology, revision to the cat fail calcs for petrol LGVs; 1A3d: Revisions to OECD household expenditure statistics. Introduction of the BEIS shipping improvements model from 2017 which resulted in a revision to both activity and emission factors
EU28+ISL	5 045	0.7	4 802	0.5	

Table 3.59 provides information on the contribution of Member States to EU-28+ISL recalculations in CH_4 from 1A3 Transport for 1990 and 2015.

Table 3.58 1A3 Transport: Contribution of MS to EU-28+ISL recalculations in CH_4 for 1990 and 2015 (difference between latest submission and previous submission in kt of CO_2 equivalents and percent)

	1 990		2 015		Main explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
Austria	2	3.6	2	26.0	Update of the aviation emission model for calculating emissions of 2016 including the newest EMEP/EEA 2016 (Annex 5) emission factors. Flight movement data and the calculation of distances between airport pairs have been improved. Refined calibration of specific CO_2 emissions of newly registered PCs and LDVs registrations of all years by taking into account the special characteristics of fuels used in the type approval process.
Belgium	-0	-0.1	-0	-2.6	For the 2018 submission the emissions from road transport (1A3b) have been recalculated for the complete time series using the COPERT4v11.4 software instead of 11.3 before. In the Walloon region, recalculations of the CH_4 emissions took place in the category 1A3a by using the Eurocontrol data.
Bulgaria	1	1.2	1	3.2	Updated vehicle fleet matrix and updated COPERT model resulted in updated emission estimates for all gases.
Croatia	-	-	-	-	Adjustment of the mileage in 2008 for light duty vehicles and in 2005 for mopeds and motorcycles.
Cyprus	0	0.0	0	0.0	For aviation source categories the recalculations have been caused by a revision of the methodology use to estimate fuel consumption. For Domestic water-borne navigation (1A3d ii) the recalculations have been caused by availability of new data from the Statistical Service for the years 2014 and 2015.
Czech Republic	-	-	-0	-0.0	Activity data for Diesel oil consumption was updated for year 2015.
Denmark	1	1.2	1	6.3	Small changes in the list of aircraft types – representative aircraft types has been made in the model used for calculating civil aviation emissions. The gasoline fuel consumption for road transport has been somewhat changed for gasoline, due to a large revision of the emission inventory for gasoline fuelled household and gardening machinery. A structural revision of the emission inventories for national sea transport has been made. The methodology has shifted from being bottom up activity based to fuel sold based.
Estonia	-	-	-	-	NA
Finland	0	0.0	-0	-0.1	Updated aviation fuel consumption data from Eurostat taken into account. CH_4 emission calculations from aviation gasoline changed.
France	10	1.0	-14	-8.4	1A3b: Update of the CNG and overseas gasoline / diesel energy balance. Update of the unit consumption reduction coefficients of VP of the LPGs. Update of consumption and emission factors (CH_4 and N_2O) (COPERT 5).
Germany	-0	-0.0	-1	-0.7	amongst others: revised models (especially 1.A.3.b, 1.A.3.d)
Greece	-	-	-1	-0.9	Diesel consumption and the corresponding emissions of PCs and HDVs for 2015 were recalculated.
Hungary	-5	-7.8	0	1.7	New version of COPERT (v5.1) model was used with somewhat updated fleet data; revised Eurocontrol data
Ireland	1	1.3	-1	-5.1	New COPERT 5 model
Italy	-60	-6.2	15	6.7	Recalculations were performed on the basis of the complete integration in the Italian inventory

	1 990		2 015		Main explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
					of EUROCONTROL data time series. In 2018 submission the historical series has been generally revised according to the application of COPERT 5 model.
Latvia	-0	-0.9	-0	-8.7	Difference due to switch from COPERT IV model version to COPERT 5 model version in road transport.
Lithuania	3	5.8	-0	-0.6	Emissions correction for gasoline from road transportation according updated activity data in 2015 and 1990-2015 mileage for motorcycles using COPERT V
Luxembourg	-0	-0.0	-0	-0.1	energy balance revised, error correction
Malta	1	44.0	0	16.4	recalculations were made following changes in key parameters including: 1) revisions of database on the stock of vehicles as provided by the NSO, 2) changes in fuels used for road transportation and 3) the inclusion of national parameters in the COPERT model.
Netherlands	-1	-0.3	0	0.3	Revised fuel data
Poland	-0	-0.0	-0	-0.0	AD update in domestic aviation sector
Portugal	-19	-18.6	-1	-4.9	Implementation of the COPERT V (Version 5.1.0 – December 2017) and review of the vehicle stock and mean activity. Update and correction of the Sines Port data
Romania	-	-	-0	-0.0	NA
Slovakia	-	-	-4	-29.6	New COPERT model calculation
Slovenia	-3	-11.4	-1	-13.0	New version of COPERT 4 model and updated AD in railways and road transport.
Spain	-0	-0.1	-4	-4.8	Methodological change for aviation gasoline emission estimates and updated methodology aligned with Eurocontol fuel consumption and emission estimates. For 1A3b updated methodology aligned with 2016 EMEP/EEA GB (version May 2017) and incorporation oft ruck category Euro VI.
Sweden	-0	-0.3	-22	-51.7	Updated data on consumption of diesel and gasoline and improved allocation of fuel consumption between source categories.
United Kingdom	4	0.3	-0	-0.0	1A3b: Noticeable changes include revising the VOC evaporatives methodology, resolving an issue with cat fail calcs for 2009 onward petrol LGVs, biofuel effects on PM emissions, large change to euro 6 LGV NH_3 factors and alteration in PM2.5 fraction of PM10. F 1A3d: Revision to shipping estimates, with emission factors now taken from the BEIS Shipping Improvement task. In general, this has lead to an increase in fuel oil factors and a decrease in gas oil factors
EU28	-68	-1.0	-31	-2.4	
Iceland	0	3.9	1	39.6	EF changed to default IPCC 2006 value for diesel oil
United Kingdom (KP)	1	0.1	-0	-0.2	1A3b: Noticeable changes include revising the VOC evaporatives methodology, resolving an issue with cat fail calcs for 2009 onward petrol LGVs, biofuel effects on PM emissions, large change to euro 6 LGV NH_3 factors and alteration in PM2.5 fraction of PM10. F 1A3d: Revision to shipping estimates, with emission factors now taken from the BEIS Shipping Improvement task. In general, this has lead to an increase in fuel oil factors and a decrease in gas oil factors
EU28+ISL	-71	-1.1	-31	-2.3	

Table 3.59 provides information on the contribution of Member States to EU-28+ISL recalculations in N_2O from 1A3 Transport for 1990 and 2015.

Table 3.59 1A3 Transport: Contribution of MS to EU-28+ISL recalculations in N_2O for 1990 and 2015 (difference between latest submission and previous submission in kt of CO_2 equivalents and percent)

	1990		2015		Main explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
Austria	-5	-3.6	-4	-1.8	Update of the aviation emission model for calculating emissions of 2016 including the newest EMEP/EEA 2016 (Annex 5) emission factors. Flight movement data and the calculation of distances between airport pairs have been improved. Refined calibration of specific CO_2 emissions of newly registered PCs and LDVs registrations of all years by taking into account the special characteristics of fuels used in the type approval process.
Belgium	0	0.1	-2	-0.7	For the 2018 submission the emissions from road transport (1A3b) have been recalculated for the complete time series using the COPERT4v11.4 software instead of 11.3 before. In the Walloon region, recalculations of the N_2O emissions took place in the category 1A3a by using the Eurocontrol data.
Bulgaria	0	0.4	-0	-0.1	Updated vehicle fleet matrix and updated COPERT model resulted in updated emission estimates for all gases.
Croatia	-	-	-	-	Adjustment of the mileage in 2008 for light duty vehicles and in 2005 for mopeds and motorcycles.
Cyprus	0	0.4	0	0.0	For aviation source categories the recalculations have been caused by a revision of the methodology use to estimate fuel consumption. For Domestic water-borne navigation (1A3d ii) the recalculations have been caused by availability of new data from the Statistical Service for the years 2014 and 2015.
Czech Republic	-	-	-0	-0.0	Activity data for Diesel oil consumption was updated for year 2015.
Denmark	1	0.5	2	1.4	Small changes in the list of aircraft types – representative aircraft types have been made in the model used for calculating civil aviation emissions. The gasoline fuel consumption for road transport has been somewhat changed for gasoline, due to a large revision of the emission inventory for gasoline fuelled household and gardening machinery. A structural revision of the emission inventories for national sea transport has been made. The methodology has shifted from being bottom up activity based to fuel sold based.
Estonia	-	-	-	-	NA
Finland	-	-	-0	-0.1	Updated aviation fuel consumption data from Eurostat taken into account.
France	-7	-0.7	-73	-4.6	1A3b: Update of the CNG and overseas gasoline / diesel energy balance. Update of the unit consumption reduction coefficients of VP of the LPGs. Update of consumption and emission factors (CH_4 and N_2O) (COPERT 5).
Germany	0	0.0	22	1.4	amongst others: revised models (especially 1.A.3.b, 1.A.3.d)
Greece	-	-	3	1.4	Diesel consumption and the corresponding emissions of PCs and HDVs for 2015 were recalculated
Hungary	-4	-3.0	-1	-0.6	New version of COPERT (v5.1) model was used with somewhat updated fleet data; revised Eurocontrol data
Ireland	1	0.9	6	5.5	New COPERT 5 model

	1990		2015		Main explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
Italy	-11	-1.2	-19	-2.0	Recalculations were performed on the basis of the complete integration in the Italian inventory of EUROCONTROL data time series. In 2018 submission the historical series has been generally revised according to the application of COPERT 5 model.
Latvia	1	1.0	-3	-5.8	Difference due to switch from COPERT IV model version to COPERT 5 model version in road transport.
Lithuania	-	-	-0	-0.2	Emissions correction for gasoline and diesel oil from road transportation according updated activity data in 2015
Luxembourg	0	0.0	-0	-0.6	energy balance revised, error correction
Malta	-3	-66.1	-2	-36.7	recalculations were made following changes in key parameters including: 1) revisions of database on the stock of vehicles as provided by the NSO, 2) changes in fuels used for road transportation and 3) the inclusion of national parameters in the COPERT model.
Netherlands	-1	-1.0	0	0.0	Result of recalculation diesel use
Poland	-0	-0.0	-0	-0.0	AD update in domestic aviation sector
Portugal	10	11.4	12	8.6	Implementation of the COPERT V (Version 5.1.0 – December 2017) and review of the vehicle stock and mean activity. Update and correction of the Sines Port data
Romania	-	-	-0	-0.0	NA
Slovakia	-	-	4	6.3	New COPERT model calculation
Slovenia	-2	-6.0	4	7.3	New version of COPERT 4 model and updated AD in railways and road transport.
Spain	-5	-0.9	14	1.7	Methodological change for aviation gasoline emission estimates and updated methodology aligned with Eurocontol fuel consumption and emission estimates. For 1A3b updated methodology aligned with 2016 EMEP/EEA GB (version May 2017) and incorporation oft ruck category Euro VI.
Sweden	-0	-0.3	-3	-2.2	Updated data on consumption of diesel and gasoline and improved allocation of fuel consumption between source categories.
United Kingdom	89	6.4	59	5.3	A number of smaller aircraft type now use FCs and EFs from 2016 EMEP/EEA guidebook, rather than from the local inventories. This is to reduce the reliance on surrogate data. This has a disproportional impact on piston aircraft, which use AS; resolution of an issue with the cat fail calcs for 2009 onward petrol LGVs; Incorporation of revised BEIS shipping model
EU28	63	0.8	20	0.2	
Iceland	2	12.8	7	25.0	EF changed to default IPCC 2006 value for diesel oil
United Kingdom (KP)	87	6.3	59	5.2	A number of smaller aircraft type now use FCs and EFs from 2016 EMEP/EEA guidebook, rather than from the local inventories. This is to reduce the reliance on surrogate data. This has a disproportional impact on piston aircraft, which use AS; resolution of an issue with the cat fail calcs for 2009 onward petrol LGVs; Incorporation of revised BEIS shipping model
EU28+ISL	64	0.8	27	0.3	

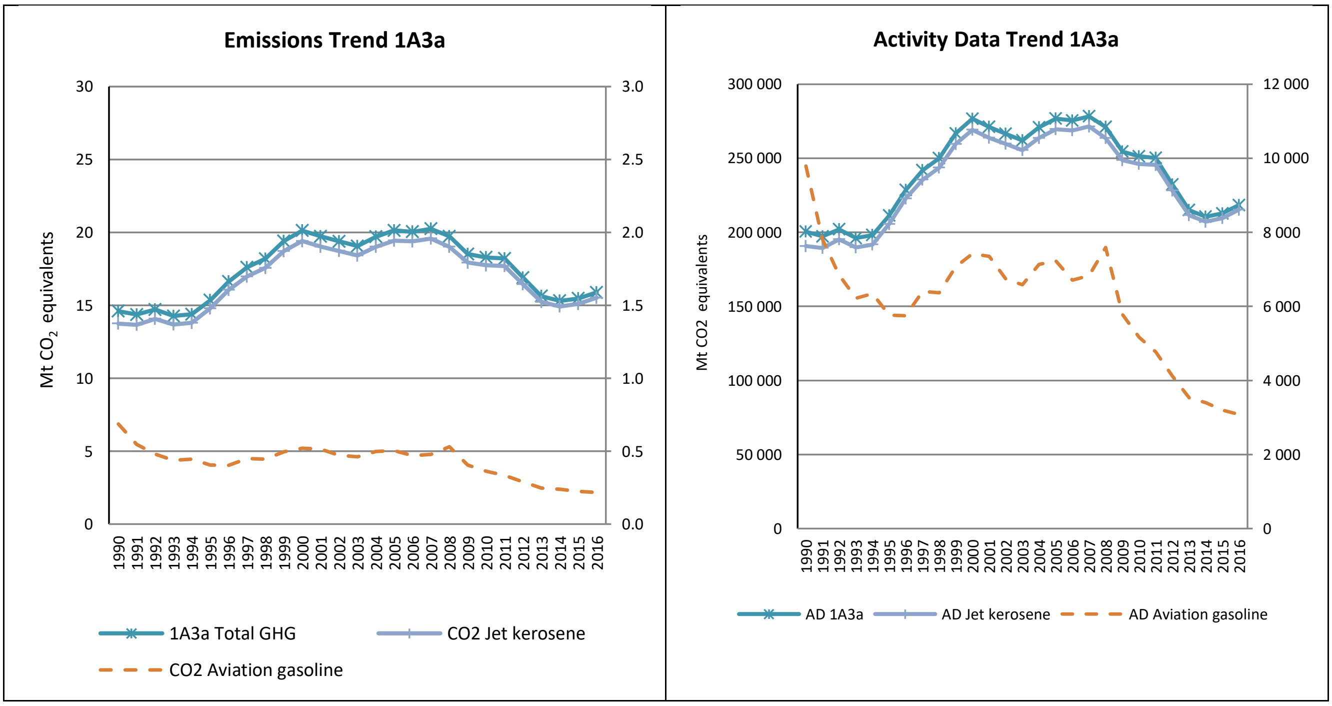
3.2.3.1 Domestic Aviation (1A3a) (EU-28+ISL)

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 Domestic Aviation account for 2 % of total transport-related GHG emissions in 2016. Between 1990 and 2016, CO_2 emissions from domestic aviation increased by 9 % in the EU-28+ISL (Table 3.60, Figure 3.86).

CO_2 emissions from Jet Kerosene account for 99 % of total CO_2 emissions from 1A3a Domestic Aviation. Between 2015 and 2016, CO_2 emissions from domestic aviation increased by 3 % in the EU-28+ISL (Table 3.60, Figure 3.86).

Figure 3.86 1A3a Civil Aviation: CO_2 Emissions in CO_2 equivalents (Mt) and Activity data in TJ



Data displayed as dashed line refers to the secondary axis.

The Member States France, Germany, Italy and Spain alone contributed 75 % to the emissions from this source. Most Member States (15 in total) increased emissions from civil aviation between 1990 and 2016 (Table 3.60). Based on the following table the Member States Germany, Italy and Spain used also T1 method for calculation emissions, but Germany and Spain used higher tier method for calculating emissions from jet kerosene, which contributes the most to this category. Thus, the total percentage of the share of higher tier methods amounts to 92%.

Table 3.60 1A3a Civil Aviation: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016		Method	Emission factor Informa-tion
	1990	2015	2016		kt CO2	%	kt CO2	%		
Austria	32	50	47	0.3%	15	48%	-2	-5%	T2,T3	CS
Belgium	12	9	8	0.0%	-5	-39%	-2	-18%	T1	D
Bulgaria	135	40	61	0.4%	-74	-55%	21	52%	T1,T2	D
Croatia	7	31	31	0.2%	25	371%	0	1%	T1	D
Cyprus	26	1	1	0.0%	-25	-98%	0	-38%	T1	D
Czech Republic	139	10	10	0.1%	-129	-93%	0	-2%	T1	D
Denmark	248	128	133	0.8%	-115	-46%	6	4%	CR,M,T2	CS
Estonia	6	1	1	0.0%	-4	-75%	0	13%	T2	D
Finland	385	184	187	1.2%	-198	-52%	3	2%	T1	CS
France	4 306	4 550	4 666	29.7%	360	8%	116	3%	T3	M
Germany	2 374	2 321	2 357	15.0%	-17	-1%	36	2%	CS,T1,T2	CS,D,M
Greece	323	390	410	2.6%	87	27%	21	5%	T2,T3	D
Hungary	4	4	4	0.0%	0	9%	0	-4%	T1	D
Ireland	51	10	10	0.1%	-41	-81%	-1	-7%	T3	CS
Italy	1 493	2 160	2 155	13.7%	662	44%	-5	0%	T1,T2	CS
Latvia	0	2	2	0.0%	2	2857%	0	12%	T1	D
Lithuania	8	2	1	0.0%	-7	-83%	0	-9%	T2	CS
Luxembourg	0	1	1	0.0%	0	133%	0	-17%	T1	D
Malta	1	4	4	0.0%	3	239%	0	7%	T1	D
Netherlands	85	31	30	0.2%	-55	-64%	-1	-2%	T1	CS,D
Poland	64	123	116	0.7%	52	82%	-7	-6%	T1	D
Portugal	178	366	447	2.8%	269	151%	81	22%	T1,T3	D
Romania	25	126	84	0.5%	59	237%	-42	-34%	T1	D,OTH
Slovakia	4	4	4	0.0%	0	-5%	0	-3%	T3	D
Slovenia	1	2	2	0.0%	1	88%	0	2%	T1	D
Spain	2 080	2 481	2 678	17.0%	599	29%	197	8%	T1,T3	D
Sweden	673	503	544	3.5%	-129	-19%	41	8%	T1	D
United Kingdom	1 502	1 588	1 537	9.8%	35	2%	-51	-3%	T3	CS
EU-28	**14 161**	**15 120**	**15 532**	**99%**	**1 371**	**10%**	**412**	**3%**	**-**	**-**
Iceland	32	20	23	0.1%	-9	-29%	2	10%	T1	D
United Kingdom (KP)	1 750	1 772	1 717	10.9%	-33	-2%	-55	-3%	T3	CS
EU-28 + ISL	**14 442**	**15 325**	**15 735**	**100%**	**1 293**	**9%**	**409**	**3%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

1A3a Domestic Aviation – Jet Kerosene (CO_2)

In 2016 CO_2 emissions resulting from jet kerosene within the category 1A3a were responsible for 99 % of CO_2 emissions in 1A3a. Within the EU-28+ISL the emissions increased between 1990 and 2016 by 13 % (Table 3.61). By far the largest absolute increase occurred in Italy. Between 2015 and 2016, EU-28+ISL emissions increased by 3 %.

Table 3.61 1A3a Civil Aviation, jet kerosene: Member States' contributions to CO_2 emissions and information on method applied and emission factor

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016		Method	Emission factor Informa-tion
	1990	2015	2016		kt CO2	%	kt CO2	%		
Austria	24	42	37	0.2%	13	54%	-4	-10%	T3	CS
Belgium	9	6	5	0.0%	-4	-47%	-2	-24%	T1	D
Bulgaria	114	37	59	0.4%	-55	-48%	22	58%	T2	D
Croatia	6	30	30	0.2%	24	375%	0	0%	T1	D
Cyprus	26	1	1	0.0%	-25	-98%	0	-38%	T1	D
Czech Republic	1	1	1	0.0%	-1	-40%	0	-21%	T1	D
Denmark	240	125	130	0.8%	-110	-46%	5	4%	CR,M,T2	CS
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	377	182	185	1.2%	-192	-51%	3	2%	T1	CS
France	4 200	4 490	4 610	29.7%	409	10%	120	3%	T3	M
Germany	2 203	2 282	2 328	15.0%	125	6%	46	2%	CS,T2	CS,M
Greece	311	383	404	2.6%	93	30%	21	5%	T3	D
Hungary	1	2	1	0.0%	0	26%	0	-11%	T1	D
Ireland	48	8	7	0.0%	-41	-85%	-1	-11%	T3	CS
Italy	1 459	2 153	2 148	13.8%	689	47%	-5	0%	T1,T2	CS
Latvia	0	1	1	0.0%	1	2556%	0	11%	T1	D
Lithuania	7	0	0	0.0%	-7	-96%	0	33%	T2	CS
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	1	4	4	0.0%	3	250%	0	7%	T1	D
Netherlands	73	27	27	0.2%	-46	-63%	0	-1%	T1	D
Poland	39	111	104	0.7%	65	165%	-7	-6%	T1	D
Portugal	176	365	446	2.9%	270	153%	81	22%	T3	D
Romania	25	123	81	0.5%	56	224%	-42	-34%	T1	OTH
Slovakia	4	4	3	0.0%	0	-2%	0	-2%	T3	D
Slovenia	NO	1	1	0.0%	1	∞	0	-8%	T1	D
Spain	2 048	2 470	2 667	17.2%	619	30%	197	8%	T3	D
Sweden	658	498	540	3.5%	-118	-18%	42	8%	T1	D
United Kingdom	1 439	1 557	1 501	9.7%	62	4%	-57	-4%	T3	CS
EU-28	**13 491**	**14 902**	**15 321**	**99%**	**1 829**	**14%**	**419**	**3%**	**-**	**-**
Iceland	27	19	21	0.1%	-5	-20%	2	12%	T1	D
United Kingdom (KP)	1 676	1 737	1 676	10.8%	0	0%	-61	-4%	T3	CS
EU-28 + ISL	**13 755**	**15 101**	**15 517**	**100%**	**1 762**	**13%**	**417**	**3%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

France, Germany, Italy, Spain and the UK account for 85 % of CO_2 emissions from jet kerosene in 2016 (Figure 3.88). Table **3.61** shows that the majority of emissions from Domestic Aviation jet kerosene were calculated using a higher tier method (92%) as presented in Table 6.1. It should be mentioned that Italy, one of the main contributors, is using T1 method for calculating emissions for N_2O. Thus, it was included in the share of the high tier methods calculation for CO_2 emissions. In Figure 3.87 the IEF is depicted, showing a mean value of around 72 t/TJ

Figure 3.88   1A3a Civil Aviation, Jet Kerosene: Emission trend and share for CO_2

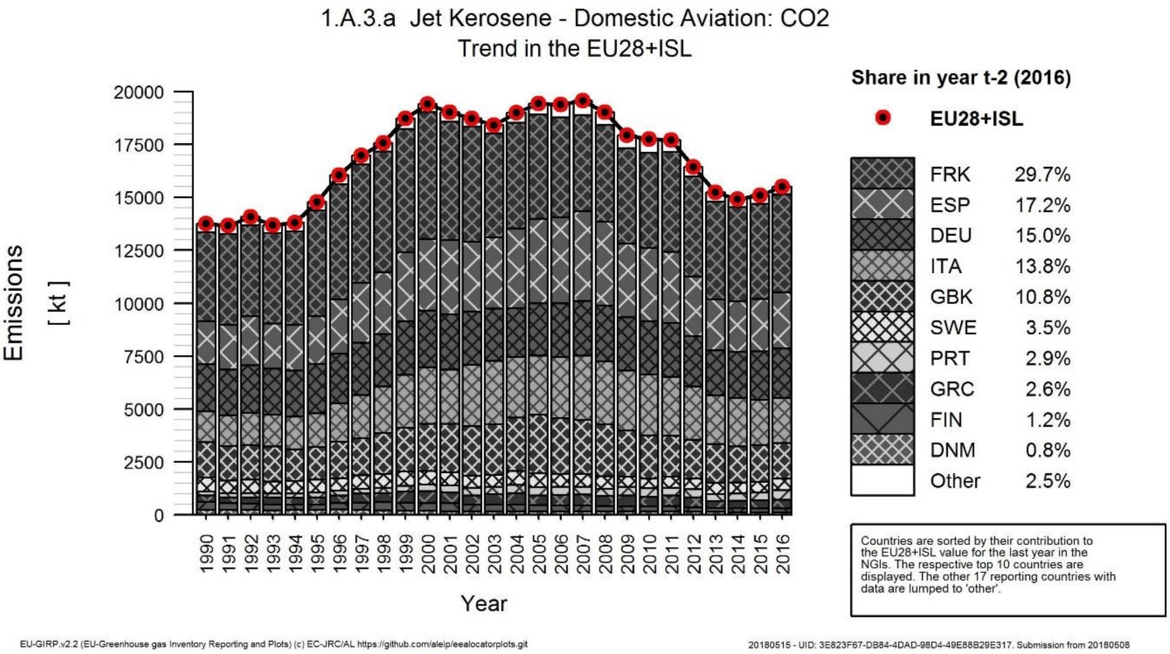
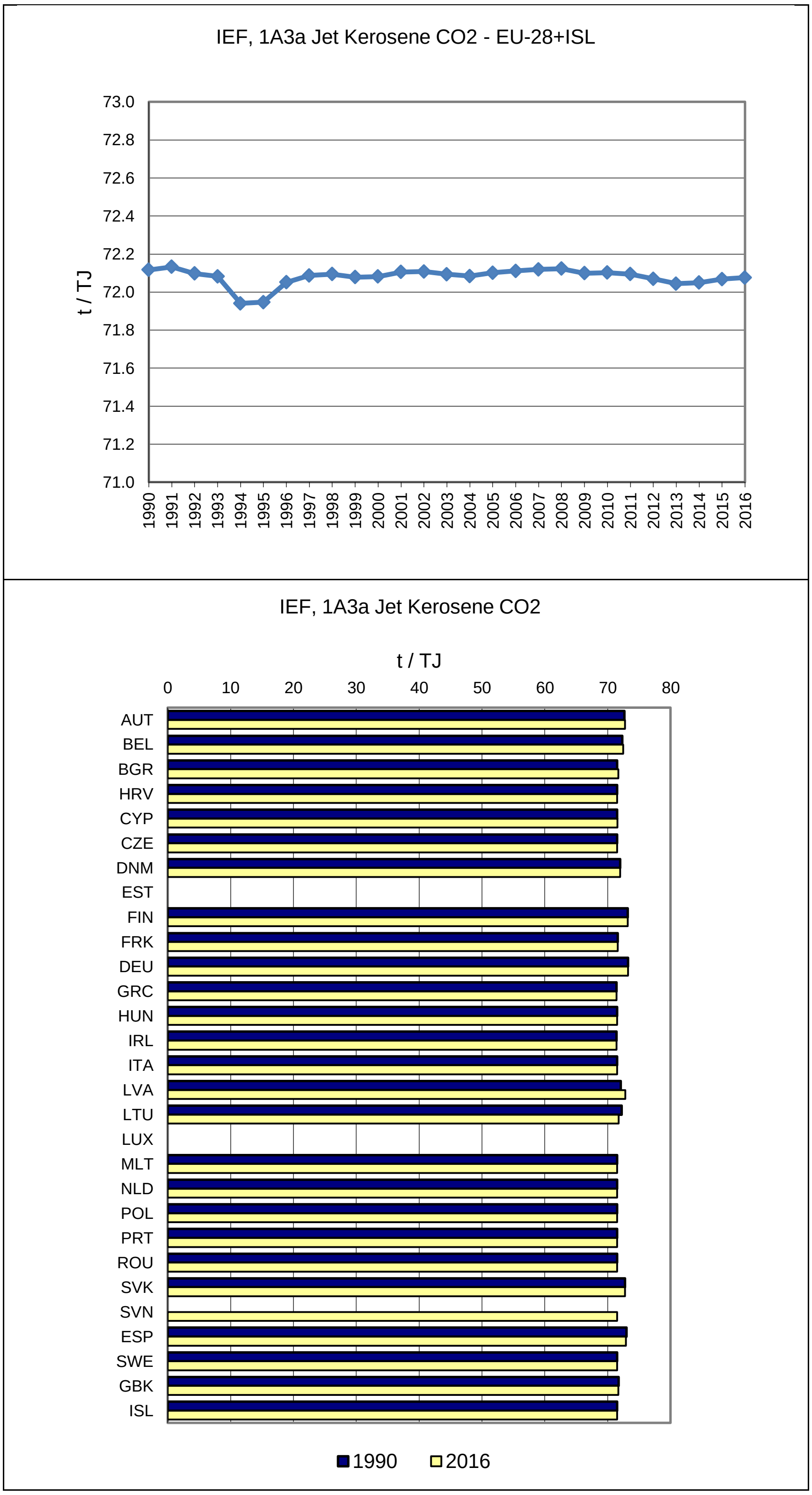


Figure 3.89   1A3a Civil Aviation, Jet Kerosene: Implied Emission Factors for CO_2 (in t/TJ)



3.2.3.2 Road Transportation (1A3b) (EU-28+ISL)

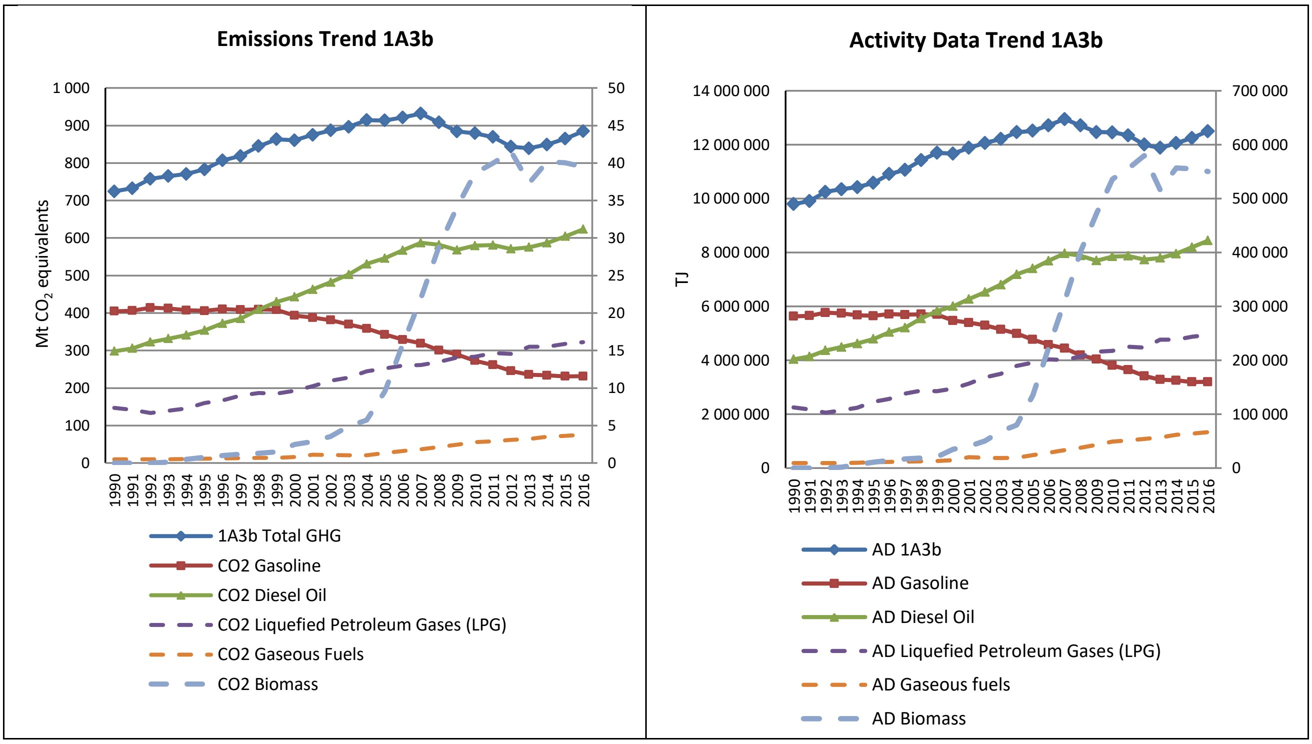
CO_2 emissions from 1A3b Road Transportation

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-28+ISL accounting for 20 % of total GHG emissions in 2016. Between 1990 and 2016, CO_2 emissions from road transportation increased by 23 % in the EU-28+ISL (Table 3.62). It is obvious that emissions dropped between 2007 and 2013 and the corresponding activity data, except for biomass, show a similar trend. This can be attributed to the economic crisis that Europe has gone through these years. The emissions from this key source are due to fossil fuel consumption in road transport, which increased by 23 % between 1990 and 2016.

Figure 3.90 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 show the gradual switch from gasoline to diesel passenger cars in several EU-28+ISL Member States.

Figure 3.90 1A3b Road Transport: CO_2 Emission Trend and Activity Data



Data displayed as dashed line refers to the secondary axis.

The Member States Germany, France, Italy, Spain and the United Kingdom contributed most to the CO_2 emissions from this source (66 %). All Member States, except Lithuania (-1%) and Sweden (-9%), show increased emissions from road transportation between 1990 and 2016. In the case of Sweden, the decreased emissions are explained by the total use of liquid biofuels (ethanol and FAME), which has increased by more than 850% since 2003. Ethanol is used by passenger cars, by ethanol buses and E85 vehicles. The total use of FAME has increased by 33-49% each year starting 2011. The Member States with the highest increases in absolute terms were Poland, Spain, France and Czech

Republic. The countries with the lowest increase in relative terms were Germany, Italy and United Kingdom (Table 3.62).

Table 3.62 1A3b Road Transport: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016		Method	Emission factor Informa-tion
	1990	2015	2016		kt CO2	%	kt CO2	%		
Austria	13 328	21 635	22 550	2.6%	9 222	69%	915	4%	T1,T2	CS,D
Belgium	19 730	25 741	25 465	2.9%	5 734	29%	-276	-1%	M,T1,T3	OTH
Bulgaria	5 780	8 684	8 796	1.0%	3 016	52%	112	1%	T2	CR
Croatia	3 506	5 667	5 880	0.7%	2 374	68%	213	4%	T1	D
Cyprus	1 167	1 827	1 957	0.2%	789	68%	130	7%	T1	D
Czech Republic	6 177	16 986	17 670	2.0%	11 494	186%	685	4%	T1	CS,D
Denmark	9 357	11 603	11 802	1.3%	2 445	26%	199	2%	CR,M,T2	CS
Estonia	2 235	2 193	2 239	0.3%	5	0%	46	2%	T1,T2	CS,D
Finland	10 808	10 333	11 850	1.4%	1 042	10%	1 516	15%	M,T2	CS
France	112 120	123 967	124 399	14.2%	12 278	11%	431	0%	T3	M
Germany	151 881	154 880	158 578	18.1%	6 697	4%	3 698	2%	CS,M,T2,T3	CS,D
Greece	11 793	14 556	14 788	1.7%	2 995	25%	232	2%	T1,T2,T3	CS,D
Hungary	7 835	11 820	12 080	1.4%	4 245	54%	260	2%	T1,T2	CS,D
Ireland	4 690	11 192	11 624	1.3%	6 933	148%	432	4%	T2,T3	CS,M
Italy	92 257	98 148	96 683	11.1%	4 427	5%	-1 465	-1%	T1,T3	CS,D
Latvia	2 403	2 942	2 957	0.3%	554	23%	16	1%	T1,T2	CS,D,OTH
Lithuania	5 247	4 802	5 186	0.6%	-61	-1%	385	8%	T1,T2	CS,D
Luxembourg	2 530	5 593	5 423	0.6%	2 893	114%	-170	-3%	T1,T2	CS,D
Malta	300	543	544	0.1%	244	81%	0	0%	T1	CR
Netherlands	26 470	28 707	28 972	3.3%	2 501	9%	265	1%	T2	CS
Poland	18 150	45 091	51 515	5.9%	33 365	184%	6 424	14%	T1,T3	D
Portugal	9 429	15 489	15 751	1.8%	6 323	67%	263	2%	NO,T2	D,NO
Romania	10 366	14 908	16 014	1.8%	5 649	54%	1 107	7%	T1,T3	D,OTH
Slovakia	4 503	6 457	6 272	0.7%	1 769	39%	-185	-3%	M	D
Slovenia	2 600	5 254	5 628	0.6%	3 028	116%	374	7%	M	M
Spain	50 429	78 057	80 140	9.2%	29 711	59%	2 083	3%	T1	D,M
Sweden	17 178	16 563	15 620	1.8%	-1 558	-9%	-943	-6%	T2	CS
United Kingdom	107 892	110 207	112 789	12.9%	4 898	5%	2 582	2%	T1,T3	CS,OTH
EU-28	**710 160**	**853 842**	**873 170**	**100%**	**163 011**	**23%**	**19 328**	**2%**	**-**	**-**
Iceland	509	809	884	0.1%	375	74%	75	9%	T1	D
United Kingdom (KP)	108 365	110 722	113 322	13.0%	4 958	5%	2 600	2%	T1,T3	CS,OTH
EU-28 + ISL	**711 141**	**855 166**	**874 587**	**100%**	**163 446**	**23%**	**19 421**	**2%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

In Table 3.63 the fuel share is presented per Member State. It is clear that diesel oil accounts for 68 % for EU-28+ISL and gasoline for 26 %. The highest LPG consumption is observed in Bulgaria (16 %) and Poland (10 %). The share of biomass is around 4 % for EU-28+ISL with Sweden having the highest percentage (18 %).

Table 3.63: *1A3b Road Transport: Member States' share of different fuel in the total consumption*

Member State	Gasoline (%)	Diesel oil (%)	LPG (%)	Gaseous fuels (%)	Biomass (%)
Austria	19.6%	74.6%	0.1%	0.2%	5.4%
Belgium	16.4%	77.7%	0.8%	0.1%	5.0%
Bulgaria	16.0%	59.7%	16.1%	2.8%	5.4%
Croatia	28.6%	67.1%	4.1%	0.2%	0.1%
Cyprus	56.4%	42.2%	NO	NO	1.3%
Czech Republic	26.2%	66.3%	1.8%	0.8%	4.9%
Denmark	31.6%	63.0%	0.0005%	0.1%	5.4%
Estonia	33.4%	65.6%	0.8%	NO	0.3%
Finland	32.8%	62.8%	NA,NO	0.06%	4.4%
France	16.3%	77.1%	0.2%	0.1%	6.4%
Germany	31.6%	62.4%	0.9%	0.3%	4.7%
Greece	48.6%	42.4%	5.3%	0.3%	3.4%
Hungary	33.2%	61.4%	0.7%	0.2%	4.5%
Ireland	25.4%	71.6%	0.1%	NO	3.0%
Italy	22.8%	66.3%	5.4%	2.7%	2.8%
Latvia	20.6%	72.0%	6.4%	NO	0.9%
Lithuania	12.2%	77.1%	7.1%	0.4%	3.2%
Luxembourg	15.2%	79.9%	0.0%	NO	4.8%
Malta	45.1%	51.0%	0.4%	NO	3.6%
Netherlands	39.3%	56.3%	1.5%	0.4%	2.4%
Poland	21.8%	65.4%	10.3%	0.1%	2.5%
Portugal	20.2%	74.0%	0.8%	0.4%	4.6%
Romania	25.9%	67.7%	1.5%	NO	4.9%
Slovakia	27.5%	64.6%	1.9%	0.3%	5.7%
Slovenia	23.6%	74.4%	0.8%	0.2%	1.0%
Spain	17.1%	77.9%	0.2%	0.5%	4.3%
Sweden	35.0%	46.1%	0.01%	0.6%	18.2%
United Kingdom	32.0%	65.3%	0.2%	IE	2.5%
EU-28	**26%**	**68%**	**2%**	**0.5%**	**4.4%**
Iceland	46.4%	48.3%	NO	NO	5.3%
EU-28 + ISL	**26%**	**68%**	**2%**	**0.5%**	**4.4%**

1A3b Road Transportation – Gaseous Fuels (CO_2)

CO_2 emissions from Gaseous fuels account for 0,4 % of CO_2 emissions from 1A3b Road Transport in 2016 (Figure 3.90). Between 2015 and 2016 CO_2 emissions from Gaseous fuels have increased by 4 %, between 1990 and 2016 emissions show an increase of 650% in EU-28+ISL. Most Member States showed increased emissions, whereas 9 Member States reported emissions as "Not occurring" or "Included elsewhere" United Kingdom includes the small amount of natural gas used for road transport with LPG consumption.

Table 3.64: 1A3b Road Transport, gaseous fuels: Member States' contributions to CO_2 emissions

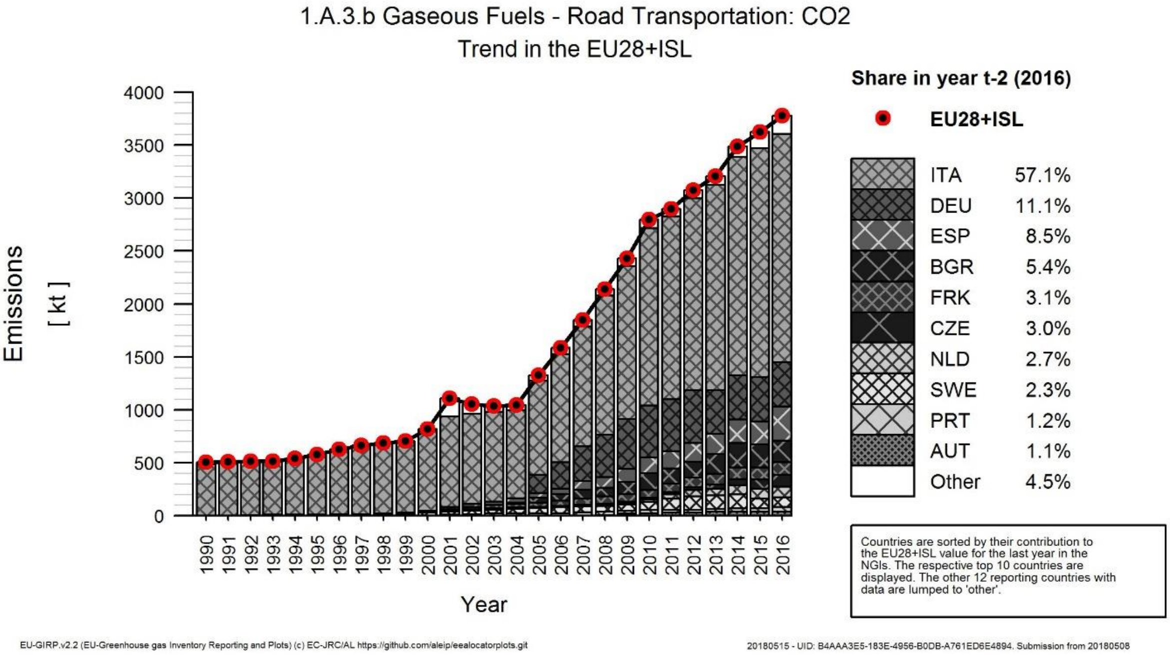
Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016	
	1990	2015	2016		kt CO2	%	kt CO2	%
Austria	NO	40	40	1.1%	40	∞	0	-1%
Belgium	NO	7	17	0.4%	17	∞	10	133%
Bulgaria	NO	216	203	5.4%	203	∞	-13	-6%
Croatia	NO	8	9	0.2%	9	∞	1	10%
Cyprus	NO	NO	NO	-	-	-	-	-
Czech Republic	IE,NO	84	113	3.0%	113	∞	30	35%
Denmark	0	7	11	0.3%	11	55362%	5	74%
Estonia	NO	NO	NO	-	-	-	-	-
Finland	NO,NA	4	5	0.1%	5	∞	1	35%
France	0	114	118	3.1%	118	32994%	4	4%
Germany	NA	414	418	11.1%	418	∞	3	1%
Greece	NO	35	36	1.0%	36	∞	1	3%
Hungary	0	10	19	0.5%	19	6167%	9	91%
Ireland	NO	NO	NO	-	-	-	-	-
Italy	483	2 159	2 159	57.1%	1 676	347%	-1	0%
Latvia	18	NA,NO	NO,NA	-	-18	-100%	-	-
Lithuania	NO	18	18	0.5%	18	∞	0	2%
Luxembourg	NO	NO	NO	-	-	-	-	-
Malta	NO	NO	NO	-	-	-	-	-
Netherlands	NO	95	102	2.7%	102	∞	6	7%
Poland	NO	38	36	0.9%	36	∞	-2	-7%
Portugal	NO	31	46	1.2%	46	∞	15	47%
Romania	NO	NO	NO	-	-	-	-	-
Slovakia	NO	26	13	0.4%	13	∞	-13	-49%
Slovenia	NO	5	6	0.2%	6	∞	2	34%
Spain	NO	221	321	8.5%	321	∞	100	45%
Sweden	3	91	87	2.3%	84	2917%	-4	-4%
United Kingdom	IE	IE	IE	-	-	-	-	-
EU-28	**504**	**3 624**	**3 778**	**100%**	**3 274**	**650%**	**153**	**4%**
Iceland	NO	NO	NO	-	-	-	-	-
United Kingdom (KP)	IE	IE	IE	-	-	-	-	-
EU-28 + ISL	**504**	**3 624**	**3 778**	**100%**	**3 274**	**650%**	**153**	**4%**

Abbreviations explained in the Chapter 'Units and abbreviations'.
Note: The information on methodologies and emission factors is not available from the CRF/XML on fuels level.

The Member States Germany, France, Italy and Spain contributed most to the CO_2 emissions from this source (80 %). All Member States, except for Latvia, show increased emissions from road transportation between 1990 and 2016. The Member States with the highest increases in absolute terms were Italy, Germany and Spain. (Table 3.62).

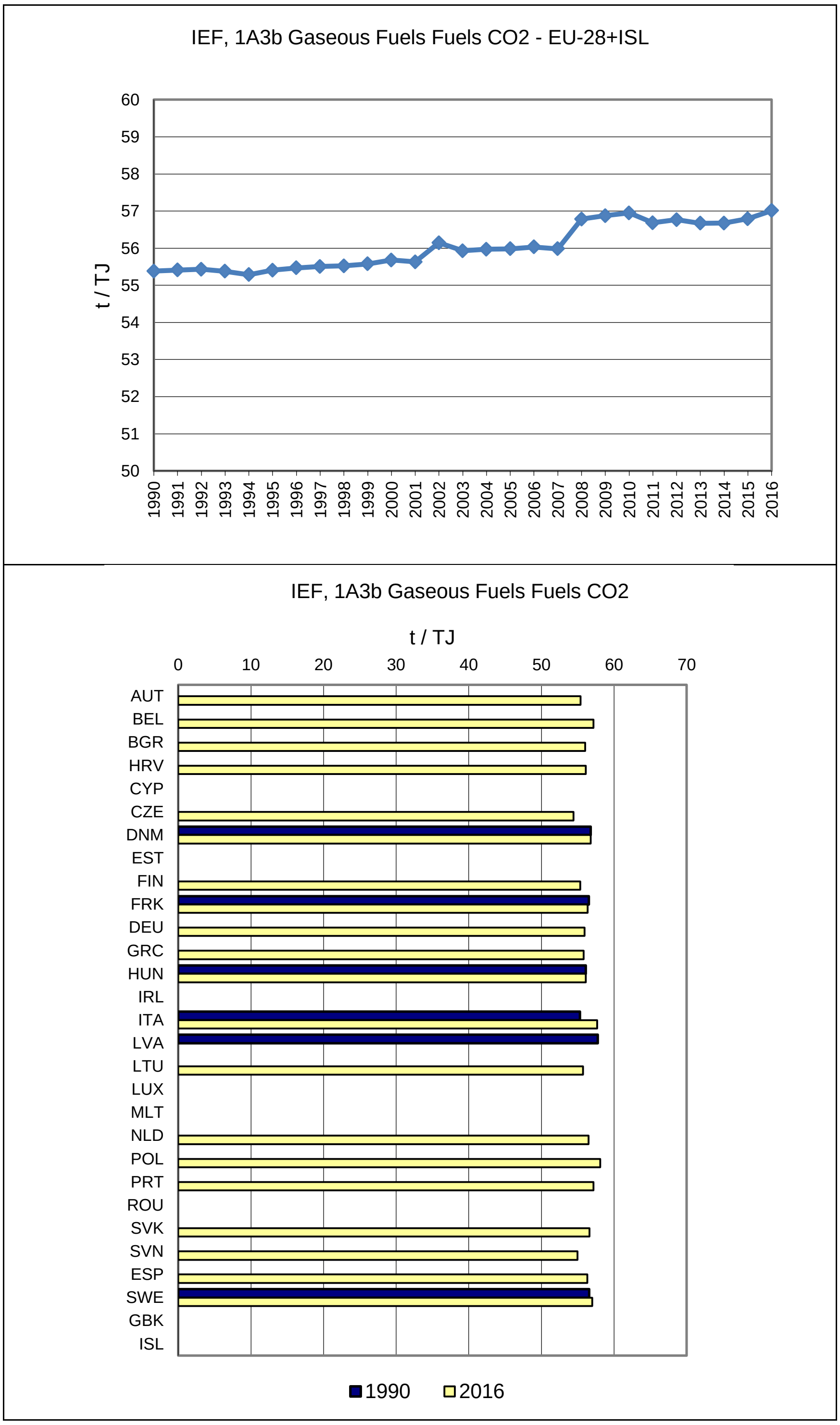
In Figure 3.7 it is depicted that the share of gaseous fuels is constantly increasing from 1990 to 2016. The reason for this increase is the increasing activity data and corresponing emissions of Italy, which a high contributor to this source category. In Figure 3.10 the IEF is depicted and the mean value is around 56 t/TJ.

Figure 3.91: 1A3b Road Transport, gaseous fuels: Emission trend and share for CO_2



1.A.3.b Gaseous Fuels - Road Transportation: CO2
Trend in the EU28+ISL
Emissions
[kt]
4000
3500
3000
2500
2000
1500
1000
500
0
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
Year
Share in year t-2 (2016)
EU28+ISL
ITA 57.1%
DEU 11.1%
ESP 8.5%
BGR 5.4%
FRK 3.1%
CZE 3.0%
NLD 2.7%
SWE 2.3%
PRT 1.2%
AUT 1.1%
Other 4.5%
Countries are sorted by their contribution to the EU28+ISL value for the last year in the NGIs. The respective top 10 countries are displayed. The other 12 reporting countries with data are lumped to 'other'.
EU-GIRP.v2.2 (EU-Greenhouse gas Inventory Reporting and Plots) (c) EC-JRC/AL https://github.com/aleip/eealocatorplots.git
20180515 - UID: B4AAA3E5-183E-4956-B0DB-A761ED6E4894. Submission from 20180508

Figure 3.92   1A3b Road Transport, gaseous fuels: Implied Emission Factors for CO_2 (in t/TJ)



1A3b Road Transportation – Diesel Oil (CO_2)

CO_2 emissions from Diesel oil account for 71 % of CO_2 emissions from 1A3b Road Transport in 2016 (Figure 3.90). All Member States show increased emissions from Diesel oil between 1990 and 2016 (Table 3.). Member States with the highest increase in per cent were Slovenia, Czech Republic, Ireland and Poland. Some of these increases are due to fuel bought in the respective countries but consumed abroad (fuel tourism).

Table 3.8 1A3b Road Transport, diesel oil: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016	
	1990	2015	2016		kt CO2	%	kt CO2	%
Austria	5 378	16 777	17 700	2.8%	12 323	229%	923	6%
Belgium	11 027	21 562	20 947	3.4%	9 920	90%	-615	-3%
Bulgaria	1 539	5 636	5 754	0.9%	4 215	274%	117	2%
Croatia	1 159	3 854	4 050	0.6%	2 891	249%	196	5%
Cyprus	667	768	870	0.1%	203	30%	102	13%
Czech Republic	2 690	12 089	12 605	2.0%	9 916	369%	516	4%
Denmark	4 436	7 660	7 889	1.3%	3 453	78%	229	3%
Estonia	697	1 463	1 475	0.2%	779	112%	13	1%
Finland	4 923	6 286	7 797	1.3%	2 873	58%	1 510	24%
France	54 220	103 412	103 507	16.6%	49 286	91%	95	0%
Germany	54 478	99 846	103 509	16.6%	49 032	90%	3 663	4%
Greece	4 264	6 105	6 534	1.0%	2 270	53%	428	7%
Hungary	2 388	7 918	7 861	1.3%	5 473	229%	-57	-1%
Ireland	1 914	8 040	8 682	1.4%	6 768	354%	642	8%
Italy	47 774	66 563	66 875	10.7%	19 101	40%	311	0%
Latvia	623	2 135	2 193	0.4%	1 570	252%	58	3%
Lithuania	2 134	3 808	4 164	0.7%	2 030	95%	356	9%
Luxembourg	1 264	4 719	4 575	0.7%	3 311	262%	-145	-3%
Malta	120	307	307	0.0%	187	157%	0	0%
Netherlands	13 014	16 831	16 709	2.7%	3 695	28%	-121	-1%
Poland	8 633	29 609	35 170	5.6%	26 536	307%	5 561	19%
Portugal	5 072	11 964	12 303	2.0%	7 232	143%	339	3%
Romania	3 648	10 950	11 855	1.9%	8 207	225%	906	8%
Slovakia	3 123	4 762	4 371	0.7%	1 249	40%	-390	-8%
Slovenia	904	3 913	4 297	0.7%	3 392	375%	384	10%
Spain	24 420	63 861	65 209	10.5%	40 789	167%	1 348	2%
Sweden	4 416	9 482	8 829	1.4%	4 413	100%	-652	-7%
United Kingdom	32 773	73 495	76 560	12.3%	43 788	134%	3 066	4%
EU-28	**297 697**	**603 815**	**622 597**	**100%**	**324 900**	**109%**	**18 782**	**3%**
Iceland	117	403	465	0.1%	349	299%	63	16%
United Kingdom (KP)	32 916	73 712	76 780	12.3%	43 863	133%	3 068	4%
EU-28 + ISL	**297 957**	**604 435**	**623 282**	**100%**	**325 325**	**109%**	**18 847**	**3%**

Abbreviations explained in the Chapter 'Units and abbreviations'.
Note: The information on methodologies and emission factors is not available from the CRF/XML on fuels level.

France, Germany, Italy, Spain and the UK account for 67 % of CO_2 emissions from diesel oil in 2016 (In Figure 3.93 the IEF is depicted and the mean value is around 74 t/TJ. For some Member States the values of the IEF is outside the range of the upper and lower IPCC default value. This is due to the fact that in most cases these IEF are country specific. In the case of Malta, investigations are ongoing to further refine the data used in the COPERT software for the calculation of the corresponding emissions. Improvements are also planned for the database on the stock of vehicles. The case of Romania was also investigated and it was concluded that the value of the IEF depends also on the country specific values for the Net Calorific Value (NCV).

Figure 3.94 1A3b Road Transport, Diesel Oil: Emission trend and share for CO_2

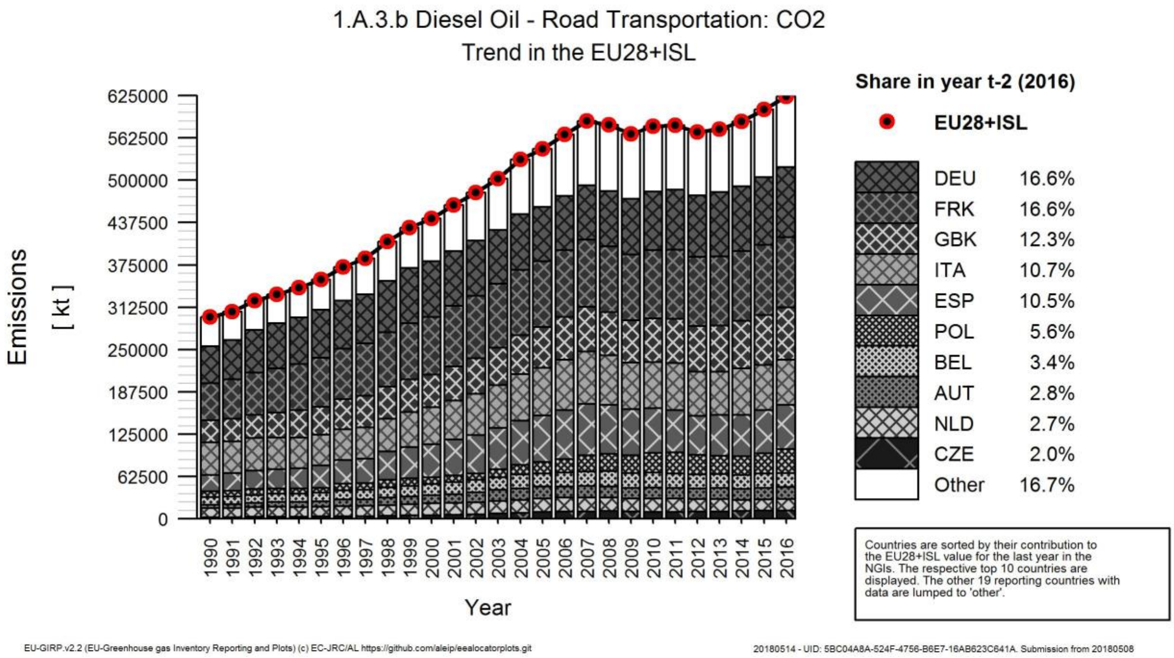
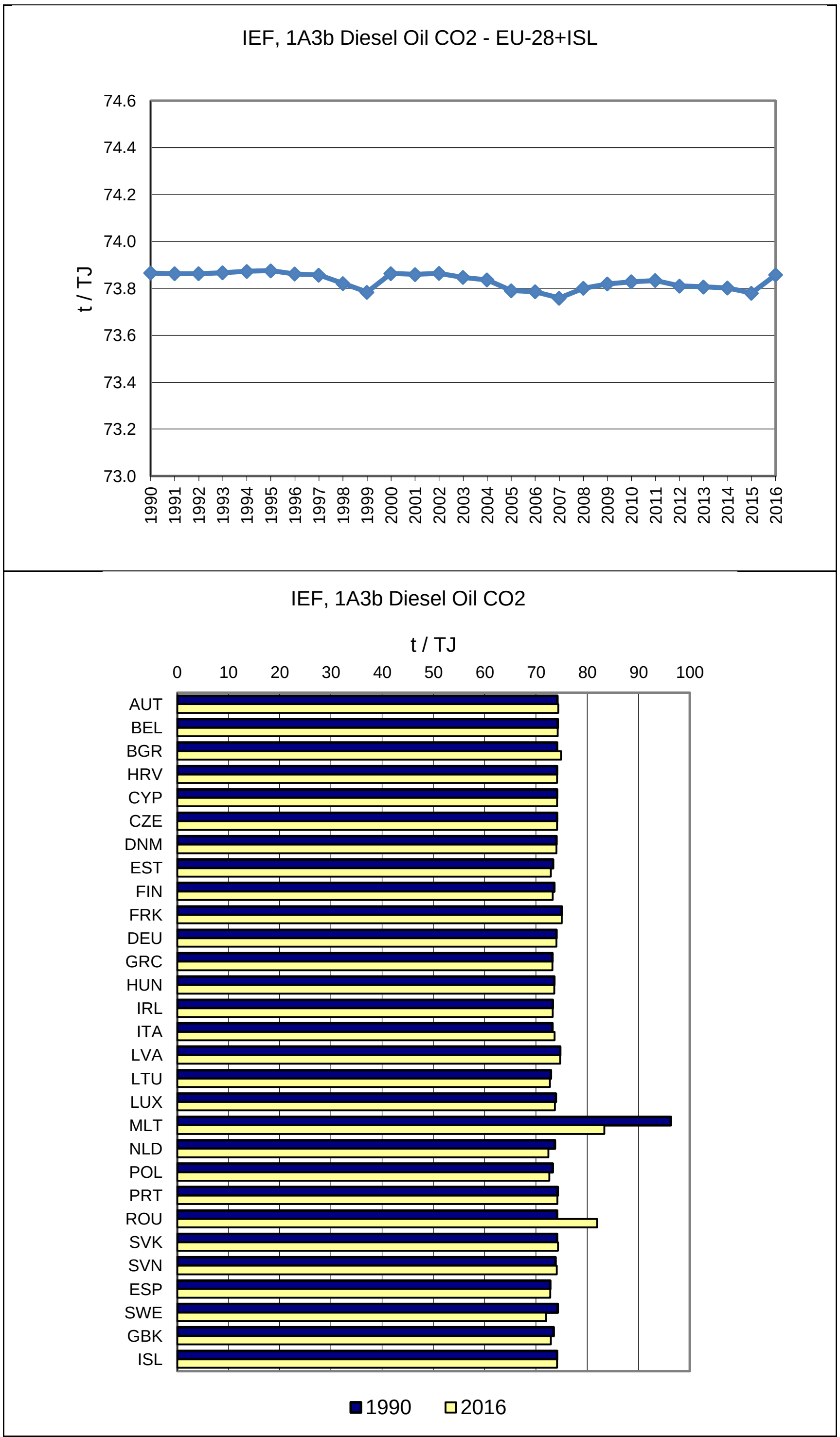


Figure 3.95 1A3b Road Transport, Diesel Oil: Implied Emission Factors for CO_2 (in t/TJ)



1A3b Road Transportation – Gasoline (CO_2)

Between 1990 and 2016, CO_2 emissions from gasoline decreased by 43 % in the EU-28+ISL (Table 3.).

Table 3.9 1A3b Road Transport, gasoline: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016	
	1990	2015	2016		kt CO2	%	kt CO2	%
Austria	7 924	4 777	4 779	2.1%	-3 145	-40%	2	0%
Belgium	8 534	3 996	4 322	1.9%	-4 212	-49%	326	8%
Bulgaria	4 241	1 559	1 476	0.6%	-2 766	-65%	-83	-5%
Croatia	2 347	1 607	1 613	0.7%	-734	-31%	6	0%
Cyprus	500	1 059	1 087	0.5%	586	117%	28	3%
Czech Republic	3 487	4 517	4 652	2.0%	1 165	33%	135	3%
Denmark	4 912	3 936	3 901	1.7%	-1 011	-21%	-35	-1%
Estonia	1 529	730	749	0.3%	-780	-51%	19	3%
Finland	5 884	4 043	4 048	1.7%	-1 837	-31%	5	0%
France	57 738	20 192	20 551	8.9%	-37 187	-64%	359	2%
Germany	97 217	53 355	53 353	23.1%	-43 863	-45%	-2	0%
Greece	7 438	7 709	7 498	3.2%	60	1%	-211	-3%
Hungary	5 404	3 811	4 124	1.8%	-1 280	-24%	314	8%
Ireland	2 758	3 145	2 935	1.3%	177	6%	-210	-7%
Italy	39 923	24 386	22 782	9.8%	-17 141	-43%	-1 605	-7%
Latvia	1 723	633	597	0.3%	-1 126	-65%	-37	-6%
Lithuania	3 053	608	657	0.3%	-2 396	-78%	49	8%
Luxembourg	1 254	871	846	0.4%	-408	-33%	-25	-3%
Malta	180	235	235	0.1%	55	30%	0	0%
Netherlands	10 814	11 375	11 755	5.1%	941	9%	381	3%
Poland	9 517	10 583	11 175	4.8%	1 658	17%	592	6%
Portugal	4 332	3 353	3 259	1.4%	-1 073	-25%	-94	-3%
Romania	6 591	3 792	3 963	1.7%	-2 628	-40%	171	5%
Slovakia	1 380	1 568	1 772	0.8%	392	28%	205	13%
Slovenia	1 695	1 296	1 283	0.6%	-412	-24%	-13	-1%
Spain	25 925	13 843	14 466	6.3%	-11 459	-44%	623	5%
Sweden	12 759	6 984	6 701	2.9%	-6 058	-47%	-283	-4%
United Kingdom	75 119	36 472	36 021	15.6%	-39 098	-52%	-451	-1%
EU-28	**404 179**	**230 433**	**230 599**	**100%**	**-173 580**	**-43%**	**166**	**0%**
Iceland	392	407	419	0.2%	26	7%	12	3%
United Kingdom (KP)	75 448	36 769	36 334	15.7%	-39 114	-52%	-435	-1%
EU-28 + ISL	**404 900**	**231 137**	**231 331**	**100%**	**-173 569**	**-43%**	**194**	**0%**

Abbreviations explained in the Chapter 'Units and abbreviations'.

Note: The information on methodologies and emission factors is not available from the CRF/XML on fuels level.

France, Germany, Italy, Spain and the United Kingdom account for 64 % for CO_2 emissions from gasoline in 2016). In Figure 3.96 the IEF is depicted and the mean value is around 72 t/TJ. The increase of the IEF from 2014 to 2015 is due to an increase in the IEF of Germany, which has a share of 23% of emissions in this sector. For some Member States the values of the IEF are outside the range of the upper IPCC default value (such as Austria and the Netherlands). This is due to the fact that in most cases these IEF are country specific.

Figure 3.97 1A3b Road Transport, Gasoline: Emission trend and share for CO_2

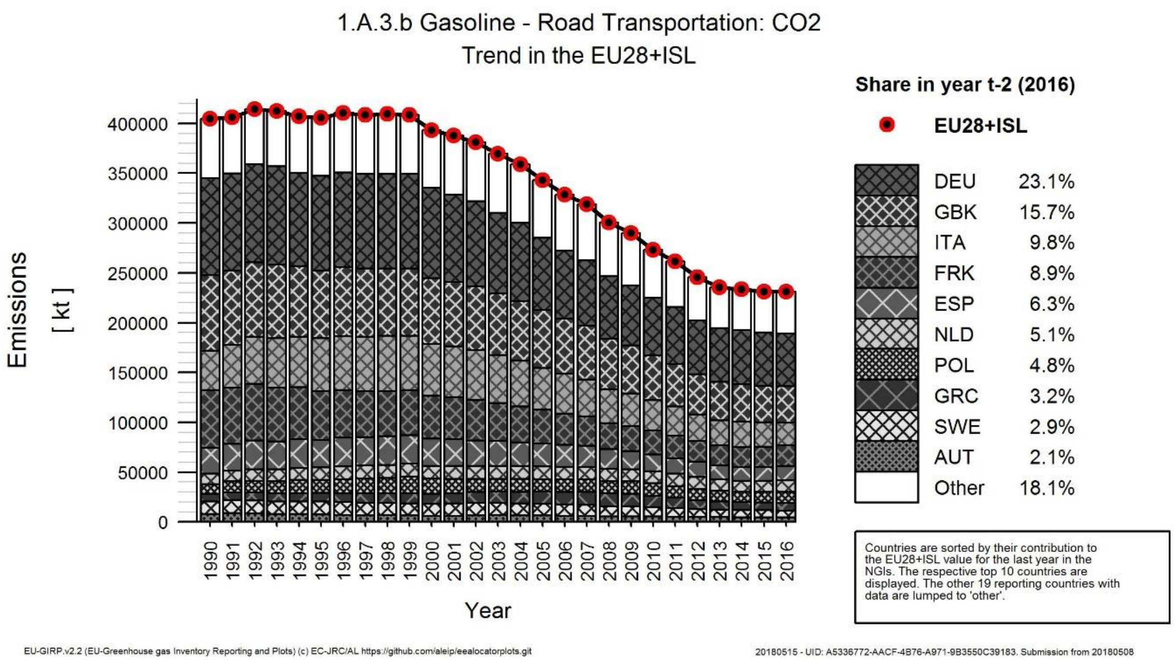
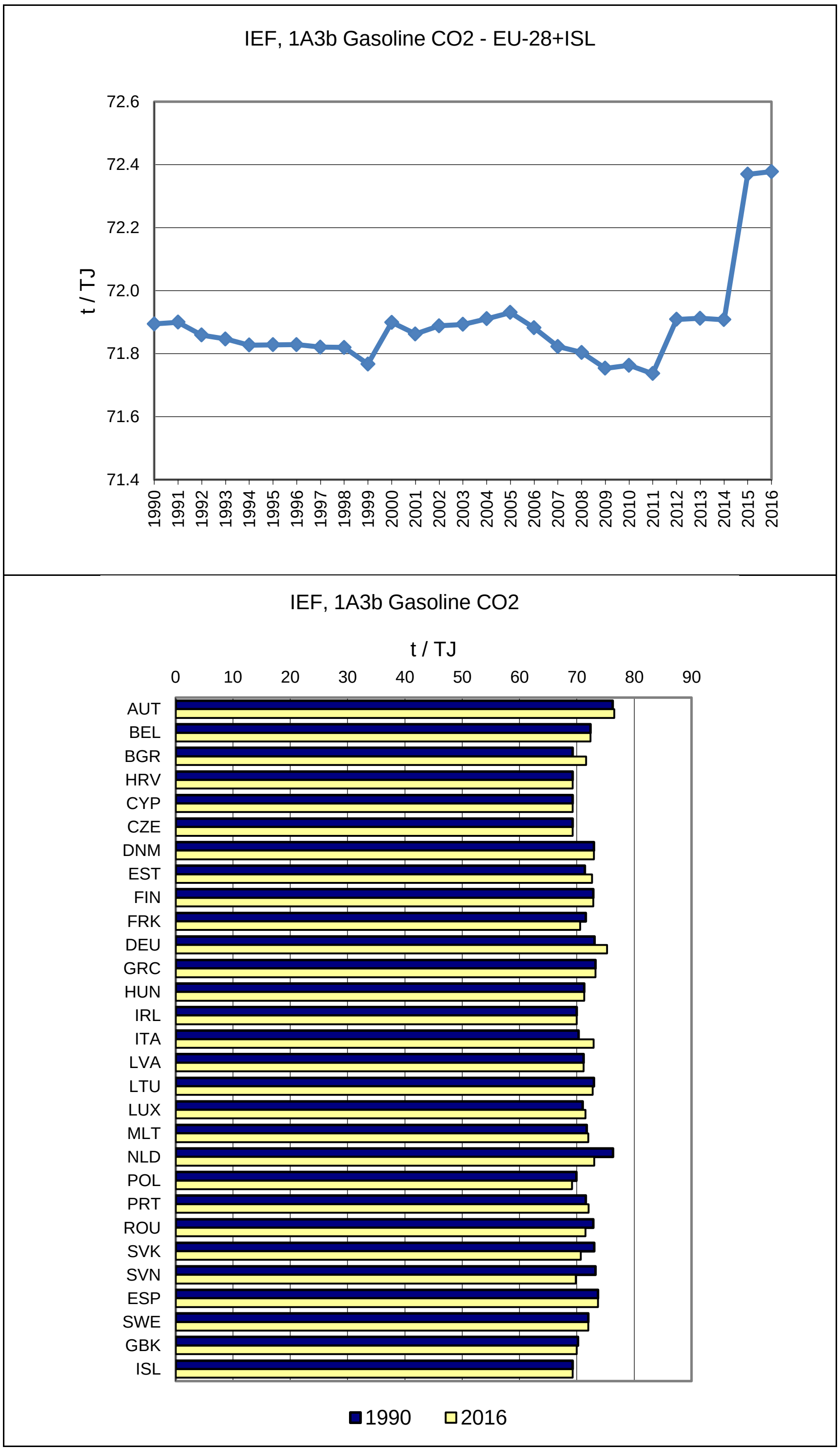


Figure 3.98 1A3b Road Transport, Gasoline: Implied Emission Factors for CO_2 (in t/TJ)



1A3b Road Transportation – LPG (CO_2)

Between 1990 and 2016, CO_2 emissions from LPG increased by 120 % in the EU-28+ISL. Three Member States report emissions as ‘Not occurring’. Between 2015 and 2016 EU-28+ISL emissions increased by 1 % (Table 3.).

Table 3.10 1A3b Road Transport, LPG: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016	
	1990	2015	2016		kt CO2	%	kt CO2	%
Austria	26	40	31	0.2%	4	15%	-9	-23%
Belgium	169	175	178	1.1%	9	5%	3	2%
Bulgaria	NO	1 273	1 364	8.5%	1 364	∞	91	7%
Croatia	NO	198	209	1.3%	209	∞	11	6%
Cyprus	NO	NO	NO	-	-	-	-	-
Czech Republic	IE,NO	297	300	1.9%	300	∞	3	1%
Denmark	9	0	0	0.0%	-9	-99%	0	-28%
Estonia	9	1	15	0.1%	6	68%	15	2881%
Finland	NO,NA	NA,NO	NO,NA	-	-	-	-	-
France	150	243	217	1.3%	67	44%	-26	-11%
Germany	9	1 258	1 291	8.0%	1 282	14170%	33	3%
Greece	91	706	720	4.5%	629	693%	14	2%
Hungary	NO	80	74	0.5%	74	∞	-6	-7%
Ireland	19	7	7	0.0%	-12	-63%	0	1%
Italy	4 026	5 002	4 833	30.0%	807	20%	-169	-3%
Latvia	37	169	163	1.0%	125	338%	-6	-4%
Lithuania	60	368	347	2.2%	287	476%	-21	-6%
Luxembourg	11	2	2	0.0%	-9	-81%	0	8%
Malta	NO	1	2	0.0%	2	∞	1	45%
Netherlands	2 642	406	405	2.5%	-2 237	-85%	-1	0%
Poland	NO,IE	4 862	5 135	31.9%	5 135	∞	273	6%
Portugal	0	107	110	0.7%	110	173252%	3	3%
Romania	NO	166	197	1.2%	197	∞	30	18%
Slovakia	NO	101	115	0.7%	115	∞	14	13%
Slovenia	NO	40	42	0.3%	42	∞	1	4%
Spain	78	130	142	0.9%	63	81%	12	9%
Sweden	0	6	2	0.0%	2	684%	-4	-60%
United Kingdom	NO	241	208	1.3%	208	∞	-32	-13%
EU-28	**7 338**	**15 880**	**16 108**	**100%**	**8 770**	**120%**	**228**	**1%**
Iceland	NO	NO	NO	-	-	-	-	-
United Kingdom (KP)	NO	241	208	1.3%	208	∞	-32	-13%
EU-28 + ISL	**7 338**	**15 880**	**16 108**	**100%**	**8 770**	**120%**	**228**	**1%**

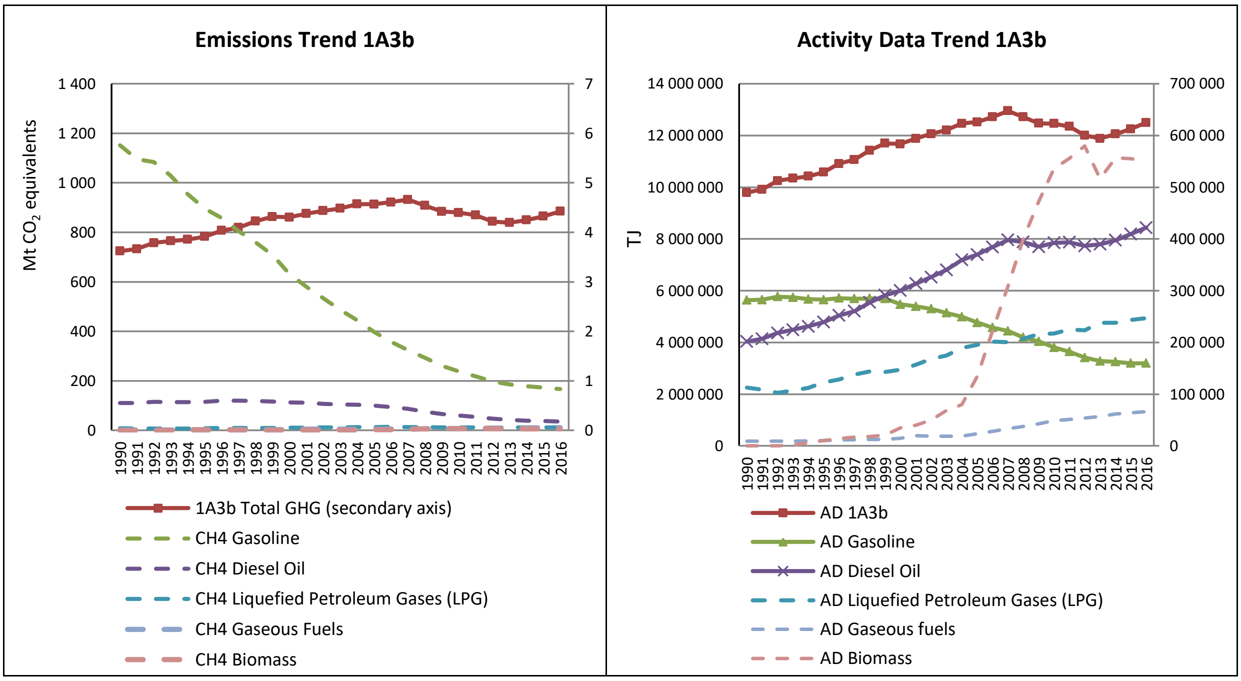
Abbreviations explained in the Chapter 'Units and abbreviations'.
Note: The information on methodologies and emission factors is not available from the CRF/XML on fuels level.

Italy accounts for 30 % and Poland for 32 % of CO_2 emissions from LPG in 2016 whereas France, Germany, Spain and the United Kingdom account for only 12 % of CO_2 emissions (Table 3.).

CH_4 emissions from 1A3b Road Transportation

CH_4 emissions from 1A3b Road Transportation account for 0.03 % of total EU-28+ISL GHG emissions in 2016 Figure 3.102 gives an overview of the CH_4 trend caused by different fuels, as well as the activity data trend, where it is clear that the gasoline share is decreasing, whereas the diesel oil is increasing.

Figure 3.99 1A3b Road Transport: CH_4 Emissions Trend and Activity Data Trend



Data displayed as dashed line refers to the secondary axis.

CH_4 emissions decreased between 1990 and 2016 by 82 % (Table 3.68). All Member States, except for Cyprus (increase by 104 %) showed a decrease in CH_4 emissions from 1990 to 2016. Between 2015 and 2016, CH_4 emissions decreased by 3 % in EU-28+ISL. In the same time period the largest decrease in relative terms was reported by Slovakia and Latvia.

Table 3.65 1A3b Road Transport: Member States' contributions to CH_4 emissions and information on method applied and emission factor

Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016		Method	Emission factor Informa-tion
	1990	2015	2016		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	67	11	10	0.9%	-57	-85%	0	-4%	T3	CS
Belgium	120	16	16	1.4%	-104	-86%	0	2%	M,T3	CS,OTH
Bulgaria	70	28	26	2.2%	-44	-63%	-2	-8%	T2	CR
Croatia	41	12	11	1.0%	-29	-72%	-1	-5%	T1,T3	CR,D
Cyprus	5	11	11	0.9%	6	104%	0	4%	T1	D
Czech Republic	38	25	27	2.3%	-11	-28%	2	6%	T1,T2	CS,D
Denmark	57	11	10	0.8%	-47	-83%	-1	-9%	CR,M,T3	CR
Estonia	23	4	4	0.3%	-19	-84%	0	0%	T1,T3	CS,D
Finland	107	17	16	1.4%	-91	-85%	-1	-7%	M,T2	D
France	982	126	123	10.6%	-858	-87%	-3	-2%	T3	M
Germany	1 317	137	136	11.7%	-1 181	-90%	-1	0%	CS,M,T2,T3	CS,M
Greece	107	77	70	6.0%	-37	-35%	-7	-9%	M,T1	D,M
Hungary	62	26	25	2.2%	-37	-59%	0	-1%	T1,T3	D,M
Ireland	48	14	13	1.1%	-35	-73%	-1	-9%	T3	M
Italy	870	215	199	17.1%	-671	-77%	-16	-7%	T3	M
Latvia	19	4	3	0.3%	-15	-82%	0	-10%	T1,T2	CR,OTH
Lithuania	51	13	13	1.1%	-38	-75%	0	-3%	T1,T3	CR,D
Luxembourg	11	1	1	0.1%	-10	-91%	0	-7%	T3	M
Malta	3	2	2	0.1%	-2	-51%	0	-4%	T3	CR
Netherlands	193	58	57	4.9%	-136	-70%	0	-1%	T3	CS
Poland	178	106	111	9.5%	-67	-38%	5	5%	T1,T3	D
Portugal	83	25	24	2.1%	-58	-71%	-1	-5%	T3	CR
Romania	90	34	35	3.0%	-56	-62%	0	1%	T1,T3	D,OTH
Slovakia	29	10	9	0.7%	-21	-71%	-2	-17%	M	D
Slovenia	26	6	6	0.5%	-20	-77%	0	1%	M	M
Spain	370	80	83	7.2%	-286	-77%	4	5%	T3	M
Sweden	152	18	16	1.4%	-136	-89%	-2	-9%	M,T2	CS,D
United Kingdom	1 237	106	100	8.6%	-1 137	-92%	-6	-5%	T3	CS
EU-28	**6 353**	**1 191**	**1 157**	**100%**	**-5 195**	**-82%**	**-34**	**-3%**	**-**	**-**
Iceland	4	3	3	0.3%	-1	-21%	0	18%	T1	D
United Kingdom (KP)	1 244	107	101	8.7%	-1 143	-92%	-6	-5%	T3	CS
EU-28 + ISL	**6 364**	**1 195**	**1 162**	**100%**	**-5 202**	**-82%**	**-33**	**-3%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

1A3b Road Transportation – Gasoline (CH_4)

Between 1990 and 2016, CH_4 emissions from gasoline decreased by 85 % in the EU-28+ISL. All Member States reported decreasing emissions, apart from Cyprus (increase by 117 %). Between 2015 and 2016 EU-28+ISL emissions decreased by 3 % (Table 3.). The largest decreases in per cent were reported by Greece (-14 %) and Latvia (-13 %).

Table 3.66 1A3b Road Transport, gasoline: Member States' contributions to CH_4 emissions

Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016	
	1990	2015	2016		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	64	9	9	1.0%	-56	-87%	0	-4%
Belgium	97	11	12	1.4%	-85	-88%	0	4%
Bulgaria	66	9	8	0.9%	-58	-88%	-1	-12%
Croatia	38	8	8	0.9%	-30	-79%	0	-4%
Cyprus	5	10	10	1.2%	5	117%	0	3%
Czech Republic	27	7	7	0.8%	-20	-74%	0	0%
Denmark	46	9	8	1.0%	-38	-83%	-1	-7%
Estonia	21	3	3	0.3%	-18	-87%	0	-2%
Finland	93	13	12	1.5%	-81	-87%	-1	-7%
France	867	95	94	11.2%	-773	-89%	-1	-1%
Germany	1 289	122	121	14.5%	-1 167	-91%	-1	0%
Greece	97	63	54	6.5%	-43	-44%	-8	-14%
Hungary	55	17	17	2.1%	-38	-69%	1	4%
Ireland	44	12	11	1.3%	-33	-76%	-1	-9%
Italy	737	141	129	15.4%	-608	-83%	-12	-9%
Latvia	16	2	2	0.2%	-15	-90%	0	-13%
Lithuania	44	6	6	0.7%	-38	-86%	0	-1%
Luxembourg	10	1	1	0.1%	-9	-92%	0	-7%
Malta	3	1	1	0.1%	-2	-60%	0	-3%
Netherlands	157	48	48	5.7%	-109	-69%	0	-1%
Poland	154	61	64	7.7%	-90	-58%	3	5%
Portugal	72	17	16	2.0%	-56	-77%	-1	-5%
Romania	81	23	23	2.8%	-58	-72%	0	0%
Slovakia	21	5	6	0.7%	-15	-73%	0	5%
Slovenia	24	5	5	0.5%	-19	-81%	0	-1%
Spain	321	57	59	7.1%	-262	-82%	2	4%
Sweden	149	14	13	1.6%	-136	-91%	-1	-8%
United Kingdom	1 149	92	89	10.6%	-1 060	-92%	-3	-3%
EU-28	**5 746**	**859**	**834**	**100%**	**-4 912**	**-85%**	**-25**	**-3%**
Iceland	4	2	2	0.2%	-2	-42%	0	18%
United Kingdom (KP)	1 155	93	90	10.7%	-1 065	-92%	-3	-3%
EU-28 + ISL	**5 756**	**862**	**837**	**100%**	**-4 919**	**-85%**	**-25**	**-3%**

Abbreviations explained in the Chapter 'Units and abbreviations'.
Note: The information on methodologies and emission factors is not available from the CRF/XML on fuels level.

France, Germany, Italy, Spain and the United Kingdom account for 59 % of CH_4 emissions from gasoline in 2016 (Table 3.). In Figure 3.17 the IEF is depicted and the IEF decreased from 40 kg/TJ in 1990 to 10 kg/TJ in 2016. All MSs show a similar trend in both the IEF and emission values, which is also linked to the decreasing trend of the corresponding activity data.

Figure 3.100 1A3b Road Transport, gasoline: Emission trend and share for CH_4 emission

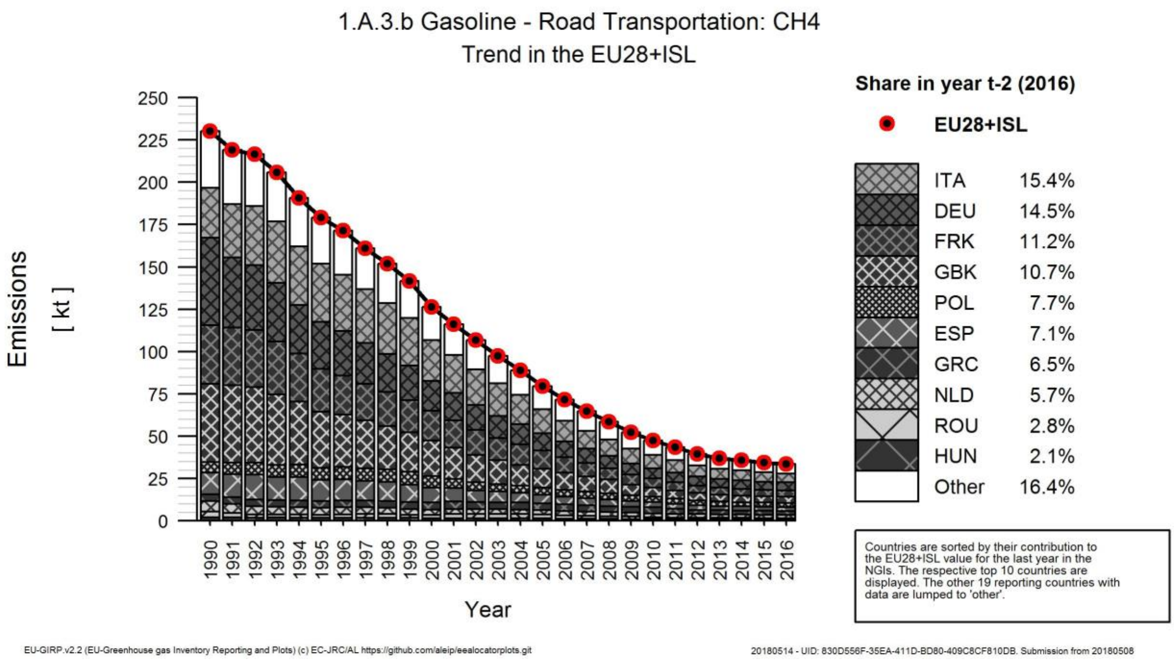
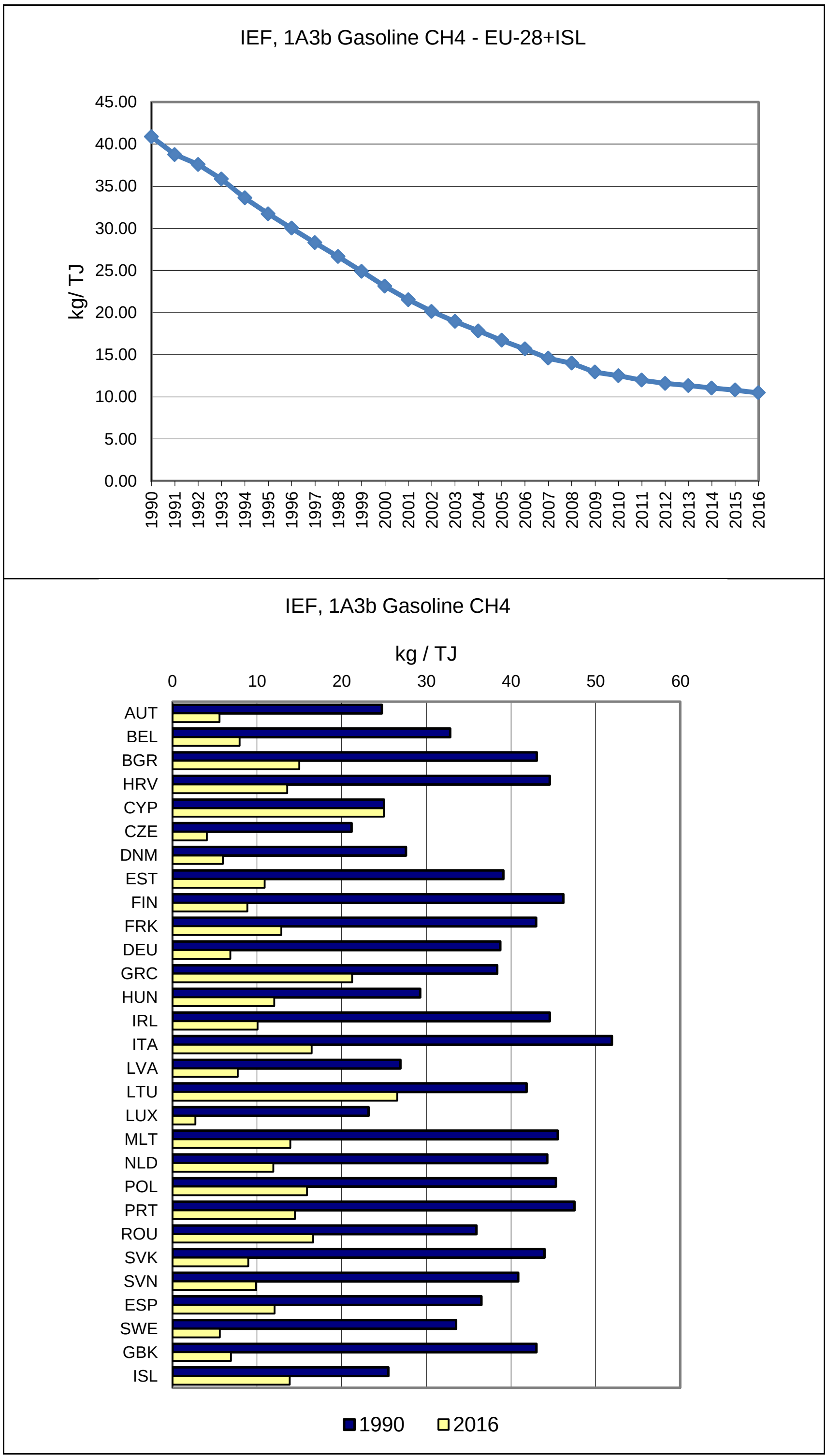


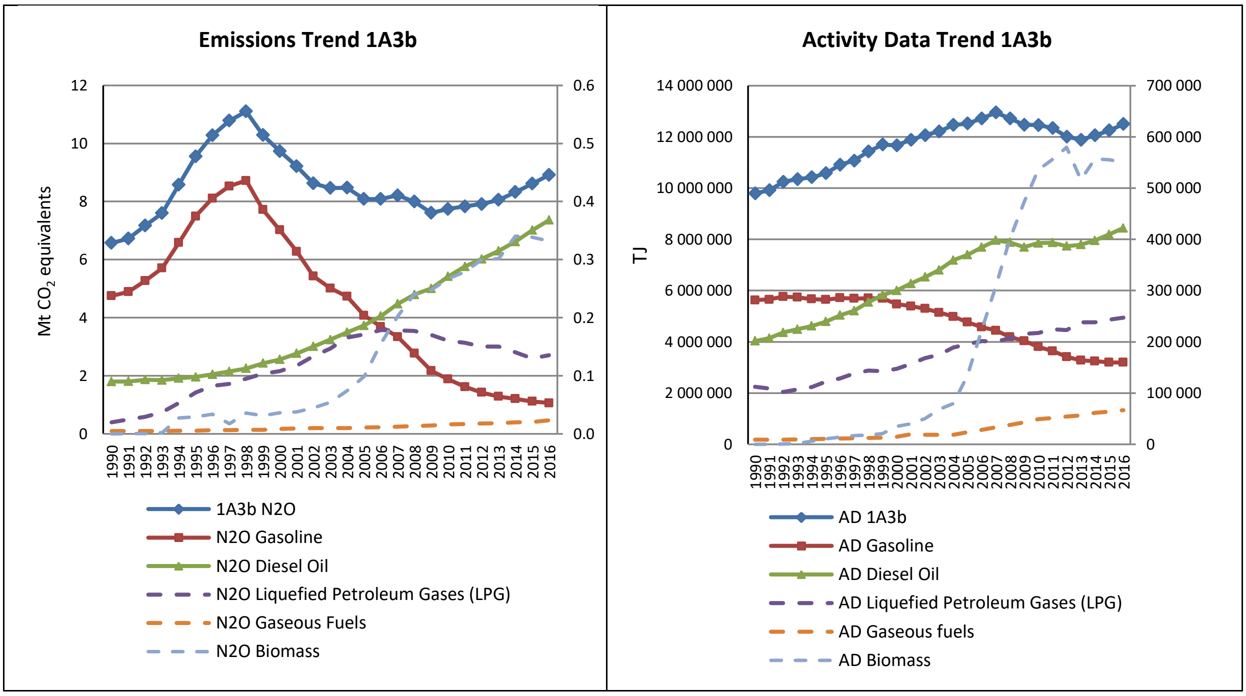
Figure 3.101 1A3b Road Transport, Gasoline: Implied Emission Factors for CH_4 (in kg/TJ)



N_2O emissions from 1A3b Road Transportation

N_2O emissions from 1A3b Road Transportation account for 0.2 % of total EU-28+ISL GHG emissions in 2016. Figure 3.102 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 3.102   1A3b Road Transport: N_2O Emissions Trend



Data displayed as dashed line refers to the secondary axis.

N_2O emissions increased between 1990 and 2016 by 36 % (Table 3.68). N_2O emissions increased 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-28+ISL 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.).

These emission factors were fully updated for passenger cars and light commercial vehicles with the launch of the first official COPERT 4 version 3.0 (November 2006) and were introduced in the rt070100 chapter of the emissions inventory guidebook dated September 2006. These emission factors introduced reductions in N_2O as the emission technology improved. In particular for gasoline vehicles, these emission factors also introduced an increase in the emission level as the vehicle grows older and a decrease as the fuel sulphur decreased. All emission factors were based on an extensive literature review and synthesis of the findings that was conducted in 2005. Use of the new emission factors over COPERT III should in general lead to reductions of the national N_2O levels.

In 2007, the HDV N_2O emission factors were updated based on a relevant report that was published by the Dutch Institute TNO (Report TNO 03.OR.VM.006.1/IJR). These emission factors were sensitive to vehicle size and driving conditions (urban, rural, highway). Depending on the national stock details, use of the emission factors could lead to both slight increases or slight decreases compared to the previous set. The new emission factors were introduced in COPERT 4 v5.0 (December 2007) but were then introduced in the AEIG with the original GB2009 revision (Technical report 9/2009 – June 2009).

Since June 2009 this basic methodology of N_2O calculation has remained without changes.

The COPERT 4 implementation of the methodology introduced some calculation errors that were fixed in the subsequent software versions. Also, a number of slight updates (extension of the methodology to other categories) have been incorporated. A summary of these updates and software fixes is provided in Table 3.67.

Table 3.67: N_2O and CH_4 relevant changes in the COPERT 4 and COPERT 5 methodology

Version: 4.3.0	Date: November 2006
METHODOLOGY: Update of the gasoline and diesel passenger car and light duty vehicle N_2O emission factors. Introduction of impact of vehicle technology, vehicle age and fuel sulfur.	
Reference: http://emisia.com/products/copert/versions	
Version: 4.5.0	Date: December2007
METHODOLOGY: Update of the diesel HDV emission factors based on Dutch study	
Reference: http://emisia.com/products/copert/versions	
Version: 4.5.1	Date: February 2008
SOFTWARE CORRECTION: Use of the cumulative mileage instead of annual mileage to calculate N_2O degradation. The correction should lead to an increase in emissions	
Reference: http://emisia.com/products/copert/versions	
Version: 4.6.1	Date: February 2009
METHODOLOGY: The Euro 5 and 6 passenger car and light duty trucks emission factors of CH_4, N_2O, NH_3 have been inherited by default from Euro 4. They were zero in the previous version. The revision will slightly increase total N_2O emissions.	
Reference: http://emisia.com/products/copert/versions	
Version: 4.7.0	Date: December 2009
SOFTWARE CORRECTION: There was a software bug during the calculation of N_2O, NH_3 and CH_4 hot and cold emissions. Because of this bug there was a misallocation between the hot and cold emissions of these pollutants. Furthermore, the N_2O cold emissions were stored in place of NH_3 cold emissions and vice versa. This is now corrected. The corrections are expected to lead to MS specific changes.	
Reference: http://emisia.com/sites/default/files/COPERT4_v7_0.pdf	
Version: 4.8.1	Date: May 2011
METHODOLOGY: N_2O hot and cold emission factors parameters for Euro 5 and Euro 6 LPG passenger cars are set equal to Euro 5 and Euro 6 gasoline ones. This is estimated to slightly increase N_2O in some MS were LPG vehicles are widespread.	
Reference: http://emisia.com/sites/default/files/COPERT4_v8_1.pdf	
Version: 4.9.0	Date: October 2011
METHODOLOGY: Bioethanol was introduced as a fuel. N_2O emissions are now split to a fossil and a non-fossil (biomass) part (for exporting to CRF).	
Reference: http://emisia.com/sites/default/files/COPERT4_v9_0.pdf	
Version: 4.10.0	Date: November 2012
METHODOLOGY: CH_4 emission factors for Euro 4, 5 and 6 gasoline passenger cars have been updated. This is estimated to slightly increase total CH_4 emissions.	
Reference: http://emisia.com/sites/default/files/COPERT4_v10_0.pdf	
Version: 4.11.0	Date: September 2014
METHODOLOGY: Updated N_2O emission factors for Euro 5/V and Euro 6/VI vehicles. The corrections are expected to lead to MS specific changes.	
Reference: http://www.emisia.com/sites/default/files/files/COPERT4_v11_0.pdf	
Version: 4.11.2	Date: January 2015
METHODOLOGY: Minor bug fixes to N_2O emission factors for Euro 5/V and Euro 6/VI vehicles. The corrections are expected to lead to MS specific changes.	
Reference: http://emisia.com/products/copert/versions	
Version: 5.1.0	Date: December 2017
METHODOLOGY: Corrected CH_4 Heavy Duty Trucks Hot Highway and Rural reduction factor to avoid negative results. Corrected CH_4 Hot-Cold emission factors for Diesel Passenger Cars Euro 5 and on. Corrected N_2O Hot Factors for LPG Passenger Cars Euro 5 and on. The corrections are expected to lead to MS specific changes.	
Reference: http://emisia.com/products/copert/versions	

Table 3.68 1A3b Road Transport: Member States' contributions to N_2O emissions and information on method applied and emission factor

Member State	N2O Emissions in kt CO2 equiv.			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016		Method	Emission factor Informa-tion
	1990	2015	2016		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	109	188	195	2.2%	85	78%	7	4%	T3	CS
Belgium	196	267	271	3.0%	75	38%	4	1%	M,T3	CS,OTH
Bulgaria	54	77	80	0.9%	26	49%	3	3%	T2	CR
Croatia	39	48	52	0.6%	13	35%	4	8%	T1,T3	CR,D
Cyprus	28	49	52	0.6%	24	87%	2	5%	T1	D
Czech Republic	137	348	363	4.1%	226	166%	16	5%	T1,T2	CS,D
Denmark	90	127	131	1.5%	41	46%	4	3%	CR,M,T3	CR
Estonia	22	20	20	0.2%	-2	-8%	0	1%	T1,T3	CS,D
Finland	154	73	75	0.8%	-79	-51%	2	3%	M,T2	D
France	894	1 480	1 526	17.1%	632	71%	46	3%	T3	M
Germany	1 113	1 518	1 569	17.6%	455	41%	51	3%	CS,M,T2,T3	CS,M
Greece	117	108	116	1.3%	-1	-1%	8	7%	M,T1	D,M
Hungary	64	118	122	1.4%	58	89%	4	3%	T1,T3	D,M
Ireland	49	108	114	1.3%	65	133%	6	5%	T3	M
Italy	824	853	847	9.5%	23	3%	-7	-1%	T3	M
Latvia	20	27	26	0.3%	6	28%	-1	-4%	T1,T2	CR,OTH
Lithuania	39	33	32	0.4%	-7	-18%	-1	-2%	T1,T3	CR,D
Luxembourg	15	48	48	0.5%	32	214%	-1	-2%	T3	M
Malta	1	3	3	0.0%	1	105%	0	0%	T3	CR
Netherlands	98	242	238	2.7%	140	143%	-4	-2%	T2	CS
Poland	176	466	494	5.5%	318	181%	28	6%	T1,T3	D
Portugal	75	148	151	1.7%	76	102%	3	2%	T3	CR
Romania	227	151	166	1.9%	-61	-27%	14	9%	T1,T3	D,OTH
Slovakia	56	62	62	0.7%	6	10%	0	0%	M	D
Slovenia	29	56	61	0.7%	33	114%	5	8%	M	M
Spain	468	816	859	9.6%	391	84%	43	5%	T3	M
Sweden	154	130	135	1.5%	-18	-12%	5	4%	M,T1,T2	CS,D
United Kingdom	1 306	1 012	1 069	12.0%	-237	-18%	57	6%	T3	CR,CS
EU-28	**6 553**	**8 578**	**8 874**	**100%**	**2 321**	**35%**	**297**	**3%**	**-**	**-**
Iceland	15	35	36	0.4%	21	143%	0	1%	T1	D
United Kingdom (KP)	1 311	1 015	1 072	12.0%	-239	-18%	57	6%	T3	CR,CS
EU-28 + ISL	**6 573**	**8 616**	**8 914**	**100%**	**2 341**	**36%**	**298**	**3%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

1A3b Road Transportation – Diesel Oil (N_2O)

N_2O emissions from Diesel oil account for 83 % of N_2O emissions from 1A3b "Road Transportation" in 2016. Between 1990 and 2016 N_2O emissions from Diesel oil increased in all Member States, except for Finland (decrease by 12 %); within the EU-28+ISL the emission increased by 309 %. The largest increase in absolute terms was reported by France and Germany. Between 2015 and 2016, EU-28+ISL emissions rose by 5 % (Table 3.69).

Table 3.69 1A3b Road Transport, diesel oil: Member States' contributions to N_2O emissions

Member State	N2O Emissions in kt CO2 equiv.			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016	
	1990	2015	2016		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	13	152	166	2.3%	153	1168%	14	9%
Belgium	59	245	242	3.3%	182	307%	-3	-1%
Bulgaria	13	43	46	0.6%	33	266%	3	8%
Croatia	10	33	38	0.5%	28	278%	5	14%
Cyprus	10	12	14	0.2%	3	30%	2	13%
Czech Republic	30	254	266	3.6%	236	789%	12	5%
Denmark	33	103	109	1.5%	76	232%	6	6%
Estonia	7	15	16	0.2%	8	117%	1	4%
Finland	65	47	58	0.8%	-8	-12%	11	24%
France	256	1 250	1 297	17.6%	1 041	407%	47	4%
Germany	119	1 298	1 357	18.4%	1 238	1037%	59	5%
Greece	39	42	54	0.7%	15	37%	11	27%
Hungary	21	86	89	1.2%	68	320%	3	3%
Ireland	13	89	97	1.3%	84	622%	8	9%
Italy	339	671	681	9.3%	342	101%	10	2%
Latvia	7	20	21	0.3%	14	210%	1	3%
Lithuania	19	21	22	0.3%	2	12%	0	2%
Luxembourg	3	44	44	0.6%	41	1549%	-1	-2%
Malta	0	1	1	0.0%	1	579%	0	5%
Netherlands	23	182	185	2.5%	161	690%	3	2%
Poland	73	317	337	4.6%	264	360%	20	6%
Portugal	31	109	115	1.6%	84	274%	6	6%
Romania	31	110	122	1.7%	91	296%	12	11%
Slovakia	41	49	49	0.7%	7	18%	0	1%
Slovenia	9	50	55	0.7%	46	520%	5	9%
Spain	195	748	789	10.7%	594	305%	41	5%
Sweden	14	109	118	1.6%	104	766%	8	8%
United Kingdom	321	900	965	13.1%	644	200%	66	7%
EU-28	**1 796**	**7 001**	**7 350**	**100%**	**5 554**	**309%**	**350**	**5%**
Iceland	2	6	7	0.1%	5	299%	1	16%
United Kingdom (KP)	323	902	968	13.1%	645	200%	66	7%
EU-28 + ISL	**1 799**	**7 009**	**7 360**	**100%**	**5 561**	**309%**	**351**	**5%**

Abbreviations explained in the Chapter 'Units and abbreviations'.
Note: The information on methodologies and emission factors is not available from the CRF/XML on fuels level.

France, Germany, Italy, Spain and the United Kingdom account for 69 % of N_2O emissions from diesel oil in 2016 (Figure 3.104). In Figure 3.103 the IEF is depicted and the EU IEF increased from 1.5 Kg/TJ in 1990 to about 3 kg/TJ in 2016. A similar situation, increase in the values of the IEF, is observed for almost all MSs.In most cases the IEF is country specific, with the exception of Cyprus and Iceland where the default emission factor was used (3.9 kg/TJ), thus a variation in the values of the IEF through the timeseries is observed.

Figure 3.104 1A3b Road Transport, diesel oil: Emission trend and share for N_2O emission

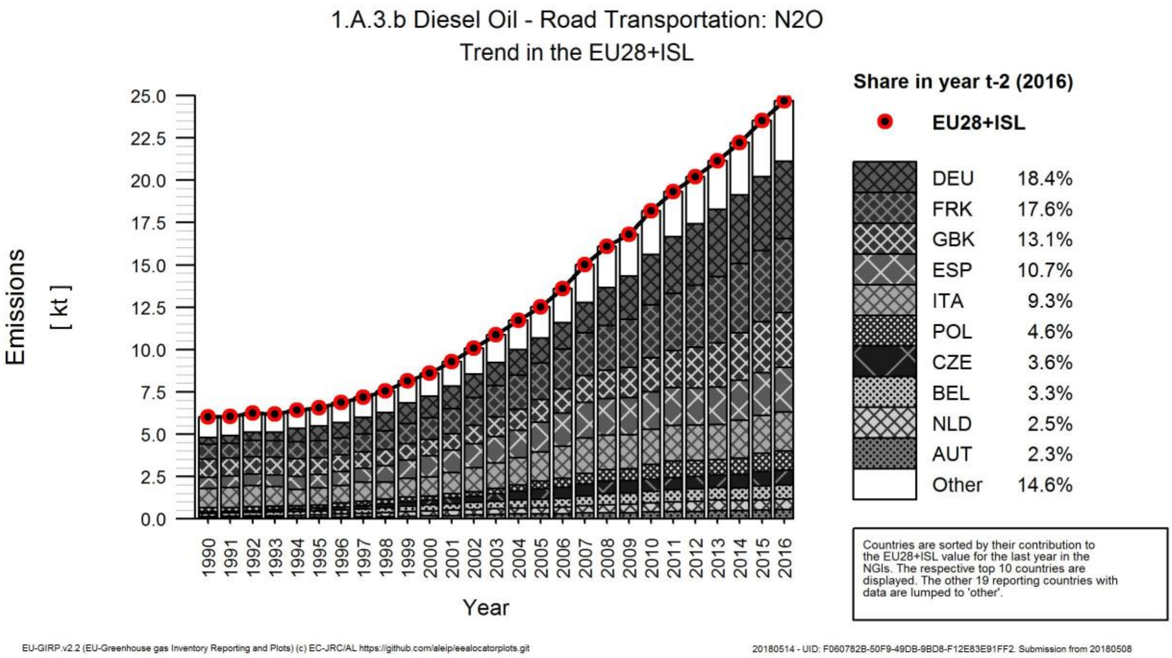
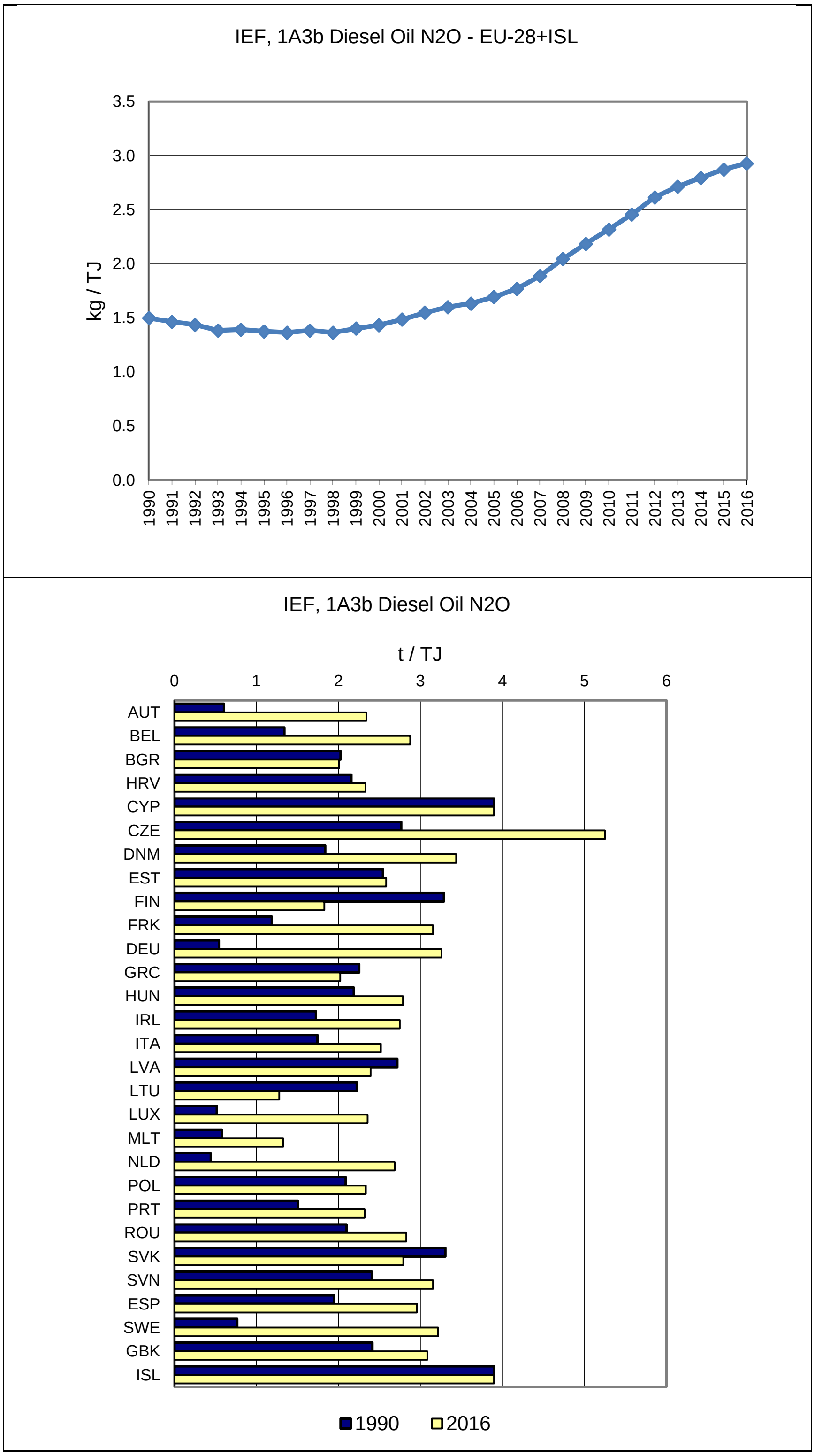


Figure 3.105 1A3b Road Transport, Diesel Oil: Implied Emission Factors for N_2O (in kg/TJ)



1A3b Road Transportation – Gasoline (N_2O)

N_2O emissions from Gasoline account for 12 % of N_2O emissions from 1A3b Road Transportation in 2016. Between 1990 and 2016, N_2O emissions from gasoline decreased by 78 % in the EU-28+ISL with a peak in 1998. As explained above, this peak is due to the implementation of the catalytic converter in the early Euro vehicles and mainly Euro 1. Emissions decreased thereafter with the introduction of Euro 2 and later vehicle technologies. Between 2015 and 2016, most Member States, (22 in total), showed a decreasing trend. The EU-28+ISL total N_2O emissions dropped by 5 % (Table 3.70).

Table 3.70 1A3b Road Transport, gasoline: Member States' contributions to N_2O emissions

Member State	N2O Emissions in kt CO2 equiv.			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016	
	1990	2015	2016		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	96	11	11	1.0%	-85	-89%	-1	-5%
Belgium	135	11	11	1.0%	-124	-92%	0	1%
Bulgaria	41	14	13	1.2%	-28	-69%	-2	-13%
Croatia	29	12	12	1.1%	-17	-59%	-1	-6%
Cyprus	17	36	37	3.5%	20	117%	1	3%
Czech Republic	107	89	93	8.7%	-14	-13%	3	4%
Denmark	57	16	14	1.3%	-43	-75%	-2	-13%
Estonia	14	5	4	0.4%	-10	-71%	0	-7%
Finland	88	16	14	1.3%	-75	-85%	-2	-12%
France	638	122	115	10.8%	-523	-82%	-7	-6%
Germany	994	134	125	11.7%	-869	-87%	-9	-7%
Greece	78	56	52	4.9%	-26	-33%	-4	-7%
Hungary	43	25	26	2.4%	-17	-40%	0	2%
Ireland	36	16	14	1.3%	-22	-61%	-2	-15%
Italy	480	115	103	9.7%	-377	-79%	-12	-10%
Latvia	12	3	2	0.2%	-10	-84%	-1	-41%
Lithuania	19	6	5	0.5%	-14	-72%	-1	-12%
Luxembourg	12	2	2	0.1%	-11	-88%	0	-8%
Malta	1	1	1	0.1%	0	13%	0	-6%
Netherlands	58	50	45	4.2%	-13	-22%	-6	-11%
Poland	103	86	89	8.4%	-13	-13%	3	4%
Portugal	44	29	27	2.5%	-17	-38%	-2	-7%
Romania	196	30	30	2.8%	-166	-85%	0	-1%
Slovakia	15	8	9	0.8%	-6	-42%	1	8%
Slovenia	20	4	4	0.4%	-15	-77%	1	26%
Spain	273	62	61	5.8%	-212	-78%	-1	-1%
Sweden	140	16	13	1.2%	-127	-91%	-3	-18%
United Kingdom	985	111	103	9.7%	-882	-90%	-8	-7%
EU-28	**4 732**	**1 089**	**1 035**	**97%**	**-3 697**	**-78%**	**-54**	**-5%**
Iceland	13	28	27	2.5%	14	109%	-1	-4%
United Kingdom (KP)	988	112	104	9.8%	-884	-89%	-8	-7%
EU-28 + ISL	**4 748**	**1 118**	**1 063**	**100%**	**-3 685**	**-78%**	**-55**	**-5%**

Abbreviations explained in the Chapter 'Units and abbreviations'.

France, Germany, Italy, Spain and the United Kingdom accounted for 48 % of N_2O emissions (Figure **3.107**). In Figure 3.106 the IEF is depicted and it is clear that high variability exists for all Member States through the whole time series. The IEF of Cyprus is constant (8 kg/TJ), since the default value for the IPCC 2006 Guidelines is used.

Figure 3.107 1A3b Road Transport, Gasoline: Emission trend and share for N_2O emissions

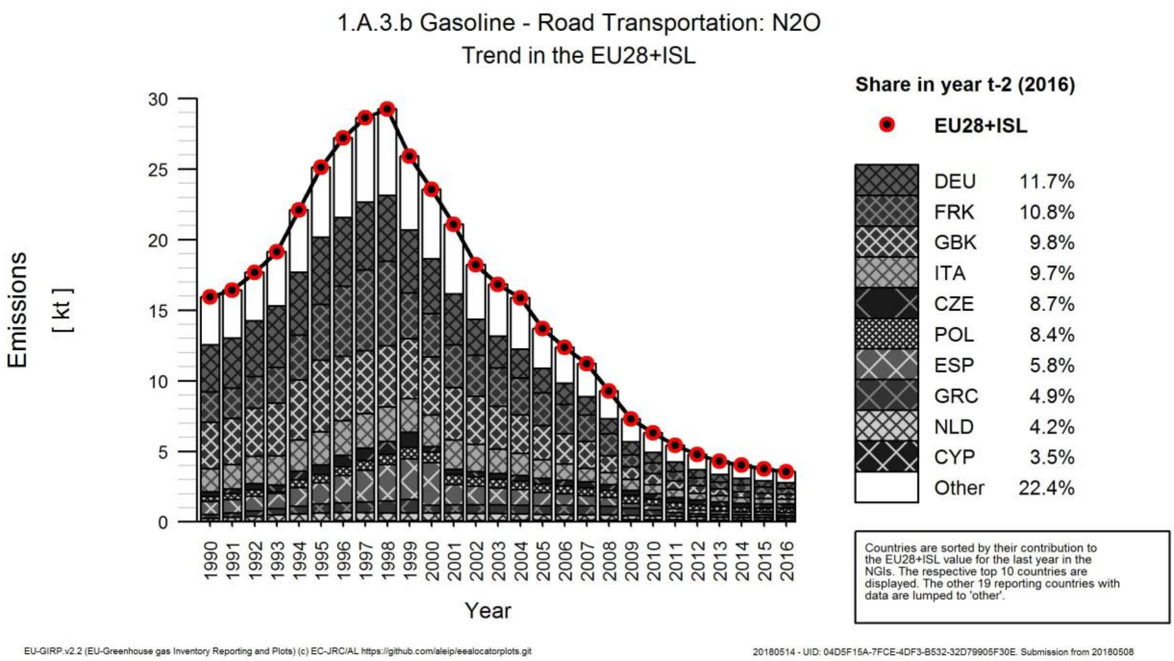
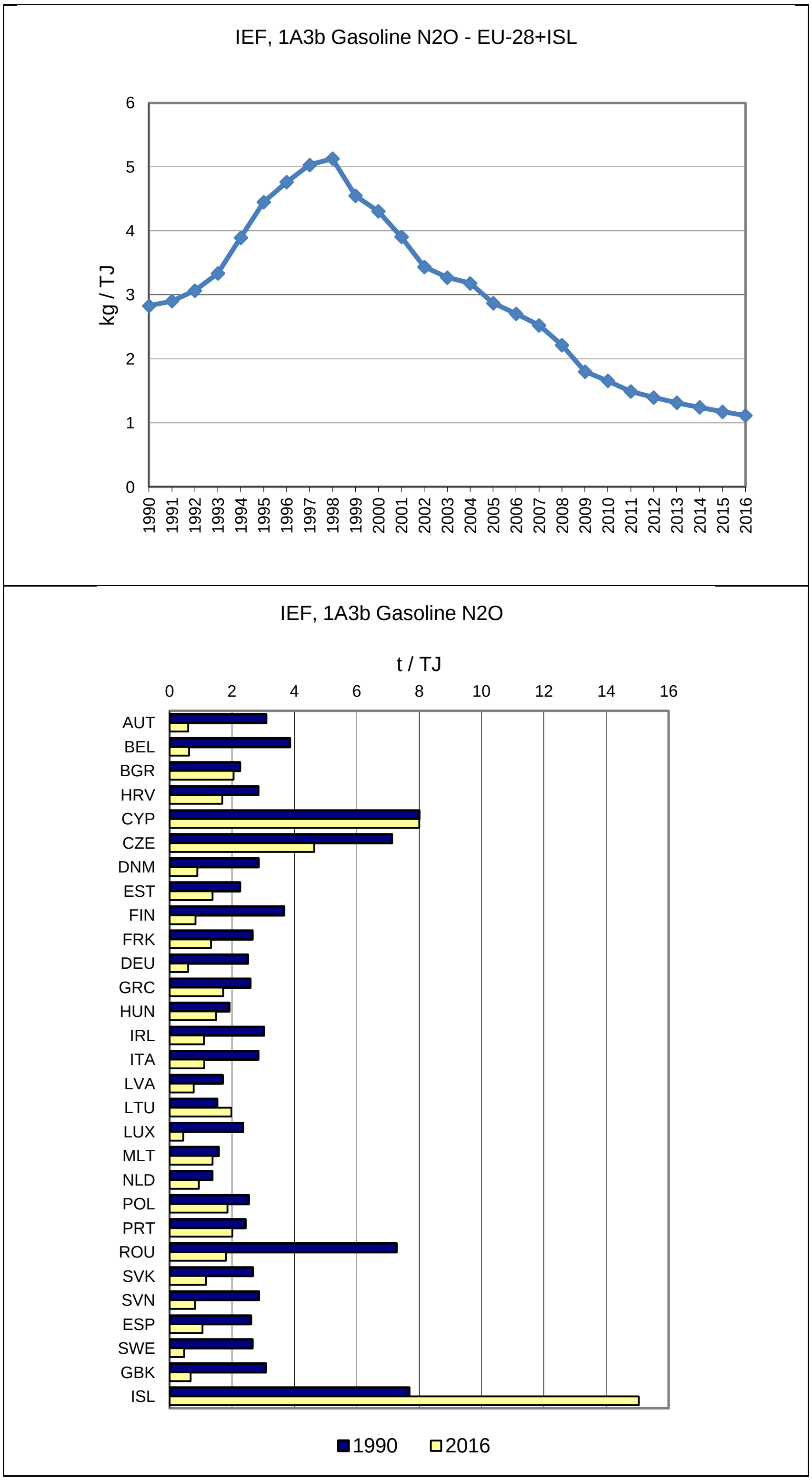


Figure 3.108 1A3b Road Transport, Gasoline: Implied Emission Factors for N_2O (in kg/TJ)

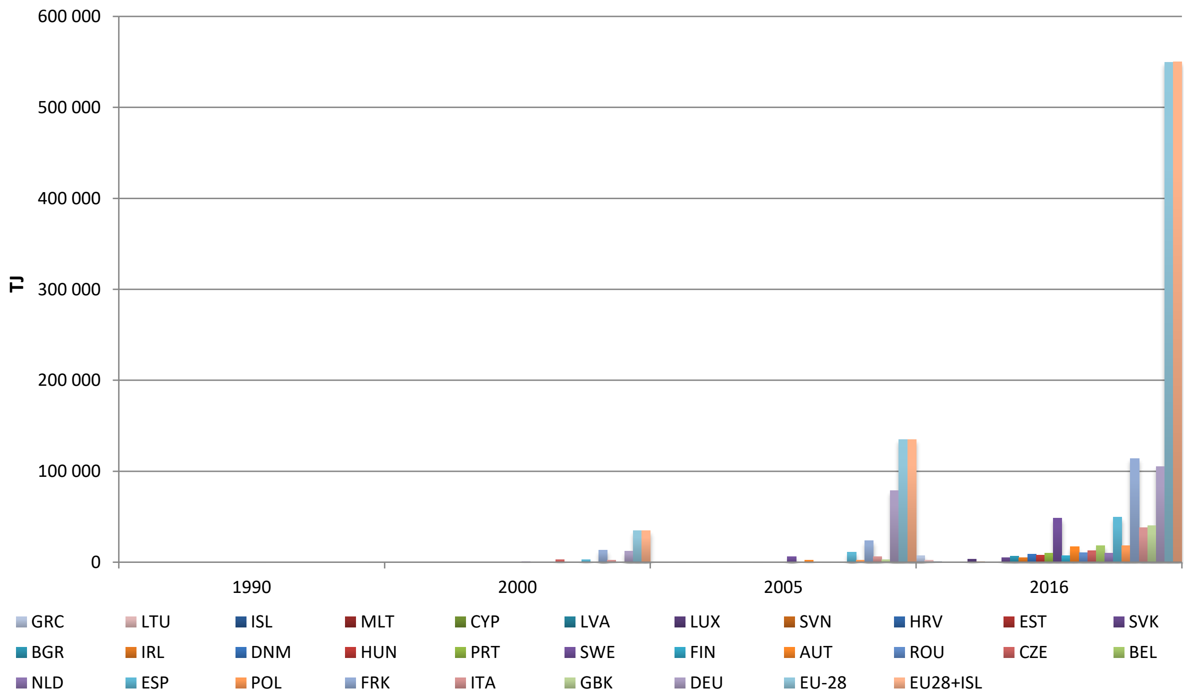


1A3b Road Transportation – Activity Data Biofuels

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 5.8 %, 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 2016, combustion of biofuels increased from 41 TJ to 553 667 TJ in the EU-28+ISL (Figure 3.109). France reports most of total amount of biofuels (20.8 % of total EU-28+ISL activity in 2015), followed by Germany (19.2 %). All Member States report biofuels activity under 1A3b for 2016.

Figure 3.109 1A3b Road Transport, Biofuels: Trend of Activity data of Biofuels

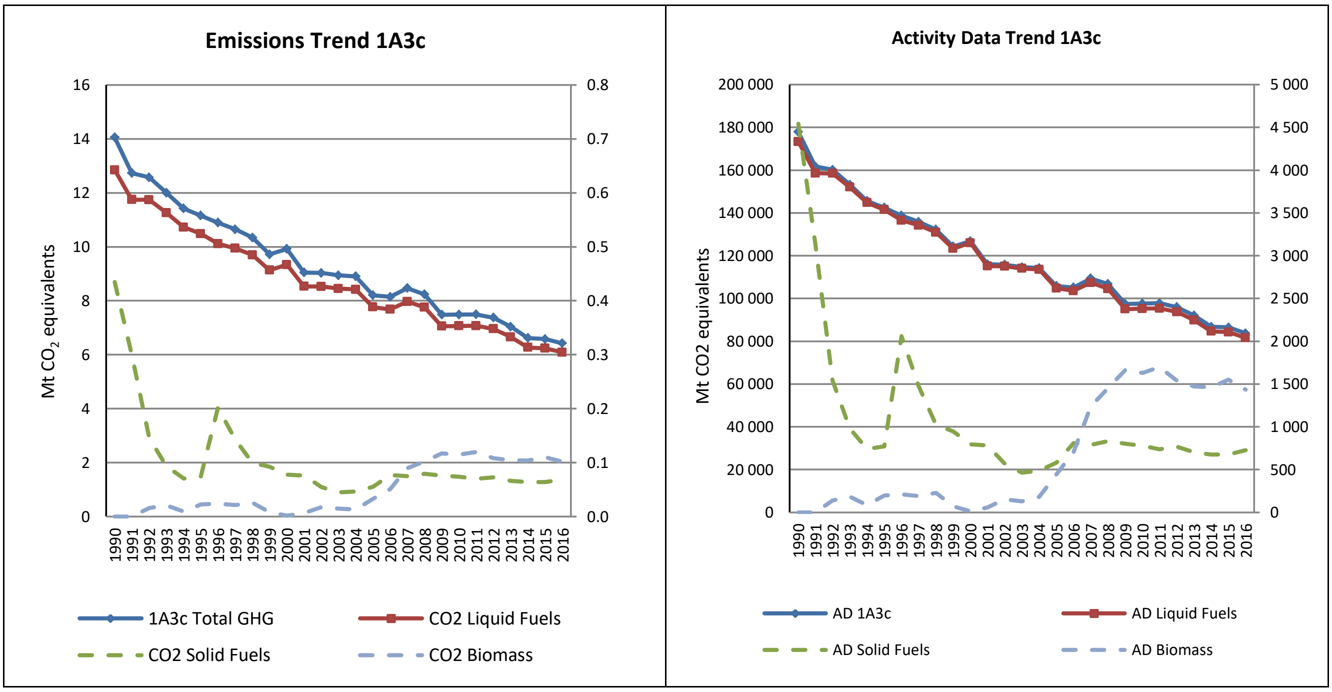


3.2.3.3 Railways (1A3c) (EU-28+ISL)

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 0.1 % of total EU-28+ISL GHG emissions in 2016. Between 1990 and 2016, CO_2 emissions from rail transportation decreased by 54 % in the EU-28+ISL. The total trend is dominated by CO_2 emissions from liquid fuels (Figure 3.110). The emissions from this key category are due to fossil fuel consumption in rail transport, which decreased by 54 % between 1990 and 2016.

Figure 3.110 1A3c Railways: CO_2 Emission Trend and Activity Data



Data displayed as dashed line refers to the secondary axis.

The Member States France, Germany and the United Kingdom contributed most to the emissions from this source (54 %). Between 1990 and 2016, Germany had by far the highest decreases in absolute terms (Table 3.71).

Table 3.71 1A3c Railways: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016		Method	Emission factor Informa-tion
	1990	2015	2016		kt CO2	%	kt CO2	%		
Austria	178	106	111	1.8%	-67	-38%	5	4%	T1,T2	CS,D
Belgium	222	66	66	1.1%	-157	-71%	0	0%	T3	CS,D
Bulgaria	323	50	40	0.7%	-282	-87%	-9	-19%	T1	D
Croatia	140	55	58	0.9%	-82	-59%	3	5%	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czech Republic	654	264	274	4.4%	-380	-58%	10	4%	T1	D
Denmark	297	248	253	4.1%	-43	-15%	5	2%	CR,T2	CS
Estonia	154	59	47	0.8%	-107	-69%	-12	-21%	T2	CS
Finland	191	68	64	1.0%	-127	-67%	-5	-7%	M,T2	CS
France	1 070	410	409	6.6%	-662	-62%	-1	0%	T1	OTH
Germany	2 901	1 018	948	15.4%	-1 952	-67%	-70	-7%	CS,M	CS,D,M
Greece	199	125	125	2.0%	-74	-37%	0	0%	T1,T2	CS
Hungary	537	134	127	2.1%	-409	-76%	-6	-5%	T1	D
Ireland	133	110	112	1.8%	-21	-16%	2	2%	T2	CS
Italy	613	69	47	0.8%	-566	-92%	-22	-32%	T2	CS
Latvia	537	207	175	2.8%	-362	-67%	-32	-16%	T1,T2	CS,D
Lithuania	350	162	158	2.6%	-192	-55%	-4	-2%	T2	CS
Luxembourg	25	7	6	0.1%	-19	-76%	-1	-9%	T1,T2	CS,D
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	91	98	99	1.6%	8	9%	0	0%	T2	CS
Poland	1 621	261	261	4.2%	-1 359	-84%	0	0%	T1	D
Portugal	177	30	31	0.5%	-146	-82%	1	3%	T1	D
Romania	452	333	353	5.7%	-99	-22%	20	6%	T1,T3	CS,D
Slovakia	372	84	87	1.4%	-286	-77%	2	3%	T1	D
Slovenia	65	37	31	0.5%	-34	-52%	-6	-16%	T1	D
Spain	422	244	234	3.8%	-188	-45%	-11	-4%	T1	D
Sweden	101	46	44	0.7%	-57	-57%	-2	-4%	T2	CS
United Kingdom	1 455	2 009	1 995	32.4%	540	37%	-14	-1%	T1,T2	CS
EU-28	**13 280**	**6 301**	**6 154**	**100%**	**-7 126**	**-54%**	**-147**	**-2%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	1 455	2 009	1 995	32.4%	540	37%	-14	-1%	T1,T2	CS
EU-28 + ISL	**13 280**	**6 301**	**6 154**	**100%**	**-7 126**	**-54%**	**-147**	**-2%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

1A3c Railways –Liquid Fuels (CO_2)

Between 1990 and 2016, CO_2 emissions from liquid fuels decreased by 53 % in the EU-28+ISL. Between 2015 and 2016, EU-28+ISL emissions decreased by 2 % (Table 3.72).

Table 3.72 1A3c Railways, liquid fuels: Member States' contributions to CO_2 emissions and information on method applied and emission factor

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016		Method	Emission factor Informa-tion
	1990	2015	2016		kt CO2	%	kt CO2	%		
Austria	171	105	110	1.8%	-61	-36%	5	4%	T2	CS
Belgium	222	66	66	1.1%	-157	-71%	0	0%	T3	CS,D
Bulgaria	323	50	40	0.7%	-282	-87%	-9	-19%	T1	D
Croatia	119	55	58	1.0%	-61	-51%	3	5%	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czech Republic	654	264	274	4.5%	-380	-58%	10	4%	T1	D
Denmark	297	248	253	4.2%	-43	-15%	5	2%	CR,T2	CS
Estonia	143	59	47	0.8%	-96	-67%	-12	-21%	T2	CS
Finland	191	68	64	1.0%	-127	-67%	-5	-7%	M,T2	CS
France	1 070	410	409	6.7%	-662	-62%	-1	0%	T1	OTH
Germany	2 847	986	917	15.1%	-1 930	-68%	-70	-7%	CS,M	CS,M
Greece	199	125	125	2.1%	-74	-37%	0	0%	T2	CS
Hungary	532	134	127	2.1%	-404	-76%	-6	-5%	T1	D
Ireland	133	110	112	1.8%	-21	-16%	2	2%	T2	CS
Italy	613	69	47	0.8%	-566	-92%	-22	-32%	T2	CS
Latvia	537	207	175	2.9%	-362	-67%	-32	-16%	T2	CS
Lithuania	350	162	158	2.6%	-192	-55%	-4	-2%	T2	CS
Luxembourg	25	7	6	0.1%	-19	-76%	-1	-9%	T2	CS
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	91	98	99	1.6%	8	9%	0	0%	T2	CS
Poland	1 316	261	261	4.3%	-1 055	-80%	0	0%	T1	D
Portugal	177	30	31	0.5%	-146	-82%	1	3%	T1	D
Romania	420	333	353	5.8%	-67	-16%	20	6%	T1,T3	CS,D
Slovakia	372	84	87	1.4%	-286	-77%	2	3%	T1	D
Slovenia	65	37	31	0.5%	-34	-53%	-6	-16%	T1	D
Spain	422	244	234	3.8%	-188	-45%	-11	-4%	T1	D
Sweden	101	46	44	0.7%	-57	-57%	-2	-4%	T2	CS
United Kingdom	1 455	1 978	1 959	32.2%	504	35%	-19	-1%	T2	CS
EU-28	**12 845**	**6 237**	**6 086**	**100%**	**-6 759**	**-53%**	**-152**	**-2%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	1 455	1 978	1 959	32.2%	504	35%	-19	-1%	T2	CS
EU-28 + ISL	**12 845**	**6 237**	**6 086**	**100%**	**-6 759**	**-53%**	**-152**	**-2%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

France, Germany, Poland, Romania and the United Kingdom account for 64 % of CO_2 emissions from liquid fuels in 2016 (Figure 3.112).

Table 3.72 shows that the majority of CO_2 emissions from the combustion of liquid fuels in railways were calculated using a higher tier method (74.6%). From the calculation of the higher tier methods, MS that use only T1 method were excluded. Romania, states that the IEF values for the calculation of CO_2 emissions are country specific, thus Romania was included in the calculation of the higher tier methods. In Figure 3.111 the IEF is depicted where the mean value is around 74 t/TJ.In 2016 the IEF showed a slight increase, mainly due to the increased value of the IEF of Romania. The high IEF of Romania, is due to the fact that country specific EFs for CO_2 emissions have been determined.

Figure 3.112 1A3c Railways, Liquid Fuels: Emission trend and share for CO_2

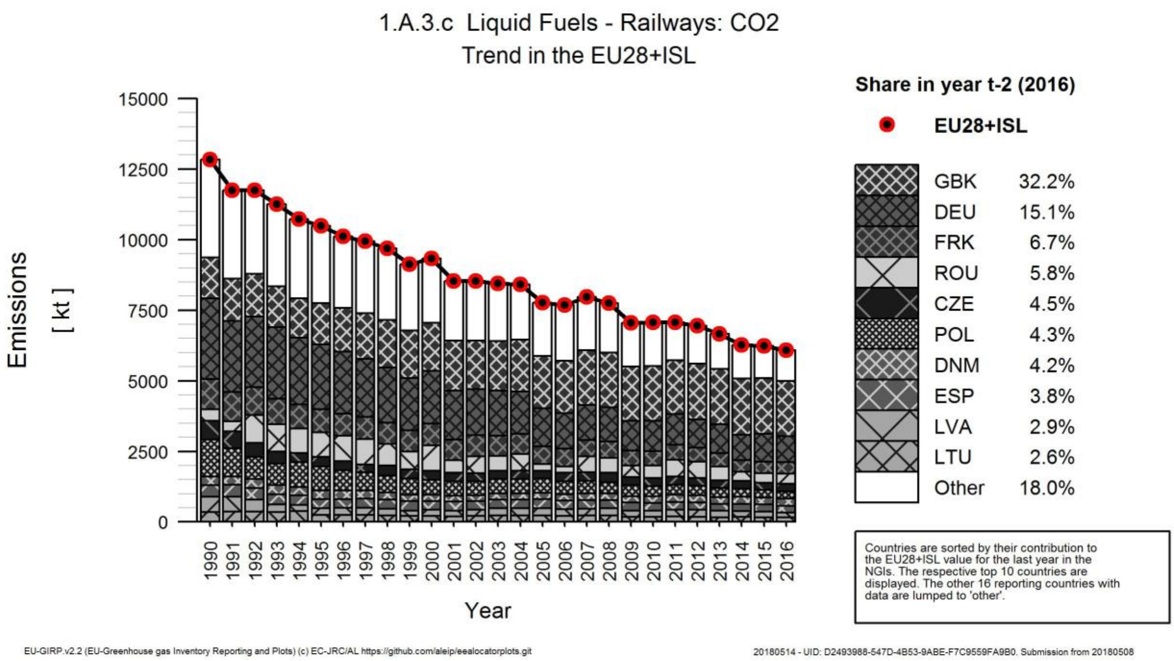
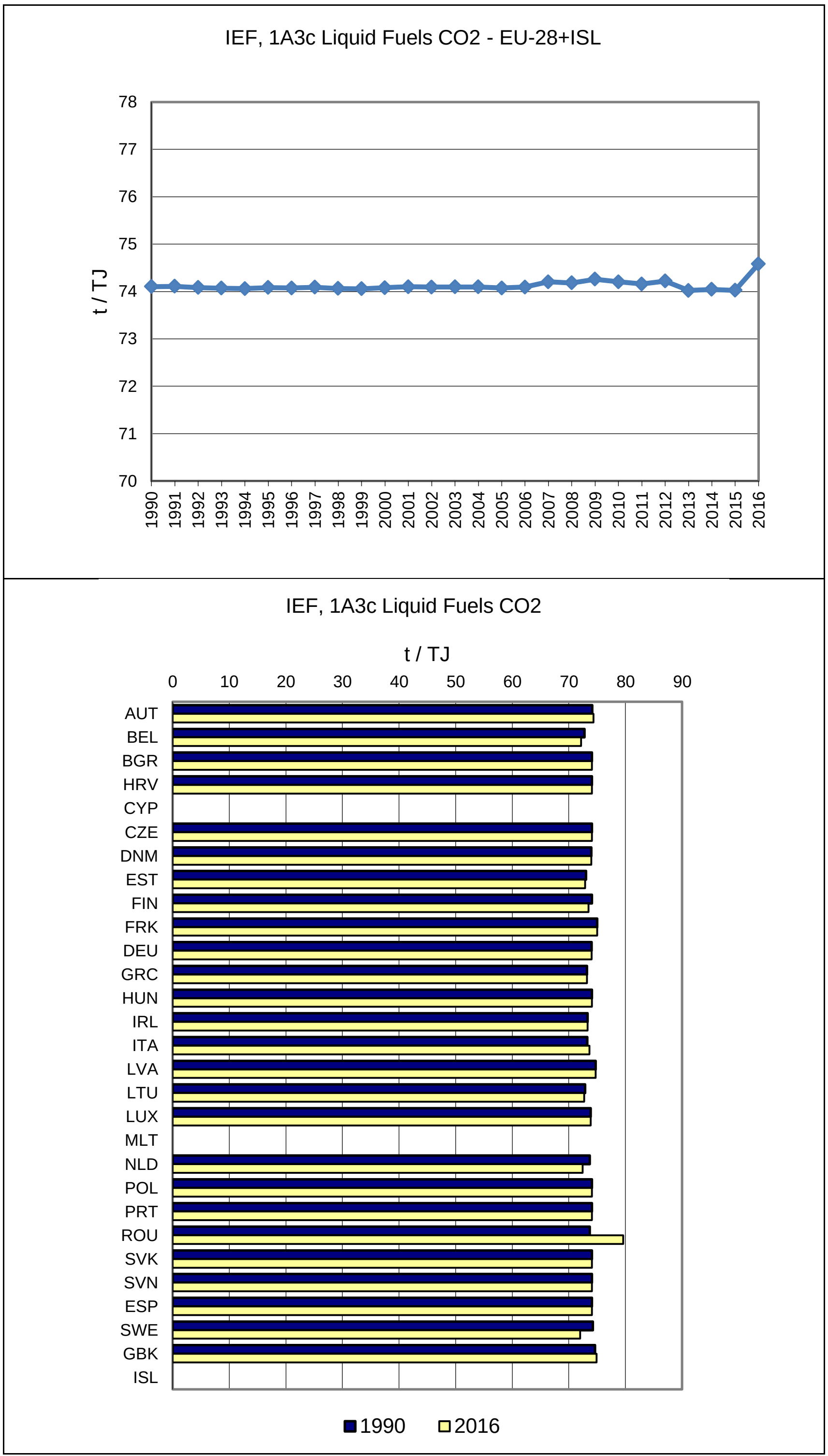


Figure 3.113 1A3c Railways, Liquid Fuels: Implied Emission Factors for CO_2 (in t/TJ)

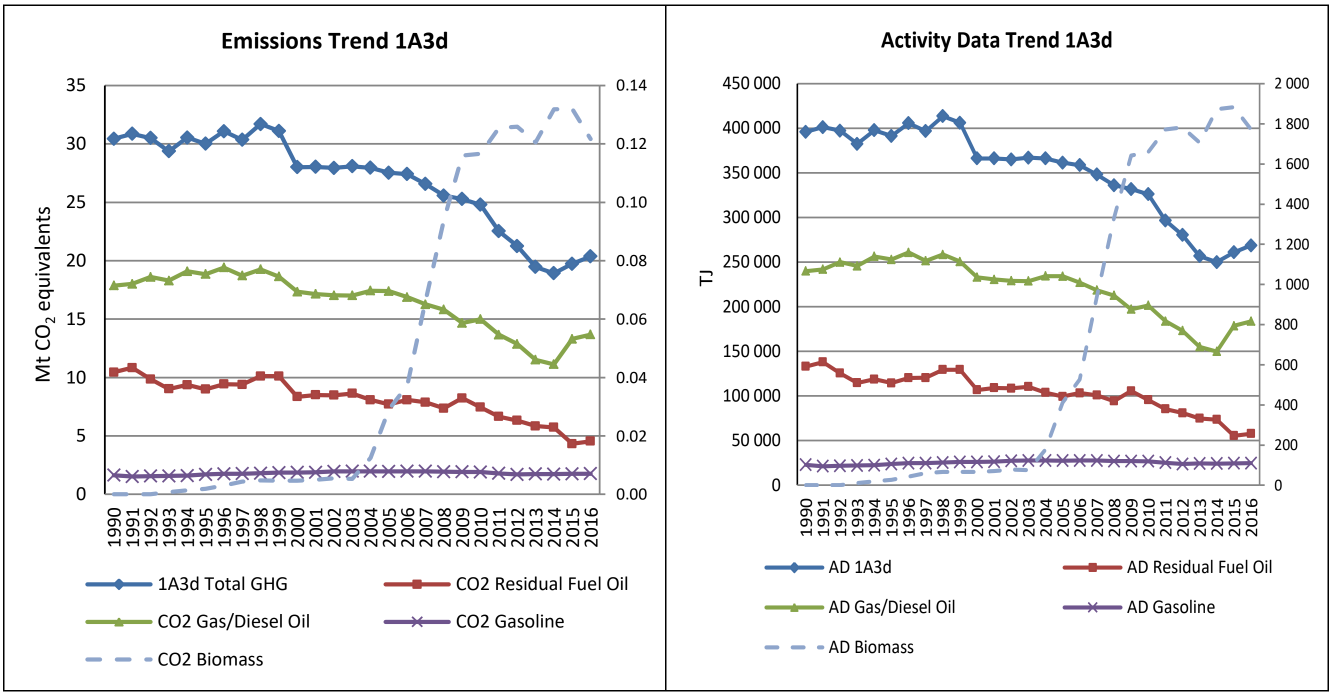


3.2.3.4 Domestic Navigation (1A3d) (EU-28+ISL)

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 0.5 % of total EU-28+ISL GHG emissions in 2016. Between 1990 and 2016, CO_2 emissions from navigation decreased by 33 % in the EU-28+ISL (Table 3.73). The emissions from this key category 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 3.114).

Figure 3.114 1A3d Domestic Navigation: CO_2 Emission Trend and Activity Data



Data displayed as dashed line refers to the secondary axis.

Five Member States (Germany, Greece, Italy, Spain and the United Kingdom) contributed the most to the emissions from this source (74 %). Most Member States (17 in total) had decreasing emissions from navigation between 1990 and 2016. The Member States with the highest decreases in absolute terms were Germany, United Kingdom and Spain (Table 3.73).

Table 3.73 1A3d Domestic Navigation: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016		Method	Emission factor Informa-tion
	1990	2015	2016		kt CO2	%	kt CO2	%		
Austria	15	11	10	0.1%	-4	-29%	-1	-5%	T1,T2	CS,D
Belgium	362	411	407	2.0%	45	13%	-4	-1%	T1,T3	CS,D
Bulgaria	56	10	7	0.0%	-49	-87%	-3	-28%	T1	D
Croatia	134	130	132	0.7%	-2	-2%	2	1%	T1	D
Cyprus	2	2	2	0.0%	0	4%	0	14%	T1	D
Czech Republic	57	10	13	0.1%	-44	-78%	3	33%	T1	D
Denmark	715	570	647	3.2%	-68	-10%	77	14%	CR,M,T2	CS
Estonia	22	40	60	0.3%	38	174%	20	51%	T2	CS
Finland	441	419	403	2.0%	-38	-9%	-16	-4%	M,T2	CS
France	1 005	1 298	1 258	6.3%	253	25%	-40	-3%	T1	CS
Germany	3 645	1 653	1 933	9.6%	-1 712	-47%	280	17%	CS	CS,D,M
Greece	1 809	1 734	1 801	9.0%	-8	0%	66	4%	T1	CS
Hungary	209	19	13	0.1%	-197	-94%	-6	-33%	T1	D
Ireland	85	219	264	1.3%	179	211%	44	20%	T2	CS
Italy	5 470	3 907	3 824	19.1%	-1 646	-30%	-83	-2%	T1,T2	CS
Latvia	1	10	14	0.1%	12	1231%	4	37%	T1,T2	CS,D
Lithuania	15	14	13	0.1%	-2	-15%	0	-3%	T1	CS
Luxembourg	1	1	1	0.0%	0	-18%	0	4%	T1,T2	CS,D
Malta	25	109	80	0.4%	55	223%	-29	-26%	T1	D
Netherlands	743	1 110	1 010	5.0%	267	36%	-100	-9%	T2	CS
Poland	151	11	22	0.1%	-129	-86%	10	89%	T1	D
Portugal	263	283	262	1.3%	-1	0%	-21	-7%	T2	D
Romania	1 151	140	131	0.7%	-1 021	-89%	-9	-7%	T2	CS
Slovakia	0	6	5	0.0%	5	21062%	-1	-23%	T1	D
Slovenia	NO,IE	NO,IE	NO,IE	-	-	-	-	-	NA	NA
Spain	5 338	1 375	1 977	9.9%	-3 361	-63%	602	44%	T1	D,OTH
Sweden	575	362	302	1.5%	-274	-48%	-61	-17%	T2	CS
United Kingdom	7 536	5 474	5 348	26.7%	-2 188	-29%	-126	-2%	T2	CS
EU-28	**29 826**	**19 329**	**19 937**	**100%**	**-9 888**	**-33%**	**609**	**3%**	**-**	**-**
Iceland	60	27	28	0.1%	-32	-54%	1	4%	T1	D
United Kingdom (KP)	7 608	5 533	5 420	27.1%	-2 188	-29%	-112	-2%	T2	CS
EU-28 + ISL	**29 958**	**19 414**	**20 037**	**100%**	**-9 920**	**-33%**	**624**	**3%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

1A3d Domestic Navigation – Residual Fuel Oil (CO_2)

CO_2 emissions from residual oil account for 23 % of CO_2 emissions from 1A3d Navigation in 2016. Between 1990 and 2016, CO_2 emissions from residual fuel oil decreased by 56 % in the EU-28+ISL. The countries with the highest decrease in absolute terms were Romania, United Kingdom and Germany. 16 Member States reported emissions as 'Not Occurring' (Table 3.74) for 2016, whereas Belgium reported emissions as 'Included Elsewhere' and specifically, the aforementioned emissions are included in gas/diesel oil, since the amounts of residual fuel oil are very small.

Table 3.74 1A3d Navigation, residual fuel oil: Member States' contributions to CO_2 emissions and information on method applied and emission factor

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016		Method	Emission factor Informa-tion
	1990	2015	2016		kt CO2	%	kt CO2	%		
Austria	NO	NO	NO	-	-	-	-	-	NA	NA
Belgium	IE	IE	IE	-	-	-	-	-	NA	NA
Bulgaria	NO	NO	NO	-	-	-	-	-	NA	NA
Croatia	7	NO	NO	-	-7	-100%	-	-	NA	NA
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czech Republic	NO	NO	NO	-	-	-	-	-	NA	NA
Denmark	357	139	123	2.7%	-234	-66%	-16	-12%	CR,T2	CS
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	123	35	32	0.7%	-91	-74%	-3	-9%	M,T2	CS
France	157	67	43	0.9%	-114	-73%	-24	-36%	T1	CS
Germany	935	4	1	0.0%	-934	-100%	-3	-86%	CS	CS,M
Greece	746	1 041	1 022	22.5%	277	37%	-19	-2%	T1	CS
Hungary	3	NO	NO	-	-3	-100%	-	-	NA	NA
Ireland	63	NO	NO	-	-63	-100%	-	-	NA	NA
Italy	2 576	1 739	1 698	37.3%	-877	-34%	-40	-2%	T1,T2	CS
Latvia	NO	NO	NO	-	-	-	-	-	NA	NA
Lithuania	NO	NO	NO	-	-	-	-	-	NA	NA
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	5	12	12	0.3%	6	119%	0	-2%	T1	D
Netherlands	NO	NO	NO	-	-	-	-	-	NA	NA
Poland	70	NO	NO	-	-70	-100%	-	-	NA	NA
Portugal	190	204	189	4.2%	0	0%	-15	-7%	T2	D
Romania	1 025	NO	NO	-	-1 025	-100%	-	-	NA	NA
Slovakia	NO	NO	NO	-	-	-	-	-	NA	NA
Slovenia	NO	NO	NO	-	-	-	-	-	NA	NA
Spain	1 378	382	803	17.6%	-575	-42%	420	110%	T1	OTH
Sweden	194	71	13	0.3%	-181	-93%	-58	-82%	T2	CS
United Kingdom	2 581	626	592	13.0%	-1 988	-77%	-34	-5%	T2	CS
EU-28	**10 408**	**4 320**	**4 528**	**100%**	**-5 880**	**-56%**	**207**	**5%**	**-**	**-**
Iceland	22	1	1	0.0%	-22	-98%	-1	-60%	T1	D
United Kingdom (KP)	2 599	631	612	13.5%	-1 987	-76%	-19	-3%	T2	CS
EU-28 + ISL	**10 448**	**4 326**	**4 548**	**100%**	**-5 900**	**-56%**	**221**	**5%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

Greece, Italy and Spain account for 77 % of CO_2 emissions from residual fuel oil in 2016 (Figure 3.116).

Table **3.74** shows that the majority of CO_2 emissions from the combustion of residual fuel oil in navigation were calculated using a higher tier method (82.5%). Greece and Spain were not included in this calculation, since they use T1 to calculate these emissions. On the other hand, Italy stated that country specific IEF were used, thus they were considered in the calculation. In Figure 3.115 the IEF is depicted where the mean value is around 78 t/TJ. The Spanish outlier is an error in the MS submission and will be corrected in the next Inventory edition, as stated by the MS.

Figure 3.116 1A3d Navigation, Residual Fuel Oil: Emission trend and share for CO_2

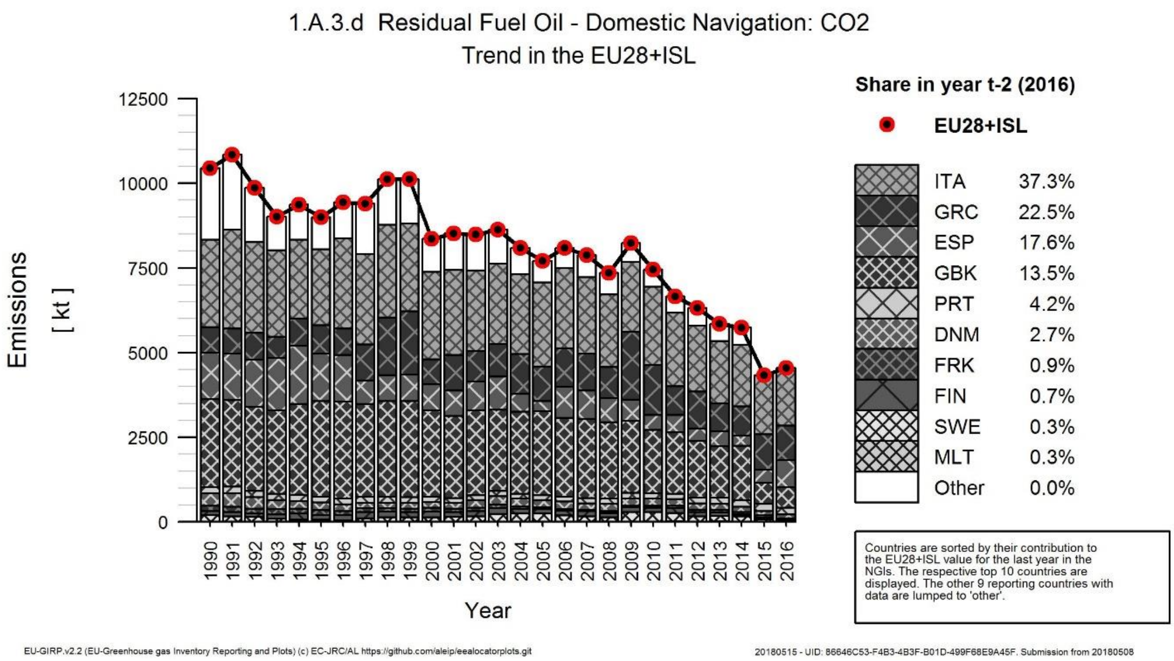
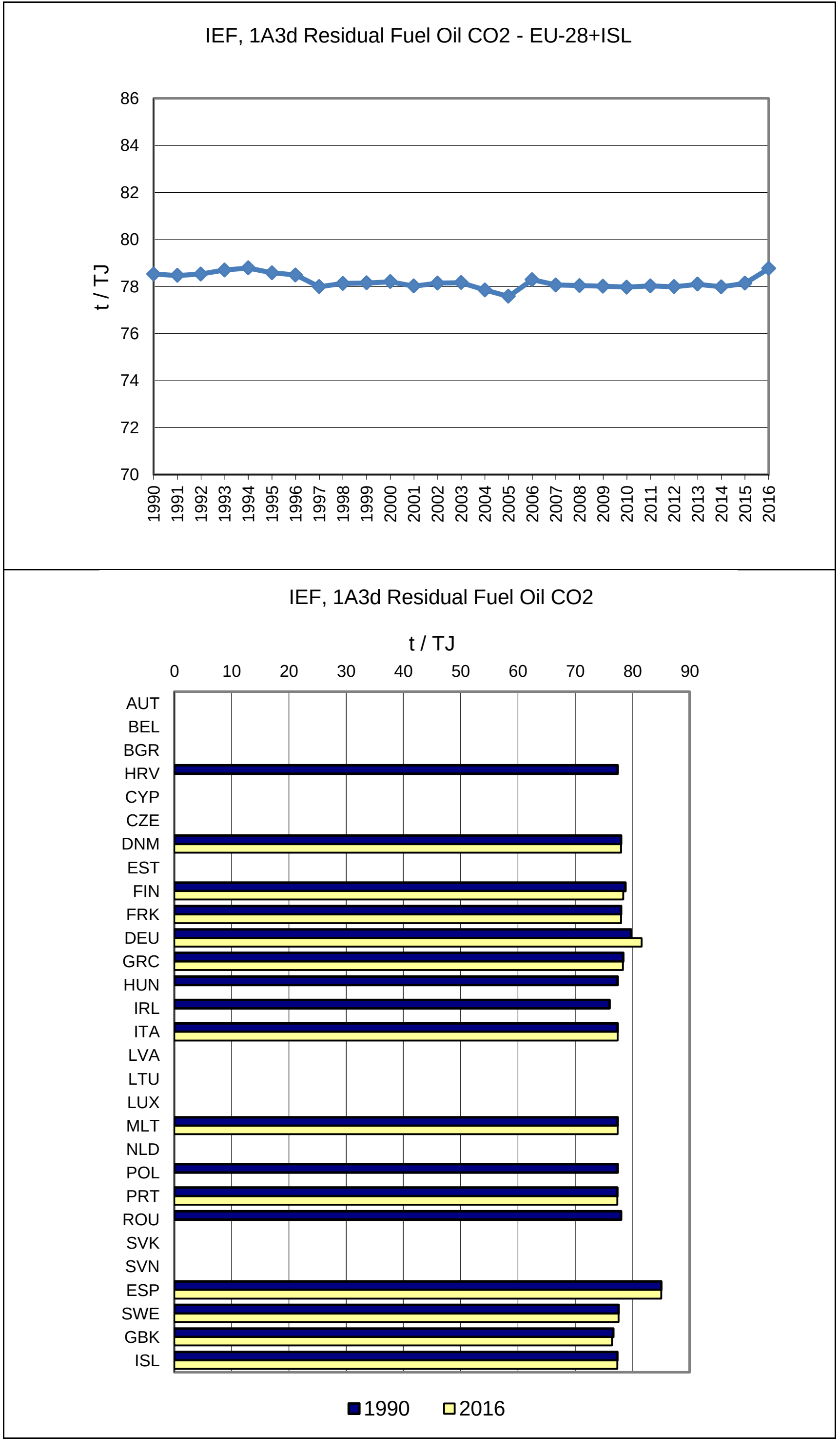


Figure 3.117 1A3d Navigation, Residual Fuel Implied Emission Factors for CO_2 (in t/TJ)



1A3d Navigation – Gas/Diesel Oil (CO_2)

CO_2 emissions from Gas/Diesel oil account for 68 % of CO_2 emissions from 1A3d Navigation in 2016 (Table 3.75). The CO_2 emissions from Gas/Diesel oil decreased by 23 % between 1990 and 2016.

Table 3.75 1A3d Navigation, gas/diesel oil: Member States' contributions to CO_2 emissions and information on method applied and emission factor

Member State	CO2 Emissions in kt 1990	CO2 Emissions in kt 2015	CO2 Emissions in kt 2016	Share in EU-28+ISL Emissions in 2016	Change 1990-2016 kt CO2	Change 1990-2016 %	Change 2015-2016 kt CO2	Change 2015-2016 %	Method	Emission factor Informa-tion
Austria	5	4	4	0.0%	-2	-35%	0	-11%	T2	CS
Belgium	362	411	407	3.0%	45	13%	-4	-1%	T1,T3	CS,D
Bulgaria	56	10	7	0.1%	-49	-87%	-3	-28%	T1	D
Croatia	128	130	132	1.0%	5	4%	2	1%	T1	D
Cyprus	2	2	2	0.0%	0	4%	0	14%	T1	D
Czech Republic	57	10	13	0.1%	-44	-78%	3	33%	T1	D
Denmark	358	427	519	3.8%	161	45%	92	22%	CR,M,T2	CS
Estonia	22	40	60	0.4%	38	174%	20	51%	T2	CS
Finland	186	256	245	1.8%	59	32%	-11	-4%	M,T2	CS
France	322	379	361	2.6%	39	12%	-17	-5%	T1	CS
Germany	2 710	1 649	1 932	14.1%	-777	-29%	283	17%	CS	CS,M
Greece	1 063	693	778	5.7%	-285	-27%	85	12%	T1	CS
Hungary	29	19	13	0.1%	-16	-56%	-6	-33%	T1	D
Ireland	22	219	264	1.9%	241	1087%	44	20%	T2	CS
Italy	2 326	1 850	1 807	13.2%	-519	-22%	-43	-2%	T1,T2	CS
Latvia	1	10	13	0.1%	12	1463%	4	36%	T2	CS
Lithuania	15	14	13	0.1%	-2	-15%	0	-3%	T1	CS
Luxembourg	1	1	1	0.0%	0	-6%	0	4%	T2	CS
Malta	19	96	67	0.5%	48	248%	-29	-30%	T1	D
Netherlands	697	1 045	944	6.9%	247	35%	-101	-10%	T2	CS
Poland	81	11	22	0.2%	-59	-73%	10	89%	T1	D
Portugal	73	79	73	0.5%	0	0%	-6	-7%	T2	D
Romania	125	139	130	0.9%	4	4%	-10	-7%	T2	CS
Slovakia	0	6	5	0.0%	5	21044%	-1	-24%	T1	D
Slovenia	IE	IE	IE	-	-	-	-	-	NA	NA
Spain	3 960	993	1 174	8.6%	-2 786	-70%	181	18%	T1	D
Sweden	304	202	199	1.5%	-105	-34%	-2	-1%	T2	CS
United Kingdom	4 851	4 527	4 416	32.3%	-435	-9%	-111	-2%	T2	CS
EU-28	**17 776**	**13 221**	**13 602**	**99%**	**-4 174**	**-23%**	**382**	**3%**	**-**	**-**
Iceland	37	25	27	0.2%	-10	-27%	2	8%	T1	D
United Kingdom (KP)	4 905	4 581	4 469	32.7%	-436	-9%	-112	-2%	T2	CS
EU-28 + ISL	**17 868**	**13 300**	**13 682**	**100%**	**-4 186**	**-23%**	**383**	**3%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

Germany, Italy, Netherlands, Spain and the United Kingdom account for 75 % of the CO_2 emissions from gas/diesel oil in 2016 (Figure 3.119).

Table 3.75 shows that the majority of CO_2 emissions from the combustion of gas/diesel oil in navigation were calculated using a higher tier method (80.4%). Greece and Spain were not taken into account for this calculation, since they are using only T1 method. Whereas Italy, using country specific emission factors, was included in the calculation of higher tier methods. In Figure 3.118 the IEF is depicted where the mean value is around 74 t/TJ. The high IEF of Romania, is due to the fact that country specific EFs for CO_2 emissions have been determined. It should be noted that Slovenia reported emission as "Included elsewere" and more specifically under Road transport, since no separate data are available.

Figure 3.119 1A3d Navigation, Gas/Diesel Oil: Emission trend and share for CO_2

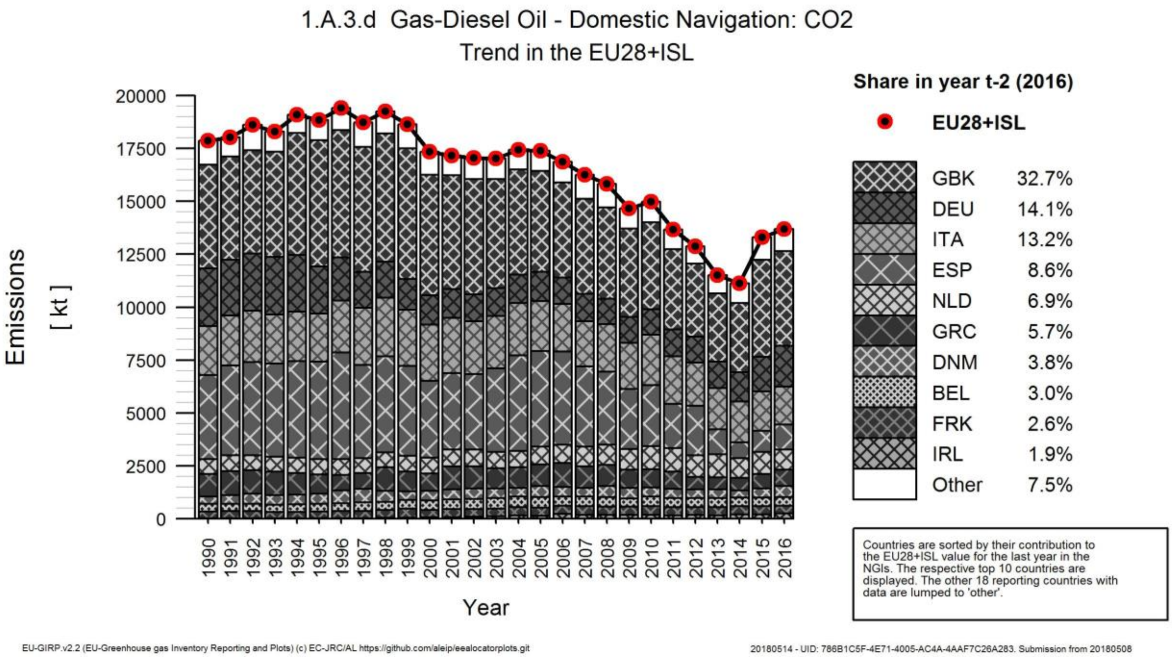
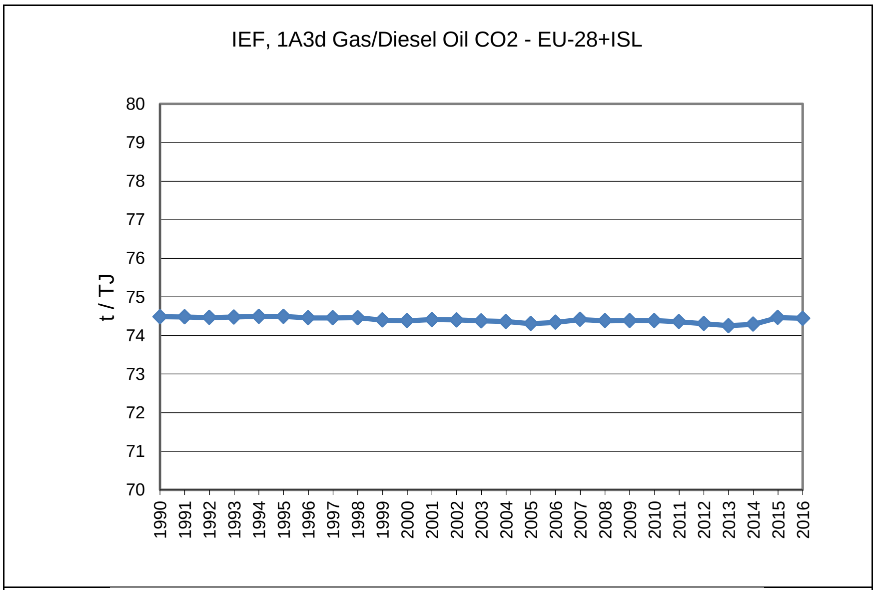
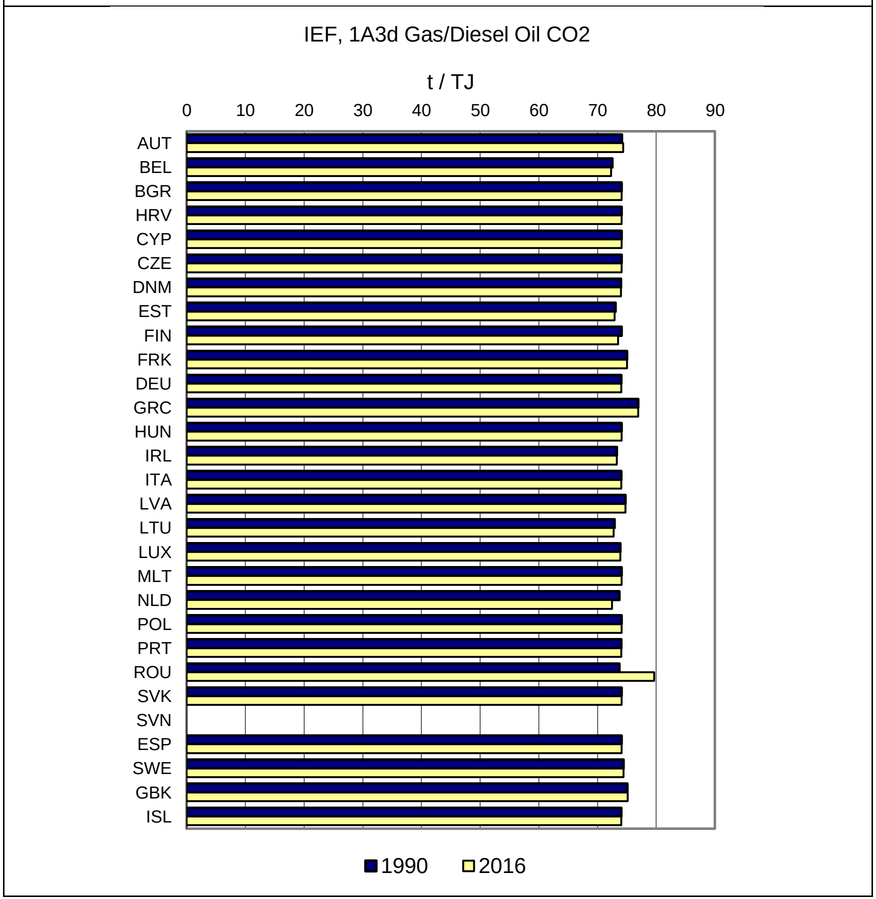


Figure 3.120 1A3d Navigation, Gas/Diesel Oil: Implied Emission Factors for CO_2 (in t/TJ)





3.2.3.1 Other (1A3e) (EU-28+ISL)

CO_2 emissions from 1A3e Other account for only 0.1 % of total EU-28+ISL GHG emissions in 2016. 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 11 % between 1990 and 2016.

Germany contributed 21 % and Poland 15 % to the EU-28+ISL emissions from this source in 2016 (Table 3.76). Between 1990 and 2016 the EU-28+ISL emissions increased by 11 %. Seven Member

States report emissions as ‘Not occurring’. Latvia reports emissions as “Included elsewhere” and more specifically, emissions from pipeline transport are included under 1.A.4.a.i Commercial/Institutional. Iceland also reports emissions as “Included elsewhere” and more specifically, these emissions are reported under 1A2gvii Industry and Construction since fuel sales statistics does not allow to disaggregate between fuel sold for airport and harbour ground based activities and construction/off-road machinery. For Portugal, fuel consumption for 1.A.3.e.ii - Off-road activities is included in the category Commercial/Institutional (under Other Sectors – 1.A.4) because is not possible to separate the fuel consumption for this sectors in the Energy Balance.

Table 3.76 1A3e Other: Member States’ contributions to CO_2 emissions and information on method applied and emission factor

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016		Method	Emission factor Informa-tion
	1990	2015	2016		kt CO2	%	kt CO2	%		
Austria	224	582	556	9.6%	331	148%	-27	-5%	T2	CS
Belgium	226	172	148	2.6%	-78	-34%	-24	-14%	CS,T3	D
Bulgaria	132	342	335	5.8%	203	154%	-7	-2%	T2	CS
Croatia	NO	NO	NO	-	-	-	-	-	NA	NA
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czech Republic	5	71	61	1.0%	56	1024%	-10	-14%	T2	CS
Denmark	NO	NO	NO	-	-	-	-	-	NA	NA
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	2	5	9	0.2%	7	317%	4	74%	T1	CS
France	212	413	389	6.7%	177	84%	-24	-6%	T2	CS
Germany	1 083	1 224	1 230	21.1%	147	14%	6	1%	CS	CS
Greece	NO	NO,IE	8	0.1%	8	∞	8	∞	T1	CS
Hungary	100	67	94	1.6%	-7	-7%	26	39%	T1	D
Ireland	62	142	140	2.4%	78	125%	-2	-1%	T2	CS
Italy	407	553	669	11.5%	262	64%	117	21%	T2	CS
Latvia	IE,NO	NO,IE	NO,IE	-	-	-	-	-	NA	NA
Lithuania	85	69	73	1.2%	-13	-15%	3	5%	T2	CS
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	342	93	92	1.6%	-251	-73%	-1	-1%	T2	CS
Poland	NO	806	863	14.8%	863	∞	58	7%	T1	D
Portugal	NO,IE	NO,IE	NO,IE	-	-	-	-	-	NA	NA
Romania	66	6	6	0.1%	-60	-91%	0	-3%	T1,T3	CS,D
Slovakia	1 814	184	298	5.1%	-1 516	-84%	114	62%	T2	CS
Slovenia	NO	3	3	0.0%	3	∞	0	-6%	T2	CS
Spain	19	108	117	2.0%	98	512%	9	8%	T1	D
Sweden	244	211	211	3.6%	-33	-13%	0	0%	T2	CS
United Kingdom	225	505	515	8.8%	290	129%	10	2%	T3	CS
EU-28	**5 249**	**5 555**	**5 816**	**100%**	**568**	**11%**	**261**	**5%**	**-**	**-**
Iceland	NO,IE	NO,IE	NO,IE	-	-	-	-	-	NA	NA
United Kingdom (KP)	225	505	515	8.8%	290	129%	10	2%	T3	CS
EU-28 + ISL	**5 249**	**5 555**	**5 816**	**100%**	**568**	**11%**	**261**	**5%**	**-**	**-**

Abbreviations explained in the Chapter ‘Units and abbreviation’ Presented methods and emission factor information refer to the last inventory year.

3.2.4 Other Sectors (CRF Source Category 1A4)

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 heating. Category 1A4c includes emissions from domestic inland, coastal, deep sea and international fishing. Emissions from transportation of agricultural goods are reported under category 1A3 Transport.

The following enumeration shows the correspondence of 1A4 sub categories and ISIC 3.1 rev 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 2016 category 1A4 contributed to 657 301kt CO_2 equivalents of which 96.1% CO_2, 2.7% CH_4 and 1.2% N_2O.

Almost all countries report increases for 1A4b fuel consumption in 2016. The main reason might be the lower temperatures in the heating period within most European countries. The following Table **3.77** presents the (15°/18°) heating degree days in 2015 and 2015 for EU-28 Member States and the energy consumption-weighted calculated values for EU-28 as well as the trend in 1A4b total fuel consumption.

Table 3.77: EU-28 heating degree days 2015 and 2016 and 1A4b trend in total fuel consumption.

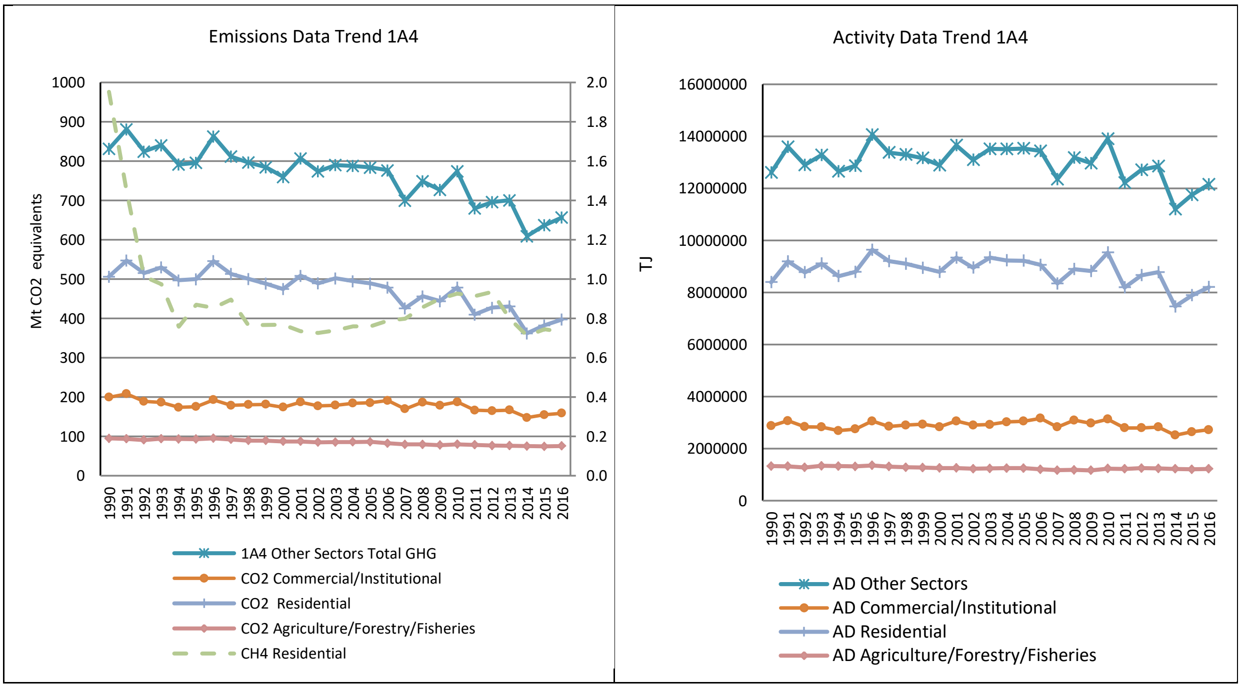
	2015	2016	Trend 2015 – 2016	Trend fuel consumption 1A4b
Austria	3 322	3 419	3%	3%
Belgium	2 630	2 689	2%	7%
Bulgaria	2 377	2 427	2%	5%
Croatia	2 250	2 273	1%	0%
Cyprus	740	680	-8%	-1%
Czech Rep	3 092	3 247	5%	4%
Denmark	3 113	3 136	1%	4%
Estonia	3 791	4 208	11%	3%
Finland	5 032	5 338	6%	5%
France	2 258	2 398	6%	4%
Germany	2 909	3 005	3%	6%
Greece	1 578	1 464	-7%	-8%
Hungary	2 593	2 707	4%	3%
Ireland	2 913	2 746	-6%	2%
Italy	1 810	1 762	-3%	0%
Latvia	3 695	4 003	8%	0%
Lithuania	3 523	3 827	9%	5%
Luxembourg	2 849	2 967	4%	5%
Malta	542	322	-41%	-1%
Netherlands	2 624	2 680	2%	2%
Poland	3 113	3 286	6%	7%
Portugal	1 076	1 237	15%	-1%

	2015	2016	Trend 2015 – 2016	Trend fuel consumption 1A4b
Romania	2 786	2 919	5%	1%
Slovakia	3 056	3 172	4%	-1%
Slovenia	2 700	2 757	2%	5%
Spain	1 640	1 729	5%	4%
Sweden	4 911	5 125	4%	0%
United Kingdom	3 015	2 976	-1%	4%
EU-28 (weighted)	2 607	2 683	3%	3%

Source: EEA 2018

Figure **3.121**shows the trend of total GHG emissions within source category 1A4 and the dominating sources which are CO_2 emissions from 1A4b Residential and from 1A4a Commercial/Residential. The emission trends of the large key sources show larger fluctuations between 1990 and 2016. Between 1990 and 2016 emissions from 1A4 decreased by 21%. From 2015 to 2016 emissions increased by 3.1% (+20 Mt CO_2 equivalents) which is mainly due to an increase of category 1A4b CO_2 emissions which increased by 3.7% (+15 Mt CO_2) and category 1A4a CO_2 emissions which increased by 2.5% (+4 Mt CO_2). The increase of 1A4b CO_2 emissions in the year 2016 is mostly influenced by Belgium (+1 Mt CO_2), Germany (+3.5 Mt CO_2), France (+2.8 Mt CO_2), Poland (+2.2 Mt CO_2) and the United Kingdom (+2.5 Mt CO_2). The trend of 1A4a CO_2 emissions in the year 2015 is mostly influenced by Germany (+1.8 Mt CO_2), Spain (+0.5 Mt CO_2), France (-1 Mt CO_2), the United Kingdom (+0.6 Mt CO_2) and Poland (+0.7 Mt CO_2).

Figure 3.121 1A4 Other Sectors: Total, CO_2 and CH_4 emission trends



Data displayed as dashed line refers to the secondary axis.

In 2016 GHG emissions from source category 1A4 accounted for 15 % of total GHG emissions. This source category includes twelve key sources which contributed to 98% of total 1A4 GHG emissions in 2016. The following list shows the key sources and their contribution to total 1A4 GHG emissions for the year 2016:

- 1 A 4 a Commercial/Institutional: Liquid Fuels - CO_2 (5.9%)

- 1 A 4 a Commercial/Institutional: Solid Fuels - CO_2 (0.7%)
- 1 A 4 a Commercial/Institutional: Gaseous Fuels - CO_2 (16.8%)
- 1 A 4 a Commercial/Institutional: Other Fuels – CO_2 (0.8%)
- 1 A 4 b Residential: Liquid Fuels - CO_2 (15.2%)
- 1 A 4 b Residential: Solid Fuels - CO_2 (5.9%)
- 1 A 4 b Residential: Solid Fuels – CH_4 (0.5%)
- 1 A 4 b Residential: Gaseous Fuels - CO_2 (39.2%)
- 1 A 4 b Residential: Biomass - CH_4 (1.6%)
- 1 A 4 c Agriculture/Forestry/Fisheries: Liquid Fuels - CO_2 (9.1%)
- 1 A 4 c Agriculture/Forestry/Fisheries: Solid Fuels - CO_2 (0.6%)
- 1 A 4 c Agriculture/Forestry/Fisheries: Gaseous Fuels - CO_2 (1.7%)

The following table shows the share of higher tier methods used for each key source of category 1A4. It comprises all methods and method combinations as reported by member states for any of the 1A4 key sources.

Table 3.78: Share of higher Tier methods for 1A4 by type of reported method and method combinations.

Methods and method combinations	Share of emissions which are estimated with a 'higher Tier method'
CS	100%
T1	0%
T1,T2	50%
T1,T3	50%
T2	100%
T2,T3	100%
T3	100%
No information	50%

Table 3.79: Key source categories for level and trend analyses and share of MS emissions using higher tier methods for sector 1A4 (Table excerpt)

Source category gas	kt CO_2 equ.		Trend	Level		share of higher Tier
	1990	2016		1990	2016	
1.A.4.a Commercial/Institutional: Gaseous Fuels (CO_2)	66847	110199	T	L	L	83%
1.A.4.a Commercial/Institutional: Liquid Fuels (CO_2)	83979	38853	T	L	L	69%
1.A.4.a Commercial/Institutional: Other Fuels (CO_2)	777	5278	T	0	0	97%
1.A.4.a Commercial/Institutional: Solid Fuels (CO_2)	47401	4474	T	L	0	65%
1.A.4.b Residential: Biomass (CH_4)	9400	10718	T	L	L	43%
1.A.4.b Residential: Gaseous Fuels (CO_2)	183941	257633	T	L	L	84%
1.A.4.b Residential: Liquid Fuels (CO_2)	181470	100076	T	L	L	77%
1.A.4.b Residential: Solid Fuels (CH_4)	9387	2981	T	L	0	10%
1.A.4.b Residential: Solid Fuels (CO_2)	136848	38501	T	L	L	63%
1.A.4.c Agriculture/Forestry/Fishing: Gaseous Fuels (CO_2)	12480	11231	0	L	L	54%
1.A.4.c Agriculture/Forestry/Fishing: Liquid Fuels (CO_2)	72355	59927	T	L	L	63%
1.A.4.c Agriculture/Forestry/Fishing: Solid Fuels (CO_2)	9751	4121	T	L	0	50%

Table 3.80 shows total GHG, CO_2 and CH_4 emissions from 1A4 Other sectors. Between 1990 and 2016 CO_2 emissions from 1A4 Other Sectors decreased by 21%, CH_4 decreased by 63% and N_2O emissions decreased by 5%.

Table 3.80 1A4 Other Sectors: Member States' contributions to total GHG, CO_2 and CH_4 emissions

Member State	GHG emissions in 1990 (kt CO2 equivalents)	GHG emissions in 2016 (kt CO2 equivalents)	CO2 emissions in 1990 (kt)	CO2 emissions in 2016 (kt)	CH4 emissions in 1990 (kt CO2 equivalents)	CH4 emissions in 2016 (kt CO2 equivalents)
Austria	14 238	9 007	13 552	8 556	494	298
Belgium	28 135	25 426	27 790	24 892	255	419
Bulgaria	8 103	1 915	7 624	1 540	286	293
Croatia	4 218	3 277	3 719	2 790	358	362
Cyprus	434	522	430	516	2	5
Czech Republic	34 044	13 546	32 189	12 528	1 676	884
Denmark	9 261	4 661	9 038	4 427	160	147
Estonia	2 038	733	1 881	559	103	127
Finland	7 565	3 916	7 258	3 663	223	189
France	102 938	90 547	96 671	87 604	4 782	1 411
Germany	208 173	135 543	203 012	133 791	4 185	1 252
Greece	8 496	5 978	8 066	5 813	104	106
Hungary	22 169	12 950	21 211	12 217	858	622
Ireland	10 586	8 515	10 031	8 288	451	155
Italy	78 986	82 519	76 101	77 809	1 142	2 302
Latvia	5 915	1 444	5 620	1 264	221	126
Lithuania	7 300	1 406	6 903	1 201	210	163
Luxembourg	1 356	1 649	1 339	1 631	11	13
Malta	196	176	195	175	1	1
Netherlands	39 509	35 304	38 887	33 873	572	1 378
Poland	57 097	58 472	53 611	54 028	2 811	3 492
Portugal	4 683	4 344	4 063	3 954	414	247
Romania	11 310	10 371	10 847	9 383	417	979
Slovakia	11 966	4 783	11 457	4 547	462	180
Slovenia	1 851	1 581	1 646	1 376	148	156
Spain	26 352	41 018	25 313	39 722	828	1 010
Sweden	11 368	3 199	10 909	2 797	297	302
United Kingdom	112 255	93 249	109 764	91 593	1 592	967
EU-28	**830 544**	**656 049**	**799 126**	**630 536**	**23 063**	**17 587**
Iceland	794	529	785	524	3	1
United Kingdom (KP)	112 578	93 687	110 082	92 030	1 595	968
EU-28 + ISL	**831 661**	**657 017**	**800 229**	**631 497**	**23 069**	**17 590**

Abbreviations explained in the Chapter 'Units and abbreviations'.

Table 3.81 provides information on the contribution of Member States to EU-28+ISL recalculations in CO_2 from 1A4 Other sectors for 1990 and 2015 and main explanations for the largest recalculations in absolute terms.

Table 3.81 1A4 Other Sectors: Contribution of MS to EU-28 recalculations in CO_2 for 1990 and 2015 (difference between latest submission and previous submission in kt of CO_2 equivalents and percent)

	1990		2015		Main explanations
	kt CO_2	%	kt CO_2	%	
Austria	-234	-1.7	-108	-1.3	Revised energy balance
Belgium	60	0.2	-262	-1.1	Flanders: new study carried out in 2017 by using tier2-methodolgy instead of tier1 in the category 1A4 and update emission factors used (complete time series) + Update (final version) of the Walloon energy balance
Bulgaria	-0	-0.0	-	-	NA
Croatia	-	-	-	-	NA
Cyprus	-	-	-19	-3.5	Revision of activity data by the Statistical Service (NIR 3.2.6.5)
Czech Republic	2 538	8.6	1 080	9.8	Updated activity data, NCV
Denmark	-11	-0.1	-222	-4.8	Revised energy statistics. The disaggregation of fuel oil between mobile sources and stationary combustion have been revised and a higher share of the consumption is now included in stationary combustion (NIR 3.2.8)
Estonia	-	-	-	-	NA
Finland	0	0.0	23	0.6	Corrections of preliminary activity data.
France	2 674	2.8	1 103	1.3	Revised energy balance. Update of CO_2 emission factors.
Germany	-	-	2 608	2.1	Revised energy statistics.
Greece	-	-	-	-	NA
Hungary	-180	-0.8	249	2.2	Revised energy statistics; reallocated waste incineration; non-CO_2 emissions are calculated separately for agriculture and forestry
Ireland	-	-	80	1.0	Revised natural gas fuel consumption in national energy balance
Italy	8	0.0	43	0.1	Update of activity data (energy conversion factor from TOE to TJ)
Latvia	-	-	-	-	NA
Lithuania	1	0.0	-	-	NA
Luxembourg	-	-	14	0.9	Energy balance revised
Malta	50	34.1	-20	-10.1	Recalculations were performed due to a revision in the methodology used to apportion the total fuel used between the various NACE catgegories. Recalculations were also made due to the use of data on fuel oil and gasoil obtained from the customs Department, which was considered to be superior to the survey results.
Netherlands	-107	-0.3	215	0.7	Recalculation with new EF's and changed diesel use
Poland	-118	-0.2	-114	-0.2	AD update and change of CO_2 EF for natural gas
Portugal	-	-	1	0.0	NA
Romania	-5	-0.0	11	0.1	Because the activity data from Energy Balance provided from National Institute of Statistics were updated for the 1990, 1992-1995, 2014-2015 period from the 1.A.4 Other sectors sub-sector, the CO_2, CH_4 and N_2O emissions values for this years were updated.
Slovakia	-	-	98	2.2	Recalculation in off-road transport due to changes in activity data (better statistics available)
Slovenia	-	-	-	-	NA
Spain	248	1.0	-151	-0.4	Replacement of estimated data by real data available from national energy statistics. Method improvements for fuel consumption in fisheries.
Sweden	232	2.2	245	9.0	Improved classification of tractors.

	1990		2015		Main explanations
	kt CO_2	%	kt CO_2	%	
United Kingdom	756	0.7	593	0.7	Introduction of the BEIS shipping improvements model leading to revisions to gas oil emissions from fishing vessels & the introduction of fuel oil emissions; DUKES revisions
EU28	5 912	0.7	5 468	0.9	
Iceland	-33	-4.1	72	12.9	Changed ox factor to default value of 1
United Kingdom (KP)	754	0.7	618	0.7	Introduction of the BEIS shipping improvements model leading to revisions to gas oil emissions from fishing vessels & the introduction of fuel oil emissions; DUKES revisions
EU28+ISL	5 877	0.7	5 565	0.9	

Table 3.82 provides information on the contribution of Member States to EU-28+ISL recalculations in CH_4 from 1A4 Other sectors for 1990 and 2015.

Table 3.82: 1A4 Other Sectors: Contribution of MS to EU-28 recalculations in CH_4 for 1990 and 2015 (difference between latest submission and previous submission in kt of CO_2 equivalents and percent)

	1990		2015		Main explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
Austria	-112	-18.4	53	22.0	Change of CH_4 emission factors for solid biomass
Belgium	-63	-19.7	-24	-6.0	Flanders and due to new study carried out in 2017 by using tier2-methodolgy instead of tier1 in the category and update emission factors used (complete time series) + Update linked to the final version of the Walloon energy balance
Bulgaria	-	-	-	-	NA
Croatia	-	-	-	-	NA
Cyprus	-0	-2.6	-0	-1.2	Revision of activity data by the Statistical Service (NIR 3.2.6.5)
Czech Republic	219	15.0	74	9.2	Updated activity data, NCV
Denmark	1	0.8	-4	-2.7	Revised energy statistics. The disaggregation of fuel oil between mobile sources and stationary combus-tion have been revised and a higher share of the consumption is now included in stationary combustion (NIR 3.2.8)
Estonia	-	-	-	-	NA
Finland	0	0.0	1	0.4	Corrections of preliminary activity data.
France	72	1.5	-60	-4.3	Revised energy balance.
Germany	-0	-0.0	60	5.3	Revised energy statistics.
Greece	-	-	-	-	NA
Hungary	-1	-0.1	7	1.1	Revised energy statistics; reallocated waste incineration; non-CO_2 emissions are calculated separately for agriculture and forestry
Ireland	-	-	0	0.2	Revised natural gas fuel consumption in national energy balance
Italy	1	0.1	6	0.2	Update of activity data (energy conversion factor from TOE to TJ)
Latvia	-	-	-17	-12.0	Corrected activity data about amount of biogas used in 1A4ai and calculated emissions accordingly; corrected emission calculation for biomass use in 1A4bi.
Lithuania	-0	-0.1	-	-	NA
Luxembourg	-	-	1	6.1	Energy balance revised

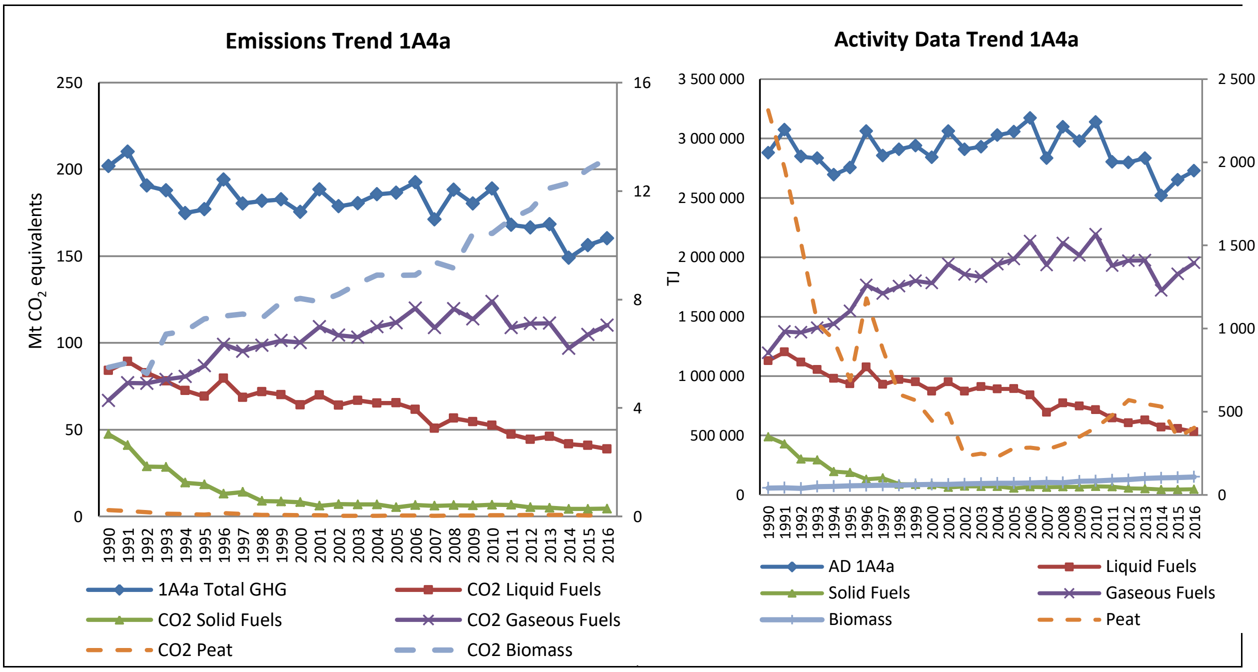
	1990		2015		Main explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
Malta	0	39.9	-0	-27.6	Recalculations were performed due to a revision in the methodology used to apportion the total fuel used between the various NACE categories. Recalculations were also made due to the use of data on fuel oil and gasoil obtained from the customs Department, which was considered to be superior to the survey results.
Netherlands	3	0.6	2	0.1	Recalculation with new EF's and changed diesel use
Poland	-	-	35	1.1	Activity data update
Portugal	-	-	-0	-0.0	NA
Romania	-0	-0.1	-3	-0.3	Not available
Slovakia	-	-	0	0.0	Recalculation in off-road transport due to changes in activity data (better statistics available)
Slovenia	0	0.1	0	0.0	Small correction of biomass used in the residential sector
Spain	1	0.1	-1	-0.1	Method improvements for fuel consumption in fisheries
Sweden	0	0.2	0	0.1	Recalculation of Energy Balance/Updating of EF for small scale combustion of wood./Improved classification of tractors.
United Kingdom	34	2.2	-25	-2.6	Revision to DUKES for fuel oil from public sector combustion; correction to the assignment of DUKES categories to straw combustion
EU28	157	0.7	103	0.6	
Iceland	1	54.4	0	22.1	Change in NCV (updated to default) for Kerosene in 1A4b; Updated EF for 1A4cii to 2006 GL (was 1996 GL before); Updated EF for Waste oil to default value
United Kingdom (KP)	35	2.2	-25	-2.5	Revision to DUKES for fuel oil from public sector combustion; correction to the assignment of DUKES categories to straw combustion
EU28+ISL	158	0.7	103	0.6	

3.2.4.1 Commercial/Institutional (1A4a)

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 accounted for 3.7% of total GHG emissions in 2016.

Figure 3.122 shows the emission trend within the category 1A4a, which is mainly dominated by CO_2 emissions from liquid and gaseous fuels. Between 1990 and 2016 CO_2 emissions decreased by 20%, mainly due to decreases in CO_2 emissions from solid (-91%) and liquid (-54%) fuels while CO_2 emissions from gaseous fuels increased by 65% and showed a continuous uptrend for the whole time series until 2010. Between 2015 and 2016 the GHG emissions increased by 2.5%, mainly driven by an increase in gaseous fuel consumption.

Figure 3.122   1A4a Commercial/Institutional: Total and CO_2 emission and activity trends



Data displayed as dashed line refers to the secondary axis.

Between 1990 and 2016, CO_2 emissions from 1A4a decreased by 20% in the EU-28 (Table 3.70). 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 9% between 1990 and 2016 and biomass consumption increased by 160%.

France, Germany, Italy and the United Kingdom contributed the most to the CO_2 emissions from this source (66%). The Member States with the highest increases in absolute terms were Spain, Italy and Romania. The Member States with the highest reduction in absolute terms were Germany, the Czech Republic, France and the United Kingdom (Table 3.83).

Table 3.83 1A4a Commercial/Institutional: Member States' contributions to CO_2 emissions and information on method applied and emission factor

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016		Method	Emission factor Informa-tion
	1990	2015	2016		kt CO2	%	kt CO2	%		
Austria	2 336	1 440	1 484	0.9%	-852	-36%	44	3%	T1,T2	CS,D
Belgium	4 286	5 515	5 850	3.7%	1 564	37%	336	6%	T1	D
Bulgaria	3 084	288	304	0.2%	-2 781	-90%	16	5%	T1,T2	CS,D
Croatia	855	584	608	0.4%	-247	-29%	24	4%	T1	D
Cyprus	75	87	81	0.1%	5	7%	-6	-7%	T1	D
Czech Republic	10 024	2 810	2 855	1.8%	-7 168	-72%	45	2%	T1,T2	CS,D
Denmark	1 459	721	734	0.5%	-725	-50%	13	2%	M,T1,T2,T3	CS,D
Estonia	48	91	104	0.1%	57	119%	13	15%	T1,T2	CS,D
Finland	2 250	944	1 032	0.6%	-1 218	-54%	89	9%	CS,M,T1,T2	CS,D
France	30 593	25 963	24 993	15.7%	-5 600	-18%	-970	-4%	T1,T2	CS,D
Germany	64 106	35 551	37 360	23.5%	-26 746	-42%	1 809	5%	CS,T2,T3	CS,D
Greece	519	713	695	0.4%	176	34%	-18	-3%	T1,T2	CS,D
Hungary	2 757	3 302	3 314	2.1%	557	20%	12	0%	T1,T2	CS,D
Ireland	2 232	1 808	1 851	1.2%	-381	-17%	43	2%	T2	CS
Italy	12 195	22 415	22 803	14.4%	10 608	87%	387	2%	T2	CS
Latvia	2 831	424	398	0.3%	-2 433	-86%	-26	-6%	T1,T2	CS,D
Lithuania	3 059	277	314	0.2%	-2 745	-90%	37	13%	T2,T3	CS
Luxembourg	637	474	571	0.4%	-66	-10%	97	20%	T1,T2	CS,D
Malta	165	110	121	0.1%	-44	-26%	11	10%	T1	D
Netherlands	8 310	7 764	7 865	5.0%	-445	-5%	101	1%	T1,T2	CS,D
Poland	9 826	7 842	8 494	5.3%	-1 332	-14%	653	8%	T1,T2	CS,D
Portugal	745	1 132	1 140	0.7%	395	53%	8	1%	T1	D
Romania	NO	2 005	2 054	1.3%	2 054	∞	48	2%	T1,T2	CS
Slovakia	4 148	1 487	1 439	0.9%	-2 709	-65%	-48	-3%	T2	CS
Slovenia	503	391	462	0.3%	-41	-8%	71	18%	T1,T2	CS,D
Spain	3 827	10 795	11 318	7.1%	7 491	196%	523	5%	T2	CS,D,OTH
Sweden	2 832	756	751	0.5%	-2 081	-73%	-5	-1%	T1,T2	CS
United Kingdom	25 442	19 222	19 825	12.5%	-5 617	-22%	603	3%	T2	CS
EU-28	**199 142**	**154 911**	**158 819**	**100%**	**-40 323**	**-20%**	**3 908**	**3%**	**-**	**-**
Iceland	16	2	2	0.0%	-15	-90%	0	-18%	T1	D
United Kingdom (KP)	25 522	19 246	19 849	12.5%	-5 672	-22%	603	3%	T2	CS
EU-28 + ISL	**199 238**	**154 938**	**158 845**	**100%**	**-40 392**	**-20%**	**3 908**	**3%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'.

1A4 a Commercial/Institutional – Liquid Fuels (CO_2)

In 2016 CO_2 emissions from liquid fuels had a share of 24% within source category 1A4a (compared to 42% in 1990). Between 1990 and 2016, CO_2 emissions decreased by 54% (Table 3.84). Five Member States had increases in this period, with the highest absolute increase in Poland and Romania. The highest absolute decreases were achieved in France, Germany, Bulgaria, Sweden and the United Kingdom. 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). Between 2015 and 2016 EU-28+ISL CO_2 emissions decreased by 5%. According to the methodology as described in chapter 3.2.4 about 69% of EU-28 emissions are calculated by using higher tier methods in 2016.

Table 3.84 1A4a Commercial/Institutional, liquid fuels: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016		Method	Emission factor Informa-tion
	1990	2015	2016		kt CO2	%	kt CO2	%		
Austria	1 423	478	483	1.2%	-940	-66%	4	1%	T2	CS
Belgium	2 315	1 405	1 485	3.8%	-829	-36%	80	6%	T1	D
Bulgaria	2 986	58	71	0.2%	-2 915	-98%	12	21%	T1	D
Croatia	526	186	182	0.5%	-344	-65%	-4	-2%	T1	D
Cyprus	75	87	81	0.2%	5	7%	-6	-7%	T1	D
Czech Republic	2 116	64	58	0.1%	-2 058	-97%	-6	-10%	T1	CS,D
Denmark	1 054	274	275	0.7%	-780	-74%	1	0%	T1,T2	CS,D
Estonia	19	15	17	0.0%	-2	-11%	2	14%	-	-
Finland	2 189	864	943	2.4%	-1 246	-57%	79	9%	T1	CS
France	21 139	14 115	12 123	31.2%	-9 016	-43%	-1 992	-14%	-	-
Germany	28 133	13 287	12 942	33.3%	-15 191	-54%	-345	-3%	CS	CS
Greece	499	324	348	0.9%	-151	-30%	24	7%	T2	CS
Hungary	1 124	121	108	0.3%	-1 016	-90%	-13	-11%	T1	D
Ireland	1 870	745	756	1.9%	-1 114	-60%	11	2%	T2	CS
Italy	1 530	1 601	1 577	4.1%	47	3%	-24	-2%	-	-
Latvia	1 017	166	117	0.3%	-900	-89%	-49	-30%	T2	CS
Lithuania	1 166	7	8	0.0%	-1 159	-99%	1	14%	T2	CS
Luxembourg	467	231	262	0.7%	-206	-44%	31	13%	T2	CS
Malta	165	110	121	0.3%	-44	-26%	11	10%	T1	D
Netherlands	450	404	395	1.0%	-55	-12%	-9	-2%	T1,T2	CS,D
Poland	IE,NO	1 269	1 280	3.3%	1 280	∞	11	1%	T1	D
Portugal	745	436	430	1.1%	-315	-42%	-5	-1%	-	-
Romania	NO	237	258	0.7%	258	∞	21	9%	T1,T2	CS
Slovakia	384	31	31	0.1%	-353	-92%	0	0%	T2	CS
Slovenia	270	278	314	0.8%	44	16%	36	13%	T1	D
Spain	3 284	2 960	3 135	8.1%	-150	-5%	175	6%	T2	D
Sweden	2 746	517	507	1.3%	-2 238	-82%	-10	-2%	T1	CS
United Kingdom	6 191	535	521	1.3%	-5 670	-92%	-14	-3%	T2	CS
EU-28	**83 884**	**40 805**	**38 827**	**100%**	**-45 057**	**-54%**	**-1 978**	**-5%**	**-**	**-**
Iceland	16	2	2	0.0%	-15	-90%	0	-18%	T1	D
United Kingdom (KP)	6 270	558	544	1.4%	-5 725	-91%	-14	-3%	T2	CS
EU-28 + ISL	**83 979**	**40 830**	**38 853**	**100%**	**-45 127**	**-54%**	**-1 978**	**-5%**	**-**	**-**

Notes: From 1990 to 1993 Poland does not report any liquid fuels for stationary sources and reports liquid fuels from 'Off-road vehicles and other machinery' under category 1A3 and therefore the notation key 'IE, NO' is reported. Abbreviations explained in the Chapter 'Units and abbreviations'.

Figure 3.123 and Figure **3.124** show CO_2 emissions and implied emission factors for EU-28+ISL as well as the share of the Member States with the highest contributions. The largest emissions are reported by France, Germany and Spain; together they cause 73% of the CO_2 emissions from liquid fuels in 1A4a. Fuel consumption decreased by 53% between 1990 and 2016. The dip in activity data 2007 is mainly due to Germany due to reasons explained earlier in this chapter. The CO_2 implied emission factor for liquid fuels was 73.1 t/TJ in 2016.

Figure 3.123 1A4a Commercial/Institutional, liquid fuels: Emission trend and share for CO_2

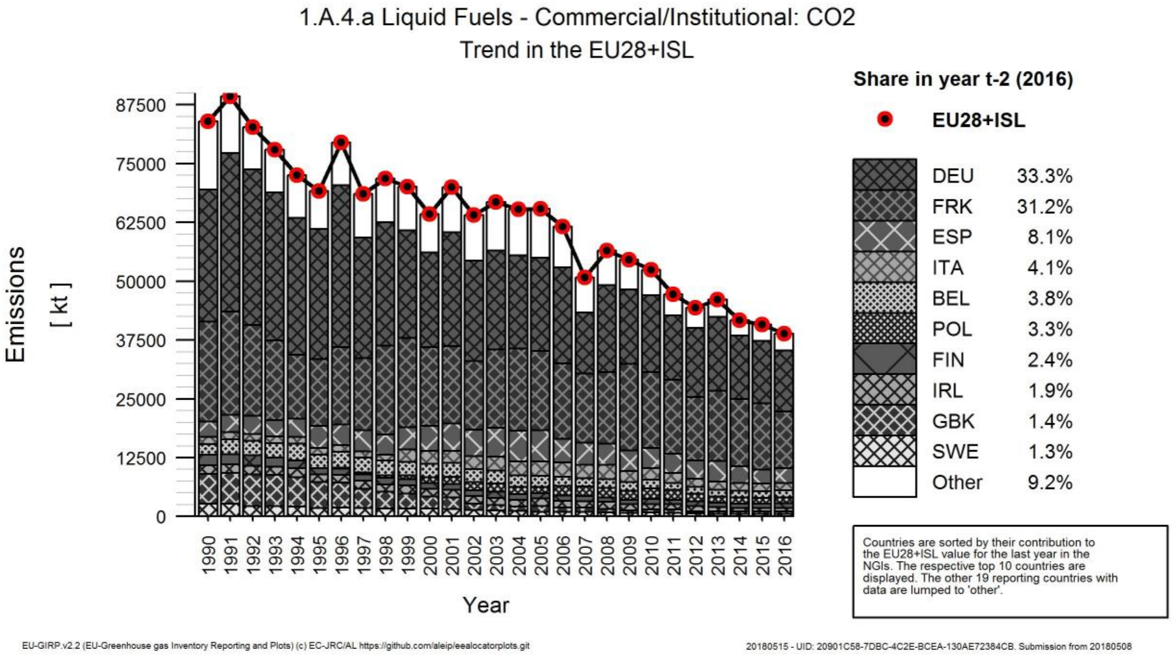
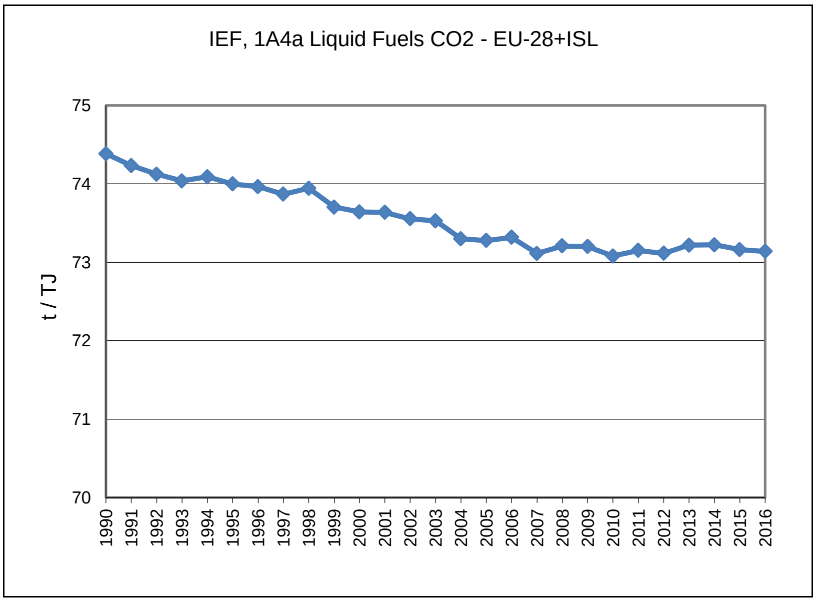
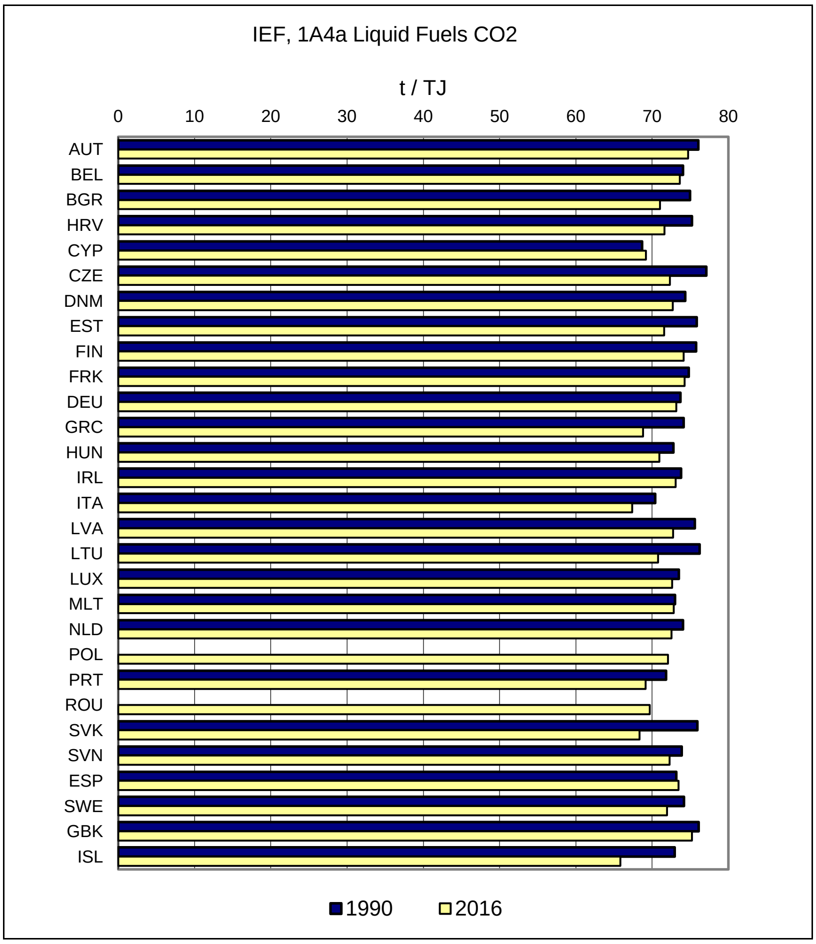


Figure 3.124 1A4a Commercial/Institutional, liquid fuels: Implied Emission Factors for CO_2 (in t/TJ)





1A4a Commercial/Institutional – Solid Fuels (CO_2)

In 2016, CO_2 from solid fuels had a share of 3% within source category 1A4a (compared to 23% in 1990). Between 1990 and 2016 CO_2 emissions decreased by 91% (Table 3.85). Twelve Member States and Island report emissions as 'Not occurring' in 2016; all other Member States reduced emissions between 1990 and 2016 except Spain and Romania. Between 2015 and 2016 CO_2 emissions decreased by 5%. According to the methodology as described in chapter 3.2.4 about xx% of EU-28 emissions are calculated by using higher tier methods in 2016.

Table 3.85 1A4a Commercial/Institutional, solid fuels: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016		Method	Emission factor Informa-tion
	1990	2015	2016		kt CO2	%	kt CO2	%		
Austria	91	10	10	0.2%	-81	-89%	0	-2%	T2	CS
Belgium	9	NO	NO	-	-9	-100%	-	-	NA	NA
Bulgaria	60	22	24	0.5%	-36	-59%	2	9%	T1,T2	CS,D
Croatia	88	0	0	0.0%	-88	-100%	0	54%	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czech Republic	6 237	105	102	2.3%	-6 135	-98%	-4	-3%	T2	CS,D
Denmark	8	NO	NO	-	-8	-100%	-	-	NA	NA
Estonia	5	NO	NO	-	-5	-100%	-	-	-	-
Finland	NO	NO	NO	-	-	-	-	-	NA	NA
France	687	285	342	7.6%	-345	-50%	57	20%	-	-
Germany	22 426	366	363	8.1%	-22 063	-98%	-4	-1%	CS	CS
Greece	20	NO,IE	NO,IE	-	-20	-100%	-	-	NA	NA
Hungary	475	12	12	0.3%	-463	-98%	0	-1%	T1,T2	CS,D
Ireland	3	NO	NO	-	-3	-100%	-	-	NA	NA
Italy	NO	NO	NO	-	-	-	-	-	-	-
Latvia	1 411	31	30	0.7%	-1 381	-98%	-1	-2%	T1,T2	CS,D
Lithuania	1 173	104	126	2.8%	-1 047	-89%	23	22%	T2	CS
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	101	3	8	0.2%	-93	-92%	5	137%	T1,T2	CS,D
Poland	8 992	2 566	2 687	60.1%	-6 305	-70%	121	5%	T1,T2	CS,D
Portugal	NO	NO	NO	-	-	-	-	-	-	-
Romania	NO	1	3	0.1%	3	∞	2	147%	T2	CS
Slovakia	1 729	258	226	5.1%	-1 503	-87%	-32	-12%	T2	CS
Slovenia	203	NO	NO	-	-203	-100%	-	-	NA	NA
Spain	147	140	155	3.5%	9	6%	16	11%	T2	CS
Sweden	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom	3 535	347	384	8.6%	-3 151	-89%	37	11%	T2	CS
EU-28	**47 400**	**4 250**	**4 473**	**100%**	**-42 927**	**-91%**	**223**	**5%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	3 536	348	385	8.6%	-3 151	-89%	37	11%	T2	CS
EU-28 + ISL	**47 401**	**4 251**	**4 474**	**100%**	**-42 927**	**-91%**	**223**	**5%**	**-**	**-**

Greece reports emissions from stationary combustion as 'NO' and emissions from mobile sources as 'IE'
Abbreviations explained in the Chapter 'Units and abbreviations'.

Figure 3.125 and Figure 3.126 shows CO_2 emissions and implied emission factors for EU-28+ISL as well as the share of the Member States with the highest contributions. The largest emissions are reported by France, Germany, Poland and the United Kingdom in 2015; together they cause 84% of the CO_2 emissions from solid fuels in 1A4a. Fuel consumption in the EU-28 decreased by 90% between 1990 and 2016. The CO_2 implied emission factor for solid fuels was 95.5 t/TJ in 2016. The comparatively low IEFs of Spain and Greece in 1990 are due to a high share of gas works gas consumption in the 1990s.

Figure 3.125   1A4a Commercial/Institutional, solid fuels: Emission trend and share for CO_2

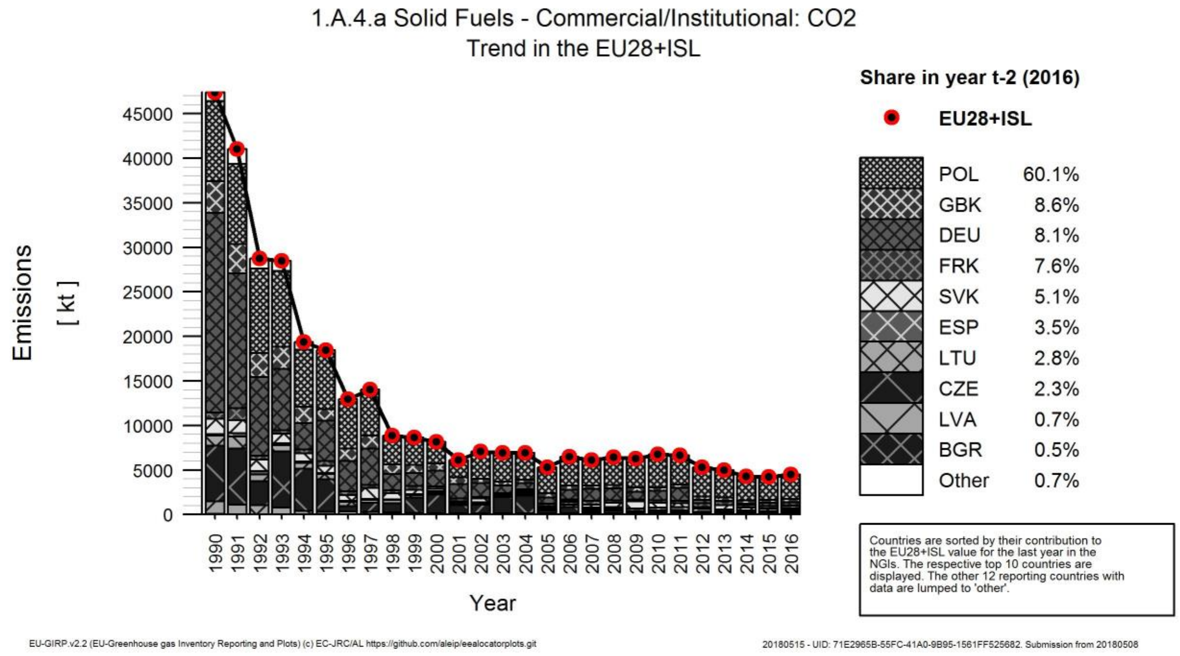
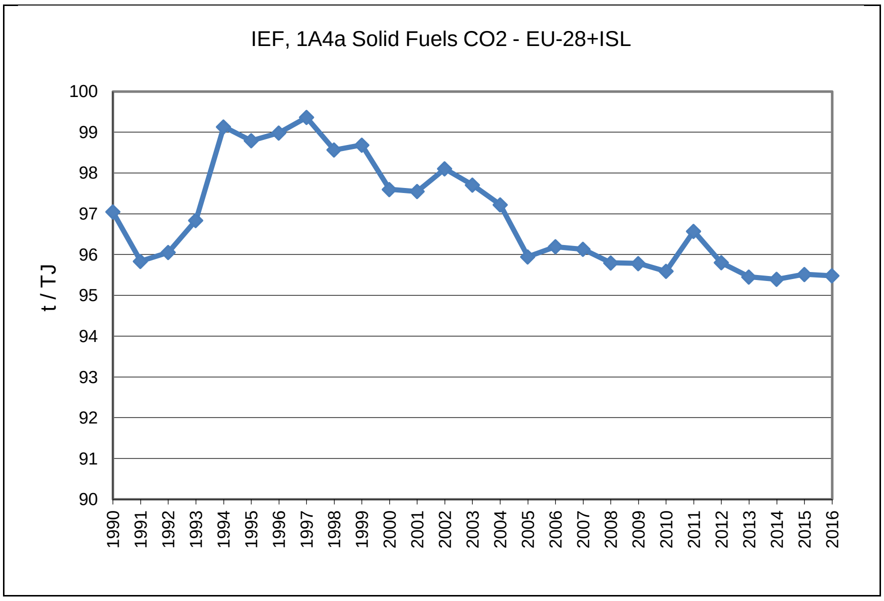
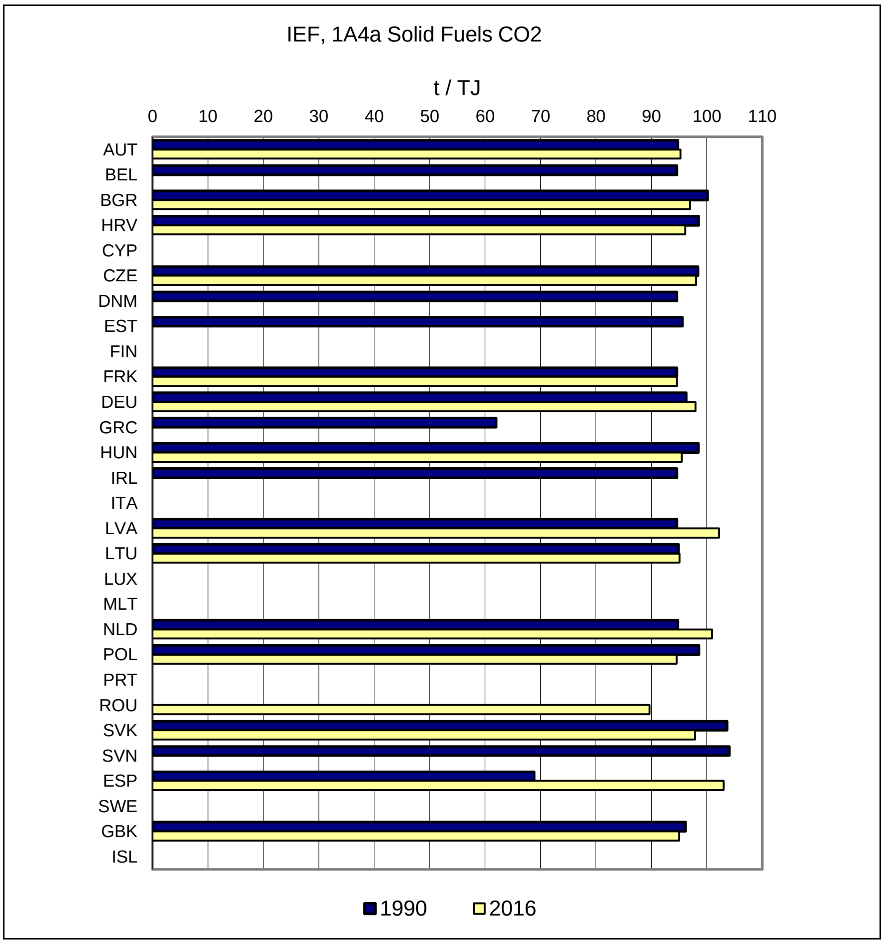


Figure 3.126   1A4a Commercial/Institutional, solid fuels: of Implied Emission Factors for CO_2 (in t/TJ)





1A4a Commercial/Institutional – Gaseous Fuels (CO_2)

In 2016 CO_2 from gaseous fuels had a share of 69% within source category 1A4a (compared to 33% in 1990). Between 1990 and 2016, the emissions increased by 65% (Table 3.86). All Member States except Latvia, Lithuania, the Netherlands and Slovakia reported increasing emissions. The highest absolute increases occurred in Germany, France, Italy, Poland, Spain and the United Kingdom. Between 2015 and 2016 CO_2 emissions increased by 5%. According to the methodology as described in chapter 3.2.4 about 65% of EU-28 emissions are calculated by using higher tier methods in 2016.

Table 3.86 1A4a Commercial/Institutional, gaseous fuels: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016		Method	Emission factor Informa-tion
	1990	2015	2016		kt CO2	%	kt CO2	%		
Austria	707	946	985	0.9%	278	39%	39	4%	T2	CS
Belgium	1 933	3 987	4 250	3.9%	2 317	120%	264	7%	T1	D
Bulgaria	39	207	209	0.2%	170	436%	1	1%	T2	CS
Croatia	241	398	425	0.4%	185	77%	28	7%	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czech Republic	1 670	2 640	2 695	2.4%	1 025	61%	55	2%	T2	CS
Denmark	363	440	450	0.4%	87	24%	9	2%	T3	CS
Estonia	20	76	87	0.1%	67	327%	11	14%	-	-
Finland	45	67	75	0.1%	29	65%	7	11%	T1	CS
France	8 768	11 564	12 528	11.4%	3 760	43%	964	8%	-	-
Germany	13 547	21 898	24 056	21.8%	10 509	78%	2 158	10%	CS	CS
Greece	IE,NO	389	346	0.3%	346	∞	-42	-11%	T2	CS
Hungary	1 158	3 006	3 033	2.8%	1 875	162%	28	1%	T1	D
Ireland	223	1 063	1 095	1.0%	871	390%	32	3%	T2	CS
Italy	10 139	16 176	16 306	14.8%	6 168	61%	130	1%	-	-
Latvia	336	228	251	0.2%	-85	-25%	23	10%	T2	CS
Lithuania	708	143	153	0.1%	-555	-78%	10	7%	T2	CS
Luxembourg	170	243	310	0.3%	140	83%	67	27%	T2	CS
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	7 758	7 357	7 462	6.8%	-296	-4%	105	1%	T1,T2	CS,D
Poland	762	3 981	4 488	4.1%	3 727	489%	507	13%	T2	CS
Portugal	NO	697	710	0.6%	710	∞	13	2%	-	-
Romania	NO	1 745	1 773	1.6%	1 773	∞	28	2%	T2	CS
Slovakia	2 035	1 198	1 182	1.1%	-853	-42%	-16	-1%	T2	CS
Slovenia	29	113	148	0.1%	119	409%	35	31%	T2	CS
Spain	396	7 695	8 027	7.3%	7 632	1929%	332	4%	T2	CS,D
Sweden	86	234	234	0.2%	148	172%	1	0%	T1	CS
United Kingdom	15 716	18 340	18 920	17.2%	3 204	20%	580	3%	T2	CS
EU-28	**66 847**	**104 831**	**110 199**	**100%**	**43 351**	**65%**	**5 368**	**5%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	15 716	18 340	18 920	17.2%	3 204	20%	580	3%	T2	CS
EU-28 + ISL	**66 847**	**104 831**	**110 199**	**100%**	**43 351**	**65%**	**5 368**	**5%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'.

Figure 3.127 and Figure 3.128 show CO_2 emissions and implied emission factors for EU-28+ISL as well as the share of the Member States with the highest contributions. The largest emissions are reported by France, Germany, Italy, Spain and the UK; together they cause 73% of the CO_2 emissions from gaseous fuels in 1A4a. Fuel combustion rose by 63% between 1990 and 2016. The CO_2 implied emission factor for gaseous fuels was 56.4 t/TJ in 2016.

Figure 3.127 1A4a Commercial/Institutional, gaseous fuels: Emission trend and share for CO_2

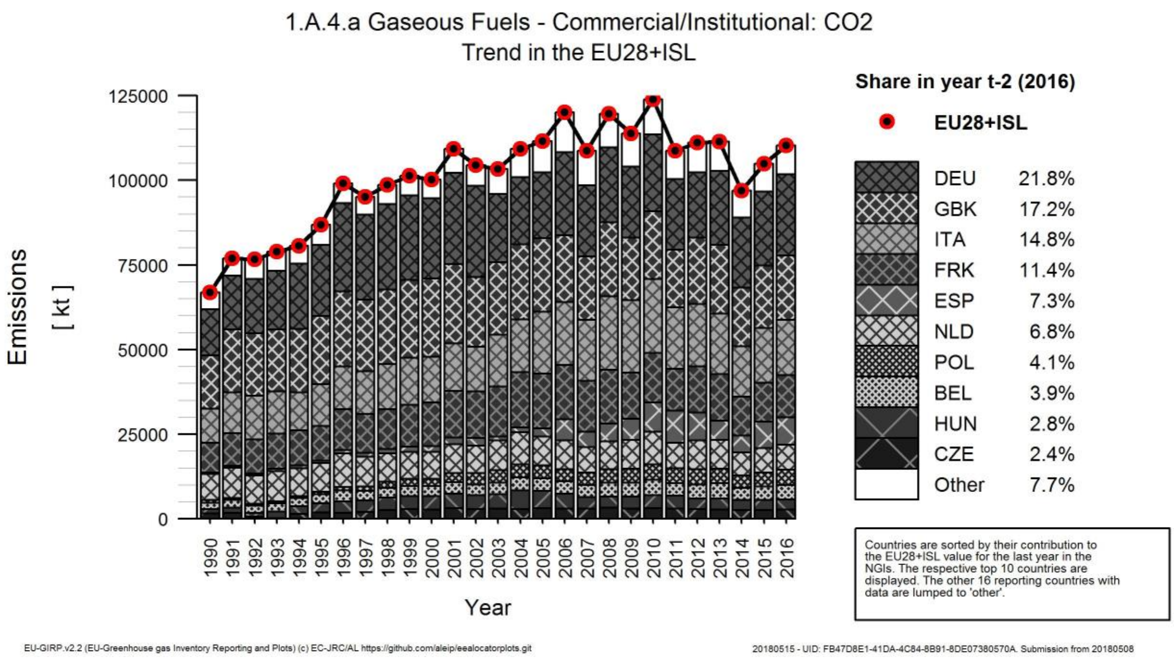
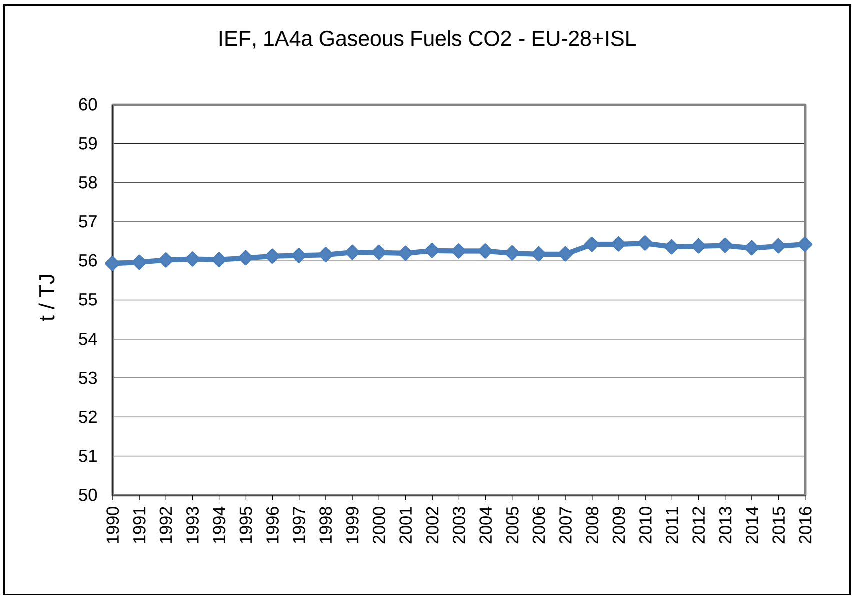
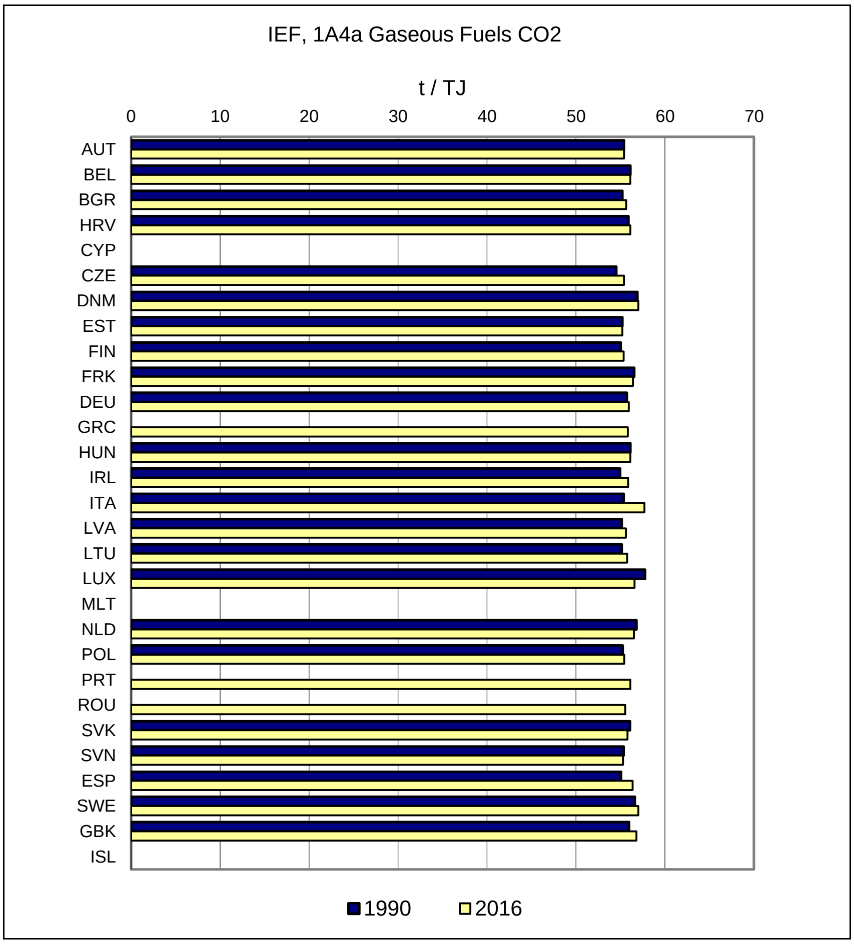


Figure 3.128 1A4a Commercial/Institutional, gaseous fuels: Overview of outliers of Implied Emission Factors for CO_2 (in t/TJ)





1A4a Commercial/Institutional – Other Fossil Fuels (CO_2)

Under this key category Member States report CO_2 emissions from waste incineration plants with energy recovery, whose main economic activity is the treatment of waste (as opposed to waste incineration plants with energy recovery whose main economic activity is power and heat production; these are reported under 1A1a).

In 2016, CO_2 from other fossil fuels had a share of 3% within category 1A4a. Between 1990 and 2016 CO_2 increased by 579% (Table 3.87). 17 Member States and Island report emissions as 'Not occurring' in 2016; Between 2015 and 2016 CO_2 increased by 6%. Emissions trend and emissions level are strongly dominated by Italy. According to the methodology as described in chapter 3.2.4 about 97% of EU-28 emissions are calculated by using higher tier methods in 2016.

Table 3.87: 1A4a Commercial/Institutional, other fuels: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016		Method	Emission factor Informa-tion
	1990	2015	2016		kt CO2	%	kt CO2	%		
Austria	116	6	6	0.1%	-109	-94%	1	12%	T2	CS
Belgium	29	123	115	2.2%	86	294%	-8	-7%	T1	D
Bulgaria	NO	NO	NO	-	-	-	-	-	NA	NA
Croatia	NO	NO	NO	-	-	-	-	-	NA	NA
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czech Republic	NO	NO	NO	-	-	-	-	-	NA	NA
Denmark	34	6	10	0.2%	-24	-71%	3	49%	T2	CS
Estonia	NO	NO	NO	-	-	-	-	-	-	-
Finland	0	NO	NO	-	0	-100%	-	-	NA	NA
France	NO	NO	NO	-	-	-	-	-	-	-
Germany	NA	NA	NA	-	-	-	-	-	NA	NA
Greece	IE,NO	NO,IE	NO,IE	-	-	-	-	-	NA	NA
Hungary	NO	164	161	3.0%	161	∞	-3	-2%	T2	CS
Ireland	NO	NO	NO	-	-	-	-	-	NA	NA
Italy	526	4 638	4 920	93.2%	4 393	835%	281	6%	-	-
Latvia	NO	NO	0	0.0%	0	∞	0	∞	T1	D
Lithuania	NO	NO	NO	-	-	-	-	-	NA	NA
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	NO	NO	NO	-	-	-	-	-	NA	NA
Poland	72	25	39	0.7%	-34	-47%	13	52%	T1	D
Portugal	NO	NO	NO	-	-	-	-	-	-	-
Romania	NO	22	19	0.4%	19	∞	-2	-11%	T2	CS
Slovakia	NO	NO	NO	-	-	-	-	-	NA	NA
Slovenia	NO	NO	NO	-	-	-	-	-	NA	NA
Spain	NO	NO	NO	-	-	-	-	-	NA	NA
Sweden	NO	6	9	0.2%	9	∞	4	63%	NA	NA
United Kingdom	NO	NO	NO	-	-	-	-	-	NA	NA
EU-28	**777**	**4 990**	**5 278**	**100%**	**4 501**	**579%**	**288**	**6%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	NO	NO	NO	-	-	-	-	-	NA	NA
EU-28 + ISL	**777**	**4 990**	**5 278**	**100%**	**4 501**	**579%**	**288**	**6%**	**-**	**-**

Greece reports emissions from stationary combustion as 'NO' and emissions from mobile sources as 'IE'

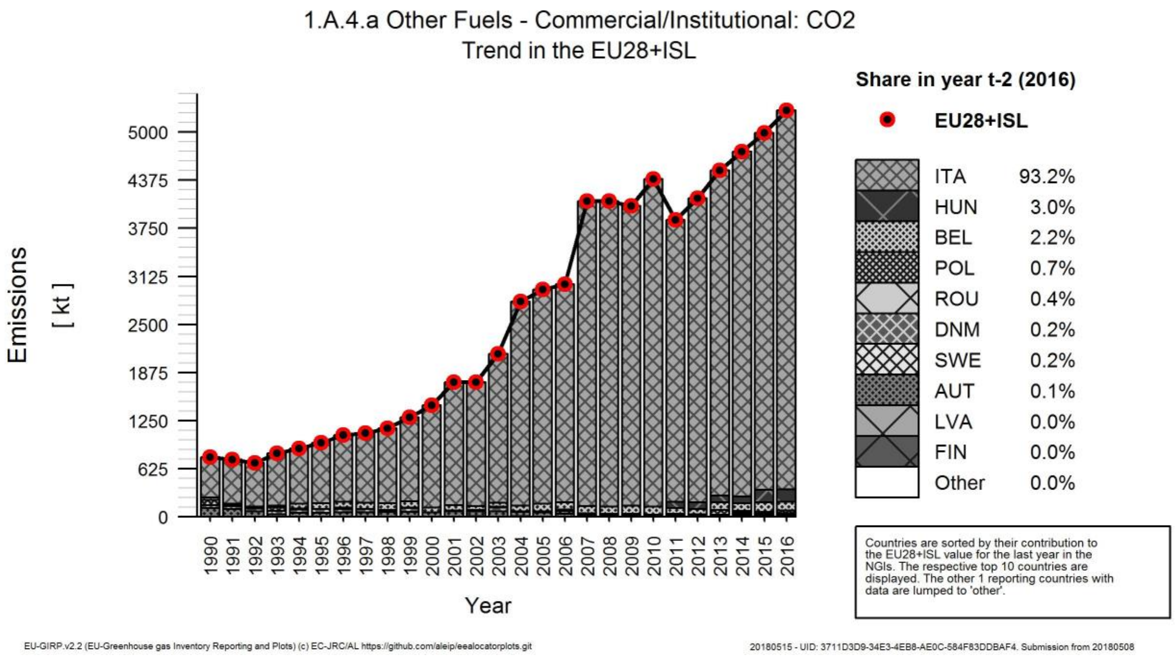


Figure 3.130 show CO_2 emissions and implied emission factors for EU-28+ISL as well as the share of the Member States with the highest contributions. The largest emissions are reported by Italy; it causes 93% of the CO_2 emissions from other fuels in 1A4a. The CO_2 implied emission factor for other fossil fuels was 115.6 t/TJ in 2016. Hungary has shifted emissions from category 5C to 1A4a. The comparatively high implied emission factor is a calculated value from a mass based calculation method and data from energy statistics.

Figure 3.129 1A4a Commercial/Institutional, other fuels: Emission trend and share for CO_2

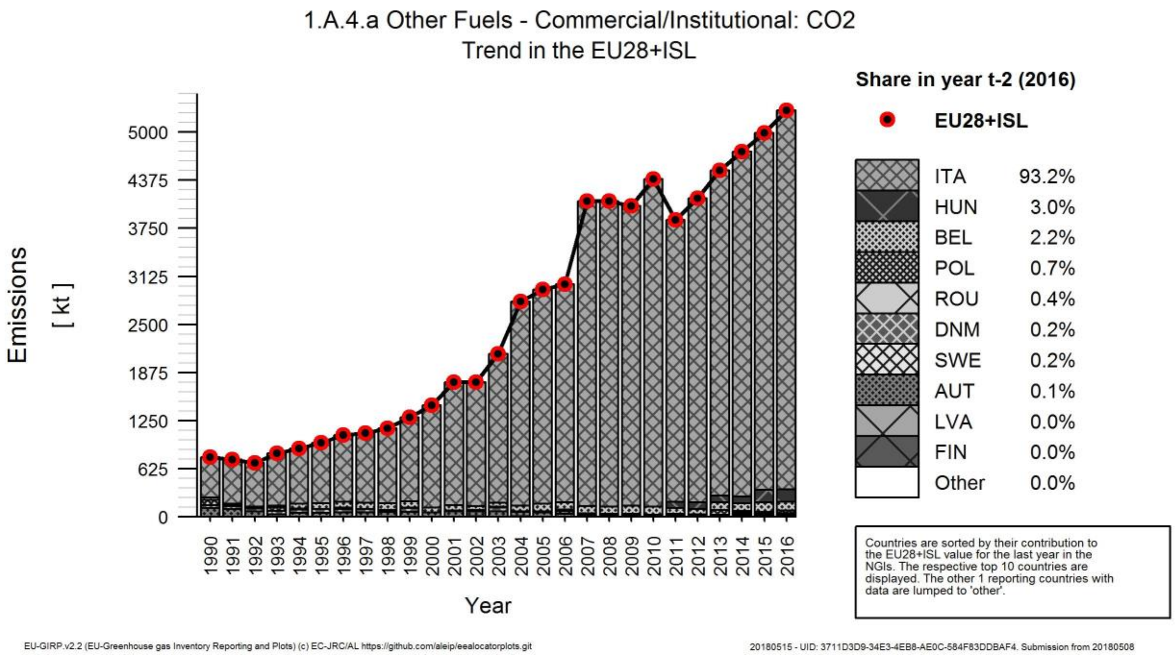
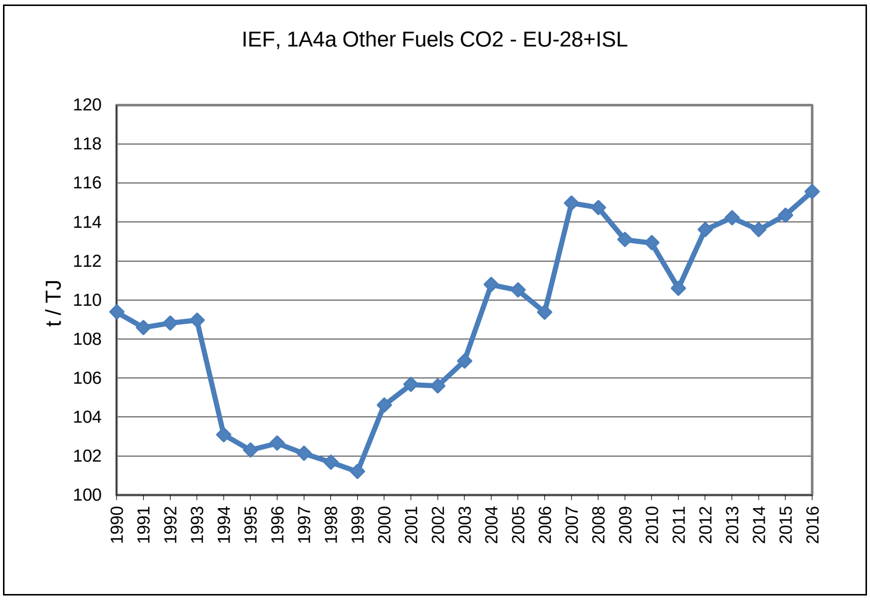
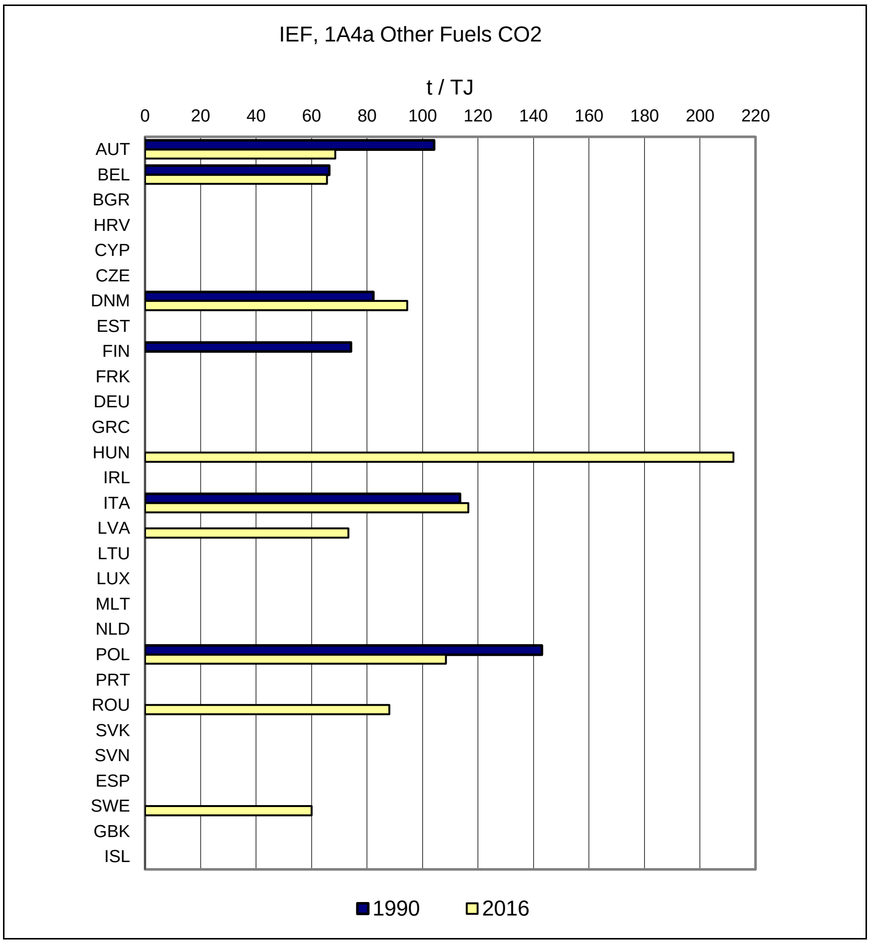


Figure 3.130 1A4a Commercial/Institutional, other fuels: Overview of outliers of Implied Emission Factors for CO_2 (in t/TJ)



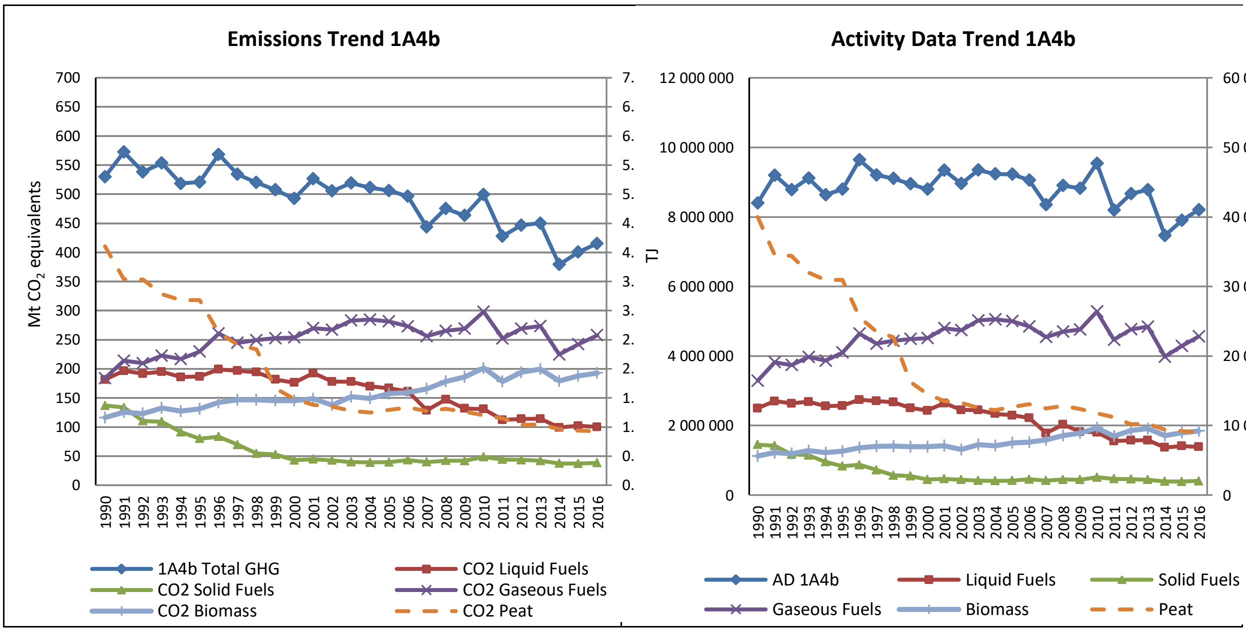


3.2.4.2 Residential (1A4b)

In this chapter information about emission trends, Member States' contribution and activity data 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-28+ISL and account for 9.2% of total GHG emissions in 2016.

igure 3.131 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 22% since 1990, although CO_2 emissions from gaseous fuels increased strongly (+40%) which was counterbalanced by decreasing emissions from liquid and solid fuels. From 2015 to 2016 CO_2 emissions increased by 3.9% and energy consumption increased by 3.9% which is correlating with the trend in EU-28 heating degree days (+3%). Biomass consumption reached a share of 22% in the year 2016 while the share of solid fuels consumption dropped to 5%.

igure 3.131 1A4b Residential: Total, CO_2 and CH_4 emission and activity trends



Data displayed as dashed line refers to the secondary axis.

CO_2 emissions from 1A4b Residential

Between 1990 and 2016, CO_2 emissions from households decreased by 22% in the EU-28+ISL (Table 3.88). 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 building stock, (5) fuel split for heating and warm water, (6) use of renewable energy sources, e.g. biomass or solar panels, and (7) the use of district heating. Fossil fuel consumption of households decreased by 12% between 1990 and 2016, with a fuel shift from coal and oil to natural gas and biomass.

Between 1990 and 2016, the largest CO_2 reduction in absolute terms was reported by Germany reducing emissions by 38.3 million tonnes. Only six Member States show increases in their emissions. 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. Between 2015 and 2016 all Member States except Luxembourg, Malta, Portugal, Slovenia and Sweden show increasing emissions with the largest increase reported by France, Germany, Poland and the United Kingdom.

Table 3.88 1A4b Residential: Member States' contributions to CO_2 emissions and information on method applied and emission factor

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016		Method	Emission factor Informa-tion
	1990	2015	2016		kt CO2	%	kt CO2	%		
Austria	9 963	6 091	6 254	1.6%	-3 709	-37%	163	3%	T1,T2	CS,D
Belgium	20 471	15 834	16 865	4.2%	-3 606	-18%	1 031	7%	CS,T1,T3	D
Bulgaria	2 887	743	808	0.2%	-2 080	-72%	65	9%	T1,T2	CS,D
Croatia	2 029	1 503	1 544	0.4%	-484	-24%	42	3%	T1	D
Cyprus	300	353	356	0.1%	56	19%	3	1%	T1	D
Czech Republic	18 375	8 043	8 459	2.1%	-9 916	-54%	416	5%	T1,T2	CS,D
Denmark	4 988	2 116	2 146	0.5%	-2 843	-57%	30	1%	M,T1,T2,T3	CS,D
Estonia	1 338	182	182	0.0%	-1 155	-86%	0	0%	T1,T2	CS,D
Finland	3 146	1 264	1 292	0.3%	-1 854	-59%	28	2%	CS,M,T1,T2	CS,D
France	54 721	48 812	51 599	13.0%	-3 122	-6%	2 787	6%	T1,T2	CS,D
Germany	128 636	86 773	90 317	22.7%	-38 319	-30%	3 543	4%	CS,T2	CS
Greece	4 654	5 050	4 687	1.2%	34	1%	-363	-7%	T1,T2	CS,D
Hungary	15 798	6 913	7 413	1.9%	-8 385	-53%	500	7%	T1,T2	CS,D
Ireland	7 052	5 874	5 889	1.5%	-1 163	-16%	15	0%	T2	CS
Italy	55 554	47 657	47 998	12.1%	-7 556	-14%	341	1%	T2	CS
Latvia	1 201	416	452	0.1%	-750	-62%	36	9%	T1,T2	CS,D
Lithuania	2 361	591	684	0.2%	-1 677	-71%	93	16%	T2	CS
Luxembourg	668	1 070	1 037	0.3%	369	55%	-32	-3%	T1,T2	CS,D
Malta	27	55	42	0.0%	16	58%	-13	-24%	T1	D
Netherlands	20 731	16 296	16 975	4.3%	-3 756	-18%	678	4%	T1,T2	CS,D
Poland	35 278	33 496	35 659	9.0%	381	1%	2 163	6%	T1,T2	CS,D
Portugal	1 639	1 791	1 748	0.4%	109	7%	-43	-2%	-	-
Romania	8 853	6 170	6 203	1.6%	-2 650	-30%	32	1%	T1,T2	CS,D
Slovakia	7 163	2 703	2 760	0.7%	-4 403	-61%	57	2%	T2	CS
Slovenia	809	703	696	0.2%	-113	-14%	-7	-1%	T1,T2	CS,D
Spain	12 808	16 206	16 999	4.3%	4 191	33%	793	5%	T2	CS,D,OTH
Sweden	6 311	745	675	0.2%	-5 636	-89%	-70	-9%	T1,T2	CS
United Kingdom	78 344	64 523	66 987	16.9%	-11 357	-14%	2 464	4%	T1,T2,T3	CS,D
EU-28	**506 104**	**381 976**	**396 726**	**100%**	**-109 377**	**-22%**	**14 751**	**4%**	**-**	**-**
Iceland	31	7	6	0.0%	-25	-80%	-1	-15%	T1,T2	D
United Kingdom (KP)	78 572	64 916	67 393	17.0%	-11 180	-14%	2 477	4%	T1,T2,T3	CS,D
EU-28 + ISL	**506 363**	**382 376**	**397 138**	**100%**	**-109 225**	**-22%**	**14 762**	**4%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'.

1A4b Residential – Liquid Fuels (CO_2)

In 2016 CO_2 from liquid fuels had a share of 24% within source category 1A4b (compared to 34% in 1990). Between 1990 and 2016 emissions decreased by 45% (Table 3.89). France, Germany and Italy show the highest absolute decreases. Only four Member States reported increasing emissions since 1990. Between 2015 and 2016 EU-28+ISL CO_2 emissions decreased by 2%. 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). According to the methodology as described in chapter 3.2.4 about 77% of EU-28 emissions are calculated by using higher tier methods in 2016.

Table 3.89 1A4b Residential, liquid fuels: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016		Method	Emission factor Informa-tion
	1990	2015	2016		kt CO2	%	kt CO2	%		
Austria	5 605	3 444	3 376	3.4%	-2 229	-40%	-68	-2%	T2	CS
Belgium	12 800	8 055	8 626	8.6%	-4 174	-33%	572	7%	T1	D
Bulgaria	158	90	73	0.1%	-85	-54%	-17	-19%	T1	D
Croatia	1 137	445	441	0.4%	-696	-61%	-4	-1%	T1	D
Cyprus	300	353	356	0.4%	56	19%	3	1%	-	-
Czech Republic	239	130	130	0.1%	-109	-46%	0	0%	T1	CS,D
Denmark	3 929	688	661	0.7%	-3 267	-83%	-27	-4%	T1,T2	CS,D
Estonia	544	45	44	0.0%	-501	-92%	-2	-4%	-	-
Finland	3 021	1 188	1 214	1.2%	-1 807	-60%	26	2%	T1	CS
France	30 994	15 580	15 537	15.5%	-15 456	-50%	-42	0%	-	-
Germany	56 382	35 782	34 149	34.1%	-22 233	-39%	-1 633	-5%	CS	CS
Greece	4 565	4 197	3 900	3.9%	-665	-15%	-296	-7%	T2	CS
Hungary	3 540	215	179	0.2%	-3 361	-95%	-36	-17%	T1	D
Ireland	1 175	2 863	3 009	3.0%	1 833	156%	146	5%	T2	CS
Italy	28 444	6 970	6 694	6.7%	-21 750	-76%	-276	-4%	T2	CS
Latvia	332	144	150	0.1%	-182	-55%	6	4%	T2	CS
Lithuania	397	116	138	0.1%	-259	-65%	22	19%	T2	CS
Luxembourg	472	545	515	0.5%	43	9%	-30	-6%	T2	CS
Malta	27	55	42	0.0%	16	58%	-13	-24%	T1	D
Netherlands	774	177	177	0.2%	-597	-77%	0	0%	T1,T2	CS,D
Poland	107	1 585	1 587	1.6%	1 480	1378%	2	0%	T1	D
Portugal	1 639	1 171	1 155	1.2%	-484	-30%	-17	-1%	-	-
Romania	922	691	671	0.7%	-251	-27%	-20	-3%	T1,T2	CS,D
Slovakia	93	12	23	0.0%	-70	-75%	12	100%	T2	CS
Slovenia	439	462	429	0.4%	-10	-2%	-33	-7%	T1	D
Spain	9 855	8 631	8 397	8.4%	-1 458	-15%	-234	-3%	T2	D
Sweden	6 225	673	597	0.6%	-5 628	-90%	-77	-11%	T1	CS
United Kingdom	7 126	7 467	7 445	7.4%	319	4%	-22	0%	T2	CS
EU-28	**181 241**	**101 774**	**99 715**	**100%**	**-81 526**	**-45%**	**-2 059**	**-2%**	**-**	**-**
Iceland	31	7	6	0.0%	-25	-80%	-1	-15%	T1,T2	D
United Kingdom (KP)	7 325	7 811	7 801	7.8%	476	6%	-10	0%	T2	CS
EU-28 + ISL	**181 470**	**102 125**	**100 076**	**100%**	**-81 394**	**-45%**	**-2 048**	**-2%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'.

Figure 3.132 and Figure 3.133 show CO_2 emissions and implied emission factors for EU-28+ISL as well as the share of the Member States with the highest contributions. The largest emissions are reported by Belgium, France, Germany, Italy, Spain and the United Kingdom; together they cause 81% of the CO_2 emissions from liquid fuels in 1A4b. Fuel consumption in the EU-28+ISL decreased by 45% between 1990 and 2016. The CO_2 implied emission factor for liquid fuels was 72.2 t/TJ in 2016.

Figure 3.132 1A4b Residential, liquid fuels: Emission trend and share for CO_2

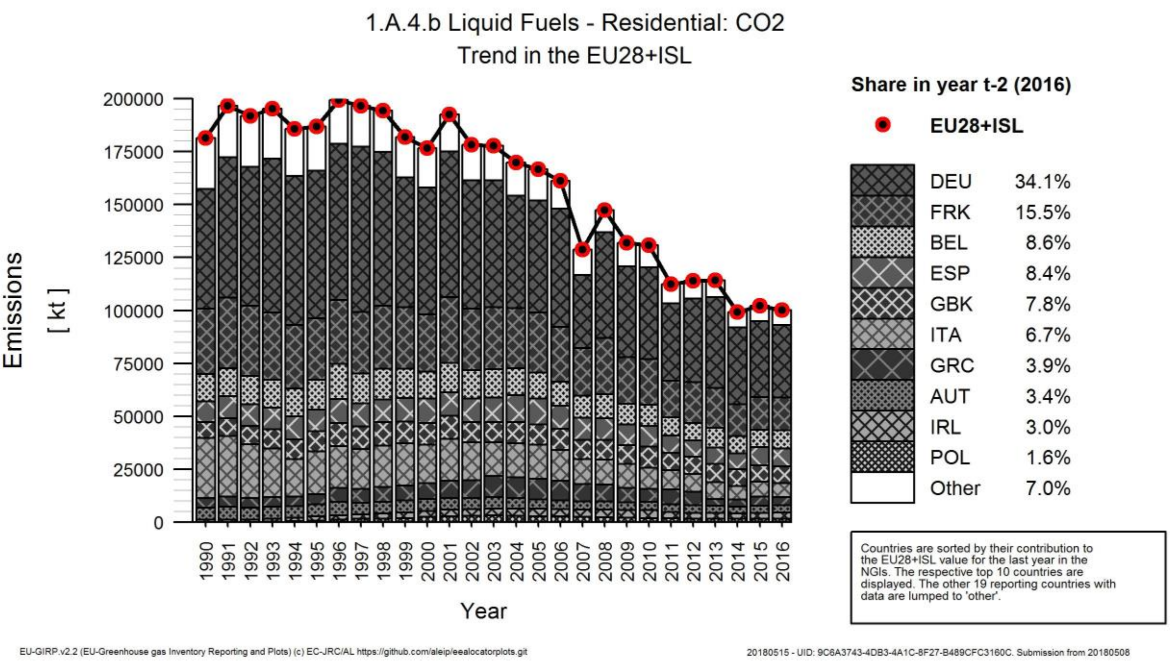
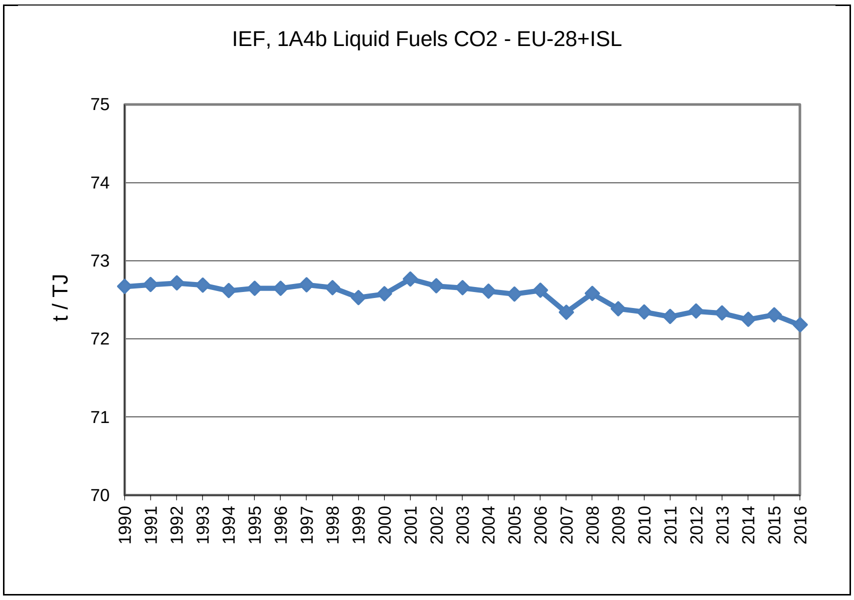
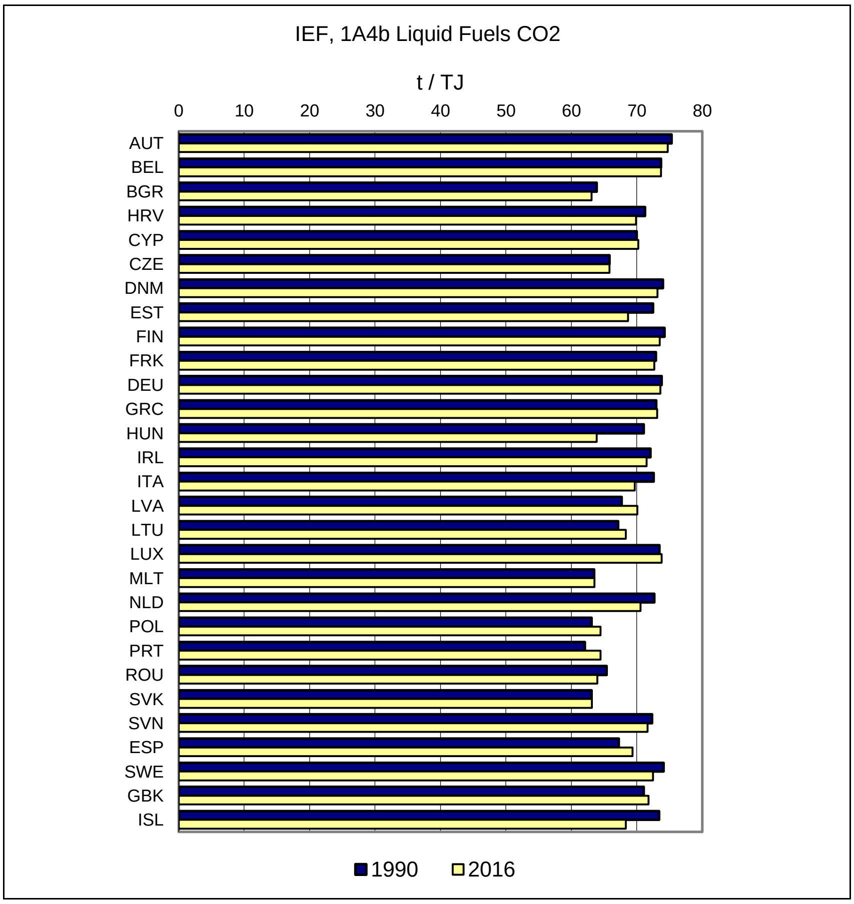


Figure 3.133 1A4b Residential, liquid fuels: Implied Emission Factors for CO_2 (in t/TJ)





1A4b Residential –Solid Fuels (CO_2)

In 2016 CO_2 from solid fuels had a share of 9% within source category 1A4b (compared to 26% in 1990). Between 1990 and 2016 CO_2 emissions decreased by 72% (Table 3.90). All Member States reported decreasing emissions with the highest reductions in absolute terms in Germany, the United Kingdom, the Czech Republic, Hungary and Slovakia. Between 2015 and 2016 CO_2 emissions increased by 4%. Iceland, Cyprus, Malta, Sweden, Italy and Portugal report emissions as 'Not occurring' in 2016. According to the methodology as described in chapter 3.2.4 about 63% of EU-28 emissions are calculated by using higher tier methods in 2016.

Table 3.90 1A4b Residential, solid fuels: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016		Method	Emission factor Informa-tion
	1990	2015	2016		kt CO2	%	kt CO2	%		
Austria	2 511	87	80	0.2%	-2 431	-97%	-7	-8%	T2	CS
Belgium	1 796	237	253	0.7%	-1 543	-86%	17	7%	T1	D
Bulgaria	2 730	533	598	1.6%	-2 132	-78%	65	12%	T1,T2	CS,D
Croatia	436	9	10	0.0%	-427	-98%	0	2%	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	-	-
Czech Republic	16 038	3 756	3 694	9.6%	-12 344	-77%	-63	-2%	T2	CS,D
Denmark	72	NO	0	0.0%	-72	-100%	0	∞	T1	D
Estonia	338	11	8	0.0%	-329	-98%	-3	-27%	-	-
Finland	33	1	1	0.0%	-32	-97%	0	-18%	T1	D
France	3 295	498	598	1.6%	-2 697	-82%	100	20%	-	-
Germany	40 661	2 814	2 690	7.0%	-37 970	-93%	-123	-4%	CS	CS
Greece	89	24	18	0.0%	-70	-79%	-5	-23%	T2	CS
Hungary	8 107	412	515	1.3%	-7 591	-94%	104	25%	T1,T2	CS,D
Ireland	2 483	831	721	1.9%	-1 762	-71%	-109	-13%	T2	CS
Italy	899	NO	NO	-	-899	-100%	-	-	NA	NA
Latvia	606	47	51	0.1%	-555	-92%	4	8%	T2	D
Lithuania	1 440	139	144	0.4%	-1 296	-90%	5	4%	T2	CS
Luxembourg	26	3	2	0.0%	-24	-91%	0	-5%	T1	D
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	61	2	5	0.0%	-57	-93%	2	104%	T1,T2	CS,D
Poland	28 420	24 582	26 026	67.6%	-2 394	-8%	1 444	6%	T1,T2	CS,D
Portugal	NO	NO	NO	-	-	-	-	-	-	-
Romania	2 703	264	213	0.6%	-2 491	-92%	-51	-19%	T1,T2	CS,D
Slovakia	5 441	245	244	0.6%	-5 197	-96%	-1	0%	T2	CS
Slovenia	345	1	1	0.0%	-344	-100%	0	-25%	T1	D
Spain	2 035	436	390	1.0%	-1 645	-81%	-47	-11%	T2	CS
Sweden	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom	16 254	2 254	2 239	5.8%	-14 015	-86%	-15	-1%	T2	CS
EU-28	**136 818**	**37 184**	**38 501**	**100%**	**-98 317**	**-72%**	**1 316**	**4%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	16 283	2 254	2 239	5.8%	-14 044	-86%	-15	-1%	T2	CS
EU-28 + ISL	**136 848**	**37 184**	**38 501**	**100%**	**-98 347**	**-72%**	**1 316**	**4%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'.

Figure 3.134 and Figure 3.135 show CO_2 emissions and implied emission factors for EU-28+ISL as well as the share of the Member States with the highest contributions. The largest emissions are reported by Poland, Germany, the Czech Republic and the United Kingdom; together they cause 90% of the CO_2 emissions from solid fuels in 1A4b. Fuel consumption in the EU-28 decreased by 72% between 1990 and 2016. The CO_2 implied emission factor for solid fuels was 94.9 t/TJ in 2016. The comparatively low IEFs of Italy and Spain in 1990 are due to a high share of gas works gas consumption in the 1990s.

Figure 3.134 1A4b Residential, solid fuels: Emission trend and share for CO_2

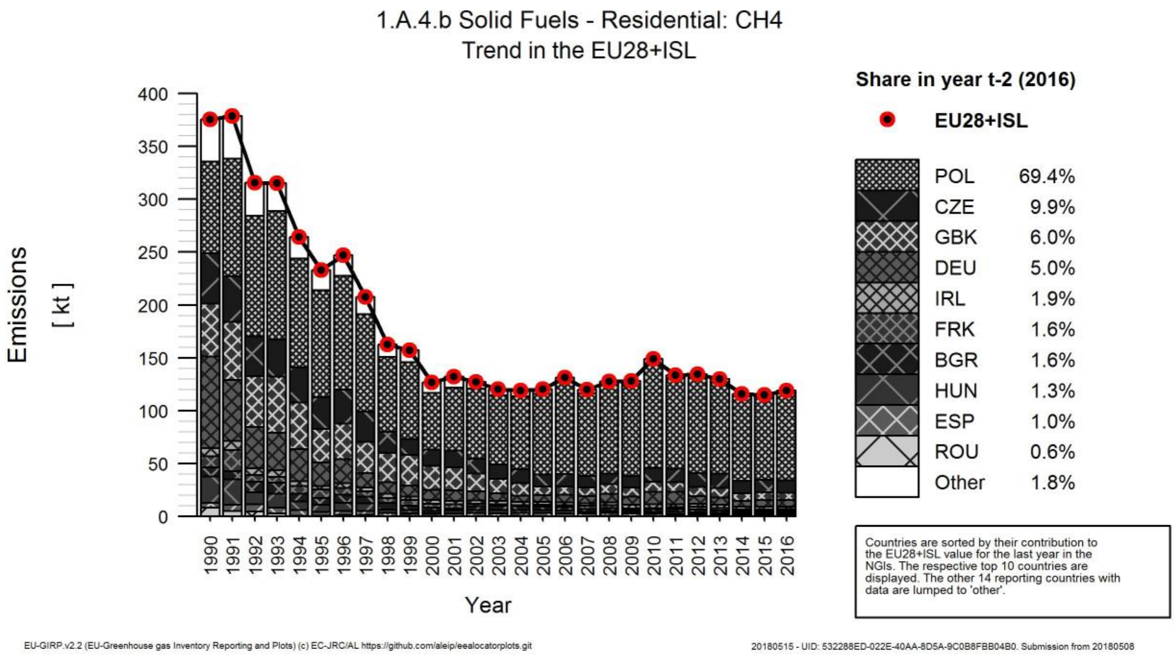
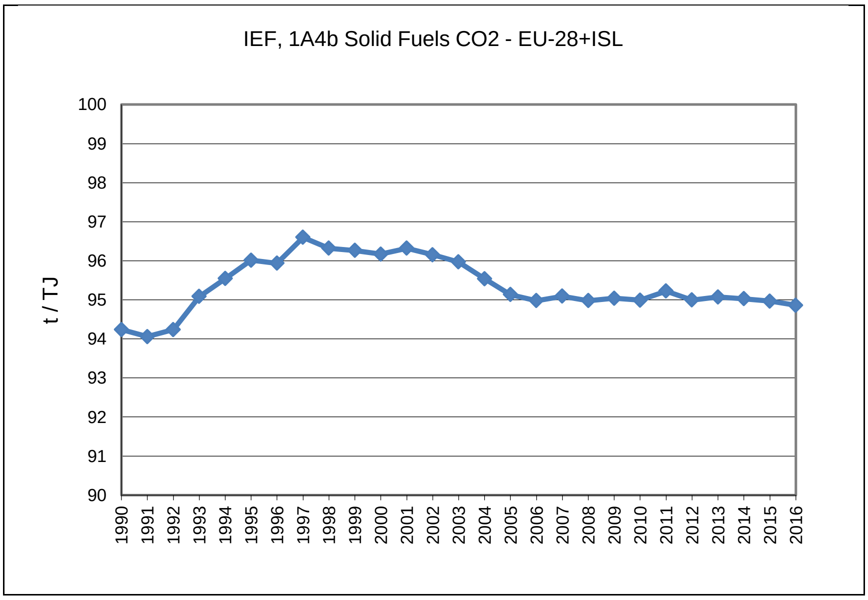
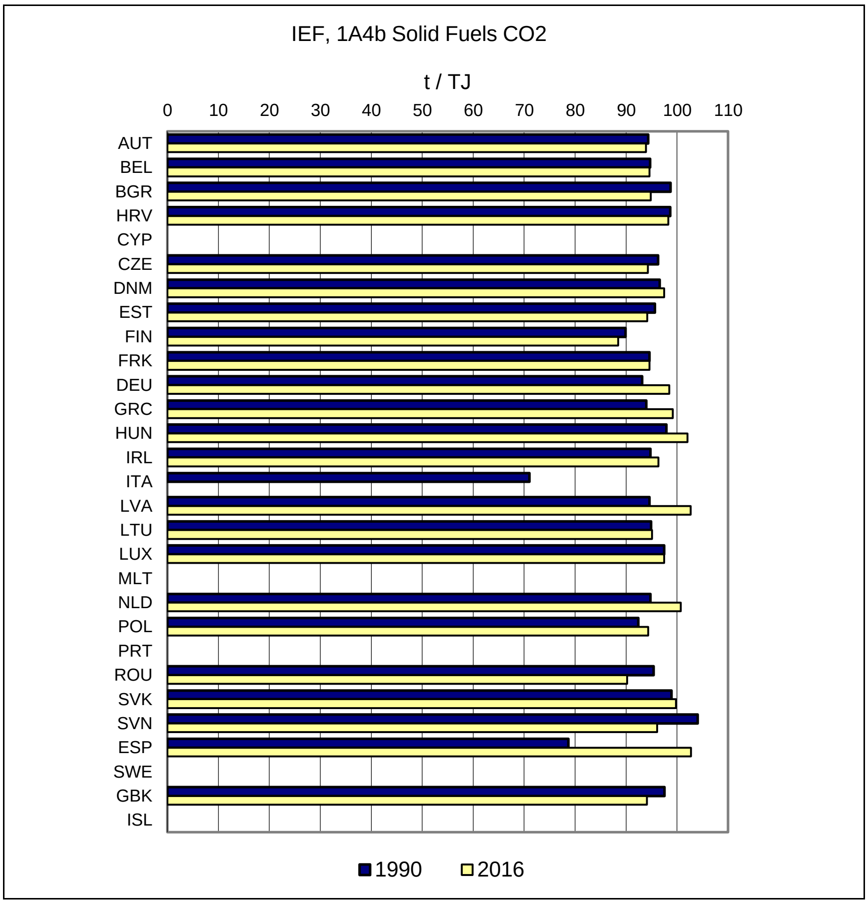


Figure 3.135 1A4b Residential, solid fuels: Implied Emission Factors for CO_2 (in t/TJ)





1A4b Residential – Gaseous Fuels (CO_2)

In 2016, CO_2 from gaseous fuels had a share of 62% within source category 1A4b (compared to 35% in 1990). Between 1990 and 2016, the emissions increased by 40% (Table 3.91). All Member States except Estonia, Lithuania, the Netherlands and Sweden reported increasing emissions. The highest absolute increase occurred in Germany, France, Spain and Italy. Between 2015 and 2016 EU-28+ISL emissions increased by 6%. According to the methodology as described in chapter 3.2.4 about xx% of EU-28 emissions are calculated by using higher tier methods in 2016.

Table 3.91 1A4b Residential, gaseous fuels: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016		Method	Emission factor Informa-tion
	1990	2015	2016		kt CO2	%	kt CO2	%		
Austria	1 847	2 559	2 797	1.1%	950	51%	238	9%	T2	CS
Belgium	5 874	7 543	7 985	3.1%	2 111	36%	442	6%	T1	D
Bulgaria	NO	121	137	0.1%	137	∞	17	14%	T2	CS
Croatia	456	1 048	1 094	0.4%	638	140%	46	4%	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	-	-
Czech Republic	2 098	4 157	4 635	1.8%	2 537	121%	478	12%	T2	CS
Denmark	988	1 428	1 484	0.6%	496	50%	57	4%	T3	CS
Estonia	117	115	131	0.1%	14	12%	16	14%	-	-
Finland	25	60	61	0.0%	35	140%	1	2%	T1	CS
France	20 432	32 735	35 464	13.8%	15 032	74%	2 729	8%	-	-
Germany	31 564	48 178	53 478	20.8%	21 913	69%	5 300	11%	CS	CS
Greece	IE,NO	830	769	0.3%	769	∞	-61	-7%	T2	CS
Hungary	4 152	6 287	6 719	2.6%	2 568	62%	432	7%	T1	D
Ireland	270	1 323	1 317	0.5%	1 047	388%	-6	0%	T2	CS
Italy	26 211	40 687	41 304	16.0%	15 093	58%	617	2%	T2	CS
Latvia	221	225	251	0.1%	30	14%	26	12%	T2	CS
Lithuania	509	285	339	0.1%	-170	-33%	54	19%	T2	CS
Luxembourg	170	522	520	0.2%	350	207%	-2	0%	T2	CS
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	19 896	16 117	16 793	6.5%	-3 102	-16%	676	4%	T1,T2	CS,D
Poland	6 750	7 328	8 045	3.1%	1 296	19%	717	10%	T2	CS
Portugal	NO	620	593	0.2%	593	∞	-27	-4%	-	-
Romania	5 228	5 215	5 319	2.1%	91	2%	104	2%	T2	CS
Slovakia	1 628	2 446	2 493	1.0%	864	53%	46	2%	T2	CS
Slovenia	25	240	266	0.1%	241	960%	27	11%	T2	CS
Spain	918	7 139	8 213	3.2%	7 294	794%	1 074	15%	T2	CS,D
Sweden	86	72	79	0.0%	-7	-9%	7	9%	T1	CS
United Kingdom	54 476	54 796	57 297	22.2%	2 821	5%	2 501	5%	T2	CS
EU-28	**183 941**	**242 076**	**257 583**	**100%**	**73 643**	**40%**	**15 507**	**6%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	54 476	54 845	57 347	22.3%	2 871	5%	2 502	5%	T2	CS
EU-28 + ISL	**183 941**	**242 125**	**257 633**	**100%**	**73 693**	**40%**	**15 508**	**6%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'.

Figure 3.136 show CO_2 emissions for EU-28 and the Member States as well as the share of the Member States with the highest contributions. The largest emissions are reported by the United Kingdom, Germany, Italy and France; together they cause 73% of the CO_2 emissions from gaseous fuels in 1A4b. Fuel consumption in the EU-28+ISL rose 39% between 1990 and 2016. The CO_2 implied emission factor for gaseous fuels was 56.5 t/TJ in 2016.

Figure 3.136   1A4b Residential, gaseous fuels: Emission trend and share for CO_2

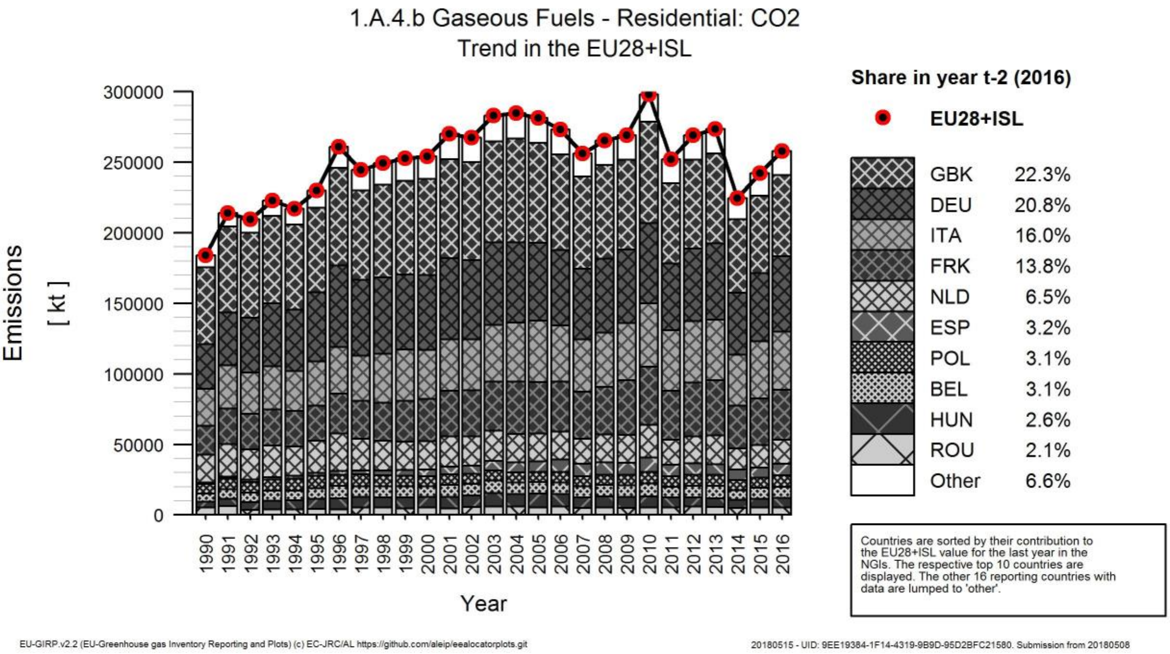
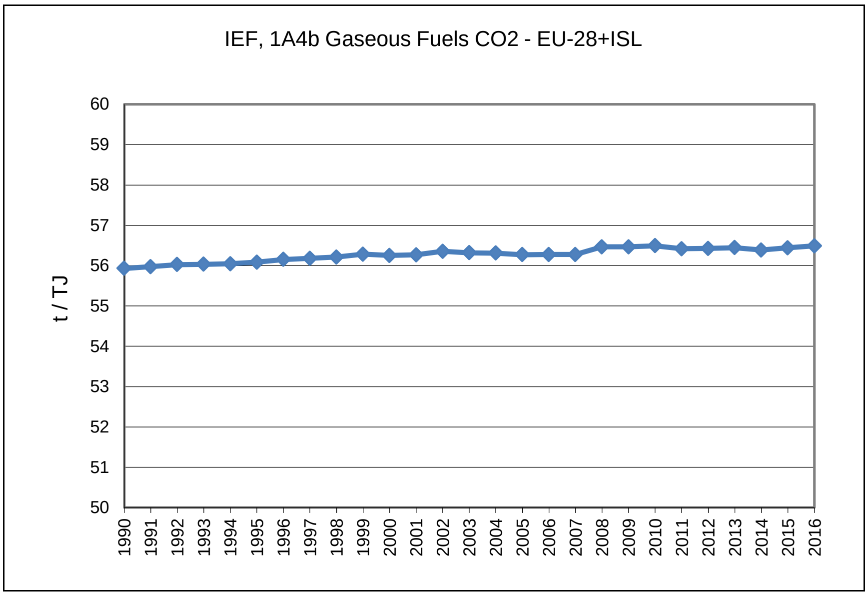
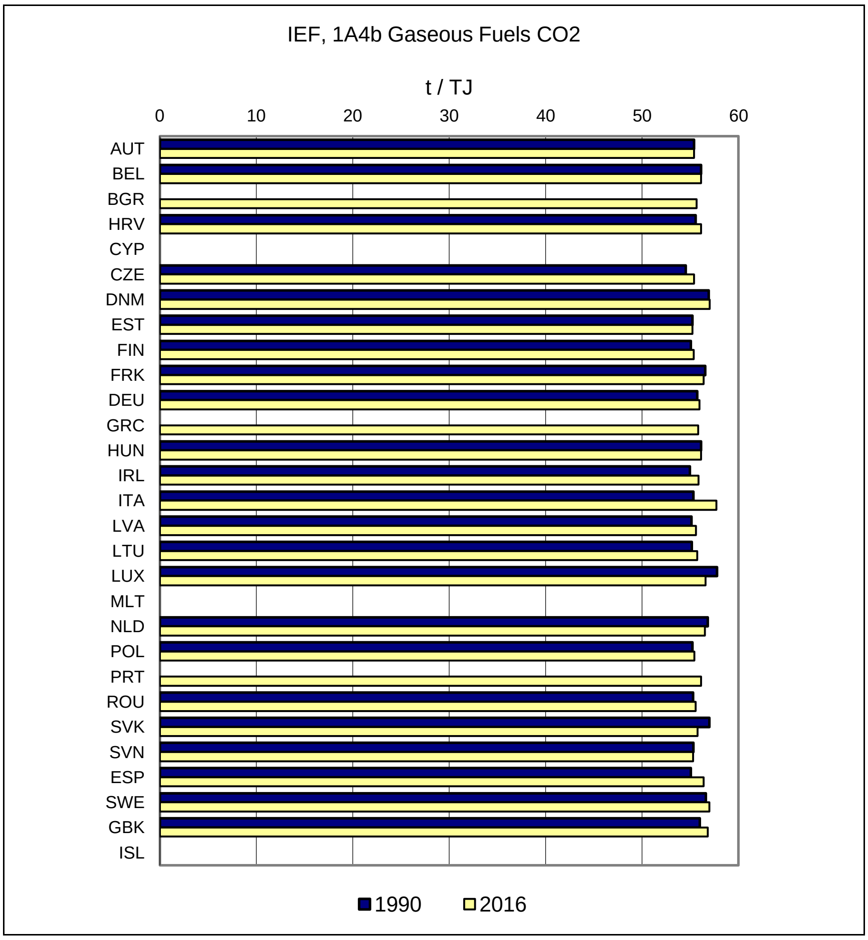


Figure 3.137   1A4b Residential, gaseous fuels: Implied Emission Factors for CO_2 (in t/TJ)





CH_4 emissions from 1A4b Residential

CH_4 emissions mainly occur from incomplete biomass and coal combustion. CH_4 emissions from 1A4b Residential accounted for 0.3% of total GHG emissions in 2016. Between 1990 and 2016, CH_4 emissions from households decreased by 27% in the EU-28 (Table 3.92). France, Germany, the Check Republic and the United Kingdom reported the highest decrease in emissions while Italy, Poland and Romania reported the highest increase in emissions. Between 2015 and 2016 CH_4 emissions increased by 2%.

Table 3.92 1A4b Residential: Member States' contributions to CH_4 emissions and information on method applied and emission factor

Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016		Method	Emission factor Informa-tion
	1990	2015	2016		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	443	230	235	1.6%	-207	-47%	5	2%	T1,T2,T3	CS,D
Belgium	233	252	283	1.9%	50	21%	31	12%	CS,T1,T3	CR,D
Bulgaria	262	267	286	1.9%	24	9%	19	7%	T1	D
Croatia	354	369	359	2.4%	5	1%	-10	-3%	T1	D
Cyprus	2	3	3	0.0%	1	69%	0	1%	T1	D
Czech Republic	1 515	862	865	5.9%	-651	-43%	2	0%	T1	D
Denmark	122	112	110	0.7%	-13	-11%	-3	-2%	M,T1,T2,T3	CS,D,OTH
Estonia	95	116	122	0.8%	27	29%	6	5%	T1	D
Finland	198	154	167	1.1%	-31	-16%	13	8%	CS,M,T1,T2	CS,D
France	4 666	1 255	1 321	9.0%	-3 345	-72%	66	5%	T1,T2	CS,D
Germany	2 484	777	825	5.6%	-1 659	-67%	48	6%	T2,T3	CS,M
Greece	94	107	96	0.7%	3	3%	-10	-10%	T1	D
Hungary	829	600	594	4.0%	-234	-28%	-5	-1%	T1	D
Ireland	443	151	141	1.0%	-301	-68%	-9	-6%	T1	D
Italy	1 095	2 197	2 123	14.5%	1 028	94%	-74	-3%	T2	CR
Latvia	149	88	86	0.6%	-63	-42%	-1	-2%	T1,T2	CS,D
Lithuania	175	149	149	1.0%	-27	-15%	0	0%	T1,T2	CS,D
Luxembourg	9	10	11	0.1%	2	24%	1	7%	T1,T3	D,M
Malta	0	0	0	0.0%	0	58%	0	-24%	T1	D
Netherlands	457	431	446	3.0%	-10	-2%	15	3%	T1,T2	CS,D
Poland	2 445	2 785	2 926	19.9%	481	20%	141	5%	T1	D
Portugal	410	243	243	1.7%	-167	-41%	0	0%	-	-
Romania	407	962	965	6.6%	558	137%	3	0%	T1	D
Slovakia	452	175	164	1.1%	-288	-64%	-11	-6%	T1,T2	D
Slovenia	128	148	154	1.0%	26	20%	6	4%	T1	D
Spain	794	861	859	5.9%	65	8%	-1	0%	T2	D
Sweden	284	252	252	1.7%	-31	-11%	0	0%	M,T1	CS
United Kingdom	1 496	883	896	6.1%	-601	-40%	12	1%	T1,T2,T3	CS,D
EU-28	**20 041**	**14 437**	**14 681**	**100%**	**-5 360**	**-27%**	**244**	**2%**	**-**	**-**
Iceland	0	0	0	0.0%	0	-84%	0	-19%	T1,T2	D
United Kingdom (KP)	1 499	885	897	6.1%	-602	-40%	12	1%	T1,T2,T3	CS,D
EU-28 + ISL	**20 044**	**14 439**	**14 683**	**100%**	**-5 362**	**-27%**	**244**	**2%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'.

1A4b Residential – Biomass (CH_4)

In 2016 CH_4 from biomass had a share of 2.6% within source category 1A4b (compared to 1.8% in 1990). Between 1990 and 2016 CH_4 emissions increased by 14% (Table 3.93). France reported the highest absolute decrease, while CH_4 emissions of Italy, Romania, Poland and the United Kingdom increased significantly. Between 2015 and 2016, CH_4 emissions increased by 1%. According to the methodology as described in chapter 3.2.4 about 43% of EU-28 emissions are calculated by using higher tier methods in 2016.

Table 3.93 1A4b Residential, biomass: Member States' contributions to CH_4 emissions

Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016		Method	Emission factor Informa-tion
	1990	2015	2016		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	228	213	219	2.0%	-10	-4%	5	3%	T1,T2	CS
Belgium	97	217	247	2.3%	151	156%	31	14%	T1	CR
Bulgaria	54	225	238	2.2%	184	340%	13	6%	T1	NA
Croatia	316	365	354	3.3%	38	12%	-11	-3%	T1	NA
Cyprus	1	2	2	0.0%	1	111%	0	1%	-	-
Czech Republic	324	554	560	5.2%	236	73%	6	1%	T1	-
Denmark	113	109	108	1.0%	-6	-5%	-2	-1%	T1,T3	NA
Estonia	40	113	121	1.1%	80	201%	7	6%	-	-
Finland	181	145	158	1.5%	-23	-13%	13	9%	T1	CS
France	4 252	1 084	1 137	10.6%	-3 115	-73%	53	5%	-	-
Germany	280	543	593	5.5%	313	112%	50	9%	T2	CS,M
Greece	85	104	94	0.9%	8	10%	-10	-10%	T1	NA
Hungary	186	554	540	5.0%	353	190%	-14	-3%	T1	NA
Ireland	14	10	10	0.1%	-4	-28%	0	-2%	T1	NA
Italy	996	2 142	2 068	19.3%	1 072	108%	-74	-3%	T2	NA
Latvia	96	82	81	0.8%	-16	-16%	-1	-2%	T2	NA
Lithuania	58	134	132	1.2%	73	125%	-2	-1%	T2	NA
Luxembourg	5	7	8	0.1%	3	64%	1	12%	T1	M
Malta	NO	NO	NO	-	-	-	-	-	NA	-
Netherlands	98	139	142	1.3%	44	45%	3	2%	T1,T2	CS,D
Poland	258	813	836	7.8%	578	225%	23	3%	T1	NA
Portugal	407	241	241	2.3%	-166	-41%	1	0%	-	-
Romania	181	927	934	8.7%	753	417%	7	1%	T1	-
Slovakia	36	152	141	1.3%	105	294%	-11	-7%	T1	-
Slovenia	102	145	152	1.4%	50	49%	6	4%	T1	-
Spain	651	787	789	7.4%	138	21%	2	0%	T2	NA
Sweden	277	248	248	2.3%	-29	-10%	0	0%	T1	NA
United Kingdom	62	558	566	5.3%	504	816%	8	1%	T1	-
EU-28	**9 400**	**10 614**	**10 718**	**100%**	**1 318**	**14%**	**104**	**1%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	-
United Kingdom (KP)	62	558	566	5.3%	504	815%	8	1%	T1	-
EU-28 + ISL	**9 400**	**10 614**	**10 718**	**100%**	**1 318**	**14%**	**104**	**1%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviation'.

Figure 3.138 and

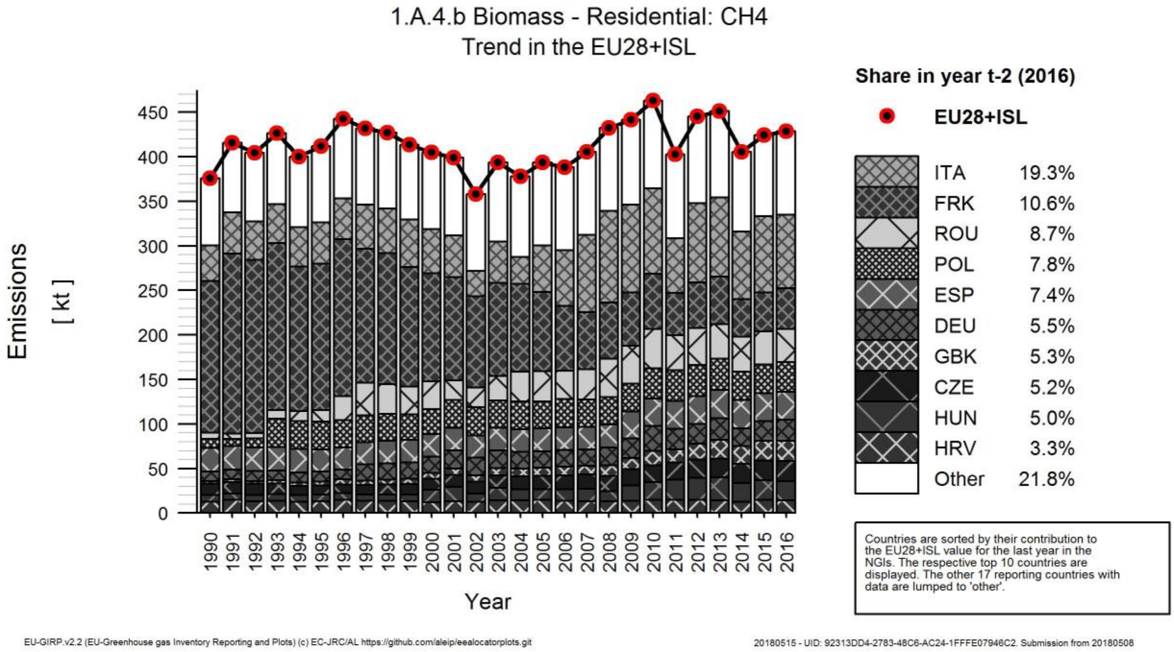


Figure 3.139 show CH_4 emissions and implied emission factors for EU-28+ISL as well as the share of the Member States with the highest contributions. The largest emissions are reported by France, Poland, Italy, Romania and Spain; together they cause 54% of the CH_4 emissions from biomass fuels

in 1A4b. Biomass fuel consumption in the EU-28 rose by 64% between 1990 and 2016. The CH_4 implied emission factor for biomass fuels was 232.5 kg/TJ in 2016.

The implied emission factors are decreasing because old biomass boilers and stoves are replaced by modern technologies (pellets, automatic boilers), which have lower CH_4 (as well as NMVOC) emissions from incomplete combustion. However, this change in improved technologies is not reflected by the member states which are using the default emission factor value (300 kg/TJ) for the whole time series.

Figure 3.138 1A4b Residential, biomass: Emission trend and share for CH_4

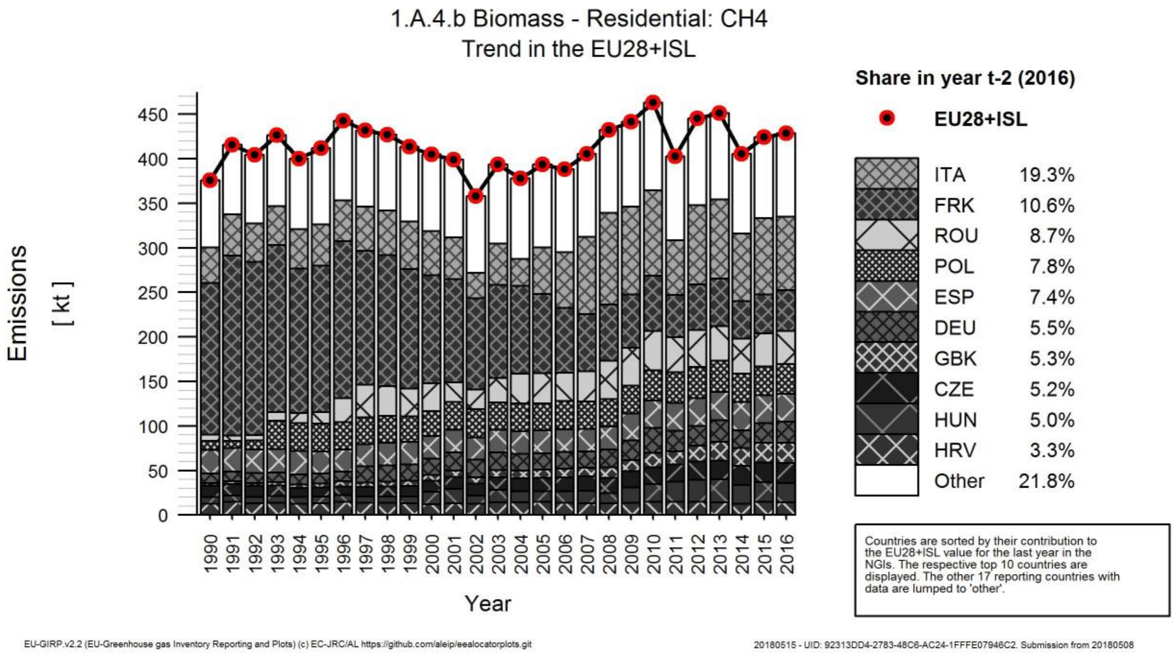
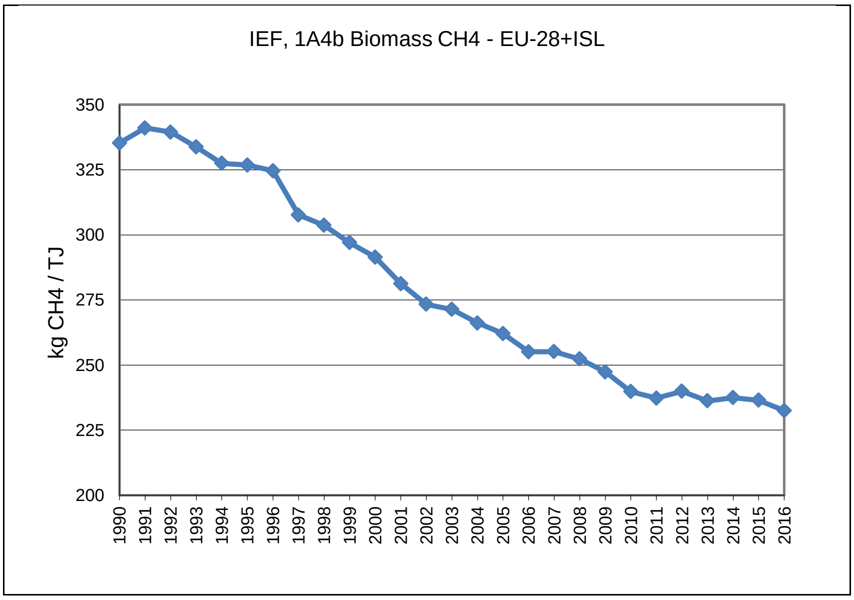
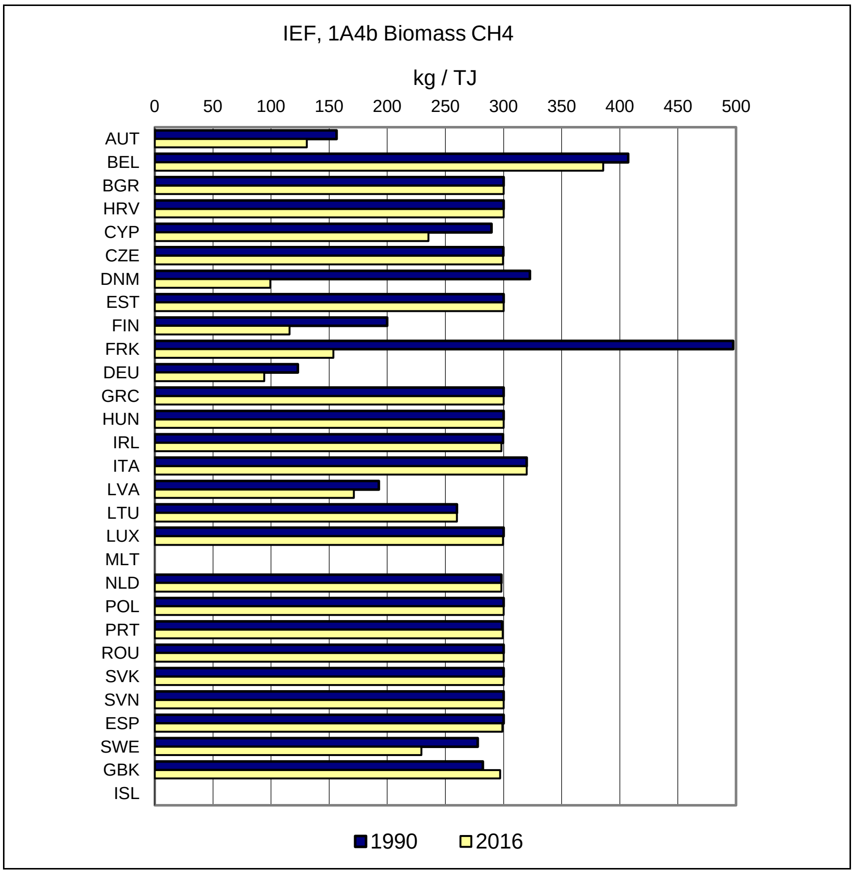


Figure 3.139 1A4b Residential, biomass: Implied Emission Factors for CH_4 (in kg/TJ)





1A4b Residential – Solid Fuels (CH_4)

In 2016 CH_4 from solid fuels had a share of 0.7% within source category 1A4b (compared to 1.8% in 1990). Between 1990 and 2016 CH_4 emissions decreased by 68% (Table 3.93). All Member States reported decreasing emissions since 1990 with Germany, the Czech Republic and the United Kingdom showing the largest absolute decreases. Between 2015 and 2016, CH_4 emissions increased by 4%. According to the methodology as described in chapter 3.2.4 about 10% of EU-28 emissions are calculated by using higher tier methods in 2016.

Table 3.94: 1A4b Residential, solid fuels: Member States' contributions to CH_4 emissions

Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016		Method	Emission factor Informa-tion
	1990	2015	2016		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	200	7	6	0.2%	-193	-97%	-1	-8%	T1	D
Belgium	110	13	14	0.5%	-96	-88%	0	4%	T1	D
Bulgaria	207	42	47	1.6%	-160	-77%	5	13%	T1	D
Croatia	33	1	1	0.0%	-32	-98%	0	4%	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	-	-
Czech Republic	1 186	299	294	9.9%	-892	-75%	-5	-2%	T1	D
Denmark	6	NO	0	0.0%	-6	-100%	0	∞	T1	D
Estonia	26	1	1	0.0%	-26	-98%	0	-27%	-	-
Finland	3	0	0	0.0%	-3	-97%	0	-18%	T1	D
France	261	39	47	1.6%	-214	-82%	8	20%	-	-
Germany	2 168	159	150	5.0%	-2 018	-93%	-9	-5%	T2	CS
Greece	7	2	1	0.0%	-6	-81%	0	-23%	T1	D
Hungary	621	30	38	1.3%	-583	-94%	8	27%	T1	D
Ireland	197	65	56	1.9%	-140	-71%	-9	-13%	T1	D
Italy	10	NO	NO	-	-10	-100%	-	-	NA	NA
Latvia	48	4	4	0.1%	-44	-92%	0	-1%	T1	D
Lithuania	114	11	11	0.4%	-102	-90%	0	4%	T1	D
Luxembourg	2	0	0	0.0%	-2	-91%	0	-5%	T1	D
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	0	0	0	0.0%	0	-43%	0	133%	T1,T2	CS,D
Poland	2 172	1 952	2 069	69.4%	-104	-5%	117	6%	T1	D
Portugal	NO	NO	NO	-	-	-	-	-	-	-
Romania	212	22	18	0.6%	-195	-92%	-4	-19%	T1	D
Slovakia	412	17	17	0.6%	-396	-96%	0	-3%	T2	D
Slovenia	25	0	0	0.0%	-25	-100%	0	-25%	T1	D
Spain	116	32	28	1.0%	-87	-75%	-3	-11%	T2	D
Sweden	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom	1 249	179	178	6.0%	-1 071	-86%	-1	0%	T1,T2	CS,D
EU-28	**9 385**	**2 874**	**2 981**	**100%**	**-6 404**	**-68%**	**107**	**4%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	1 252	179	178	6.0%	-1 073	-86%	-1	0%	T1,T2	CS,D
EU-28 + ISL	**9 387**	**2 874**	**2 981**	**100%**	**-6 406**	**-68%**	**107**	**4%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'.

Figure 3.138 and

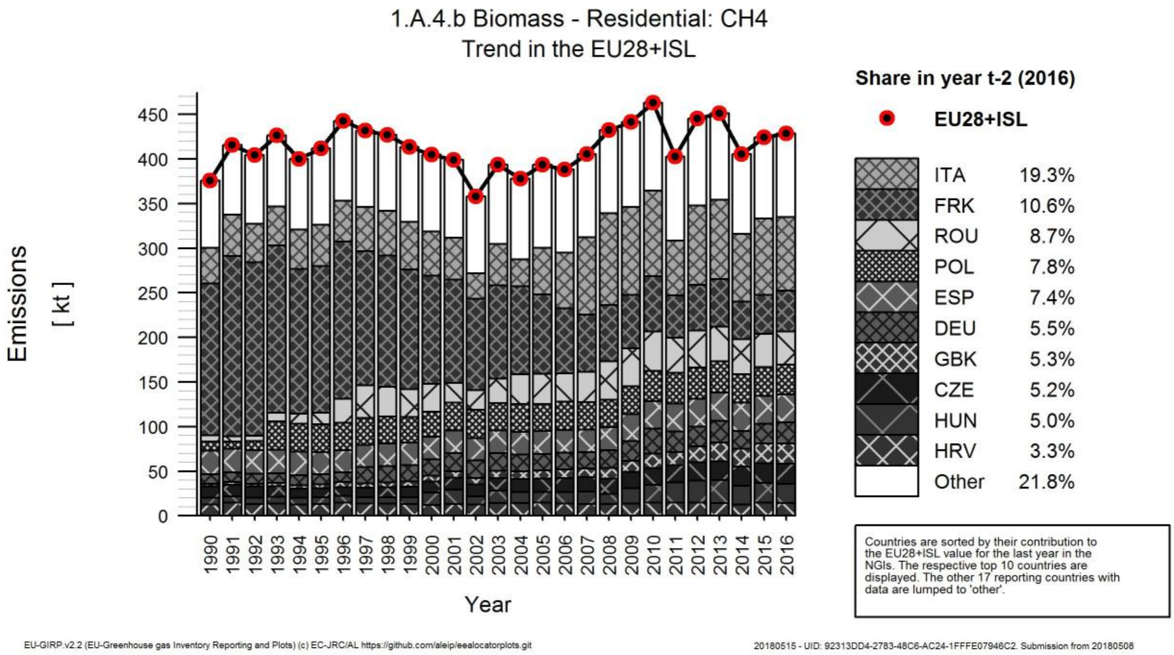


Figure 3.139 show CH_4 emissions and implied emission factors for EU-28+ISL as well as the share of the Member States with the highest contributions. The largest emissions are reported by Poland with a share of 69% of total CH_4 emissions from solid fuels in 1A4b. Solid fuel consumption in the EU-28 decreased by 72% between 1990 and 2016. The CH_4 implied emission factor for solid fuels was 293.8 kg/TJ in 2016.

Figure 3.140: 1A4b Residential, solid fuels: Emission trend and share for CH_4

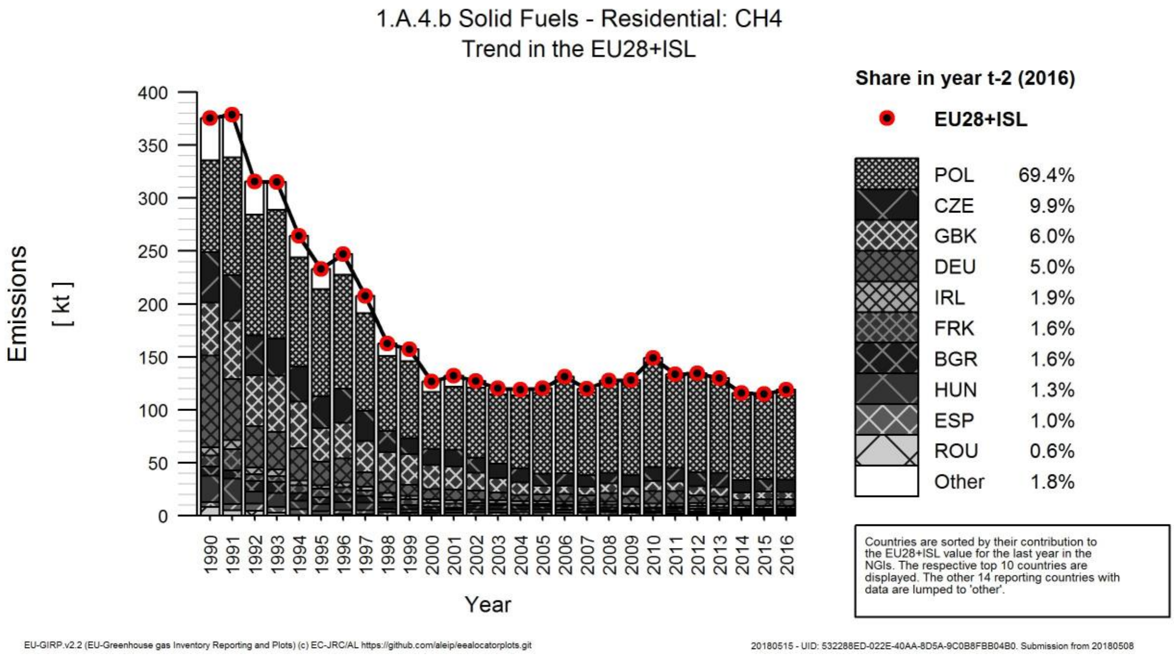
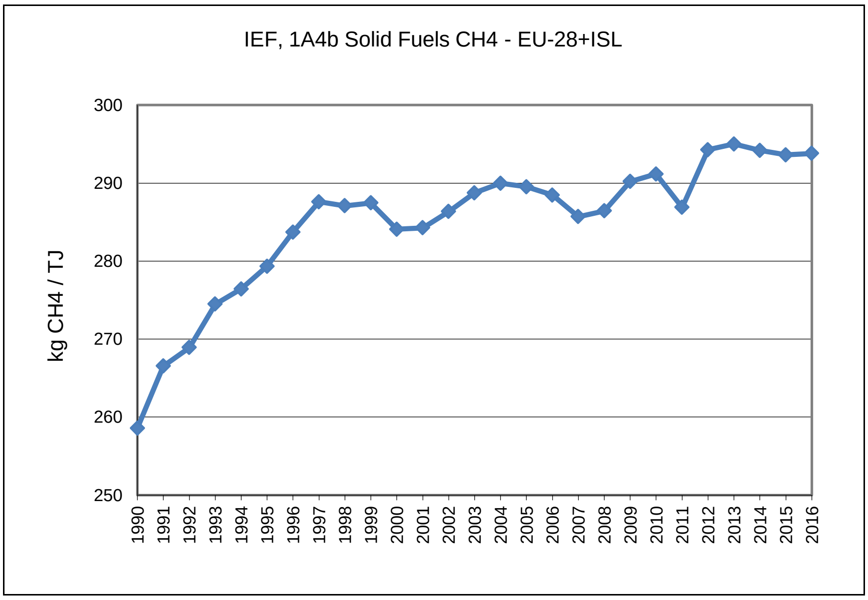
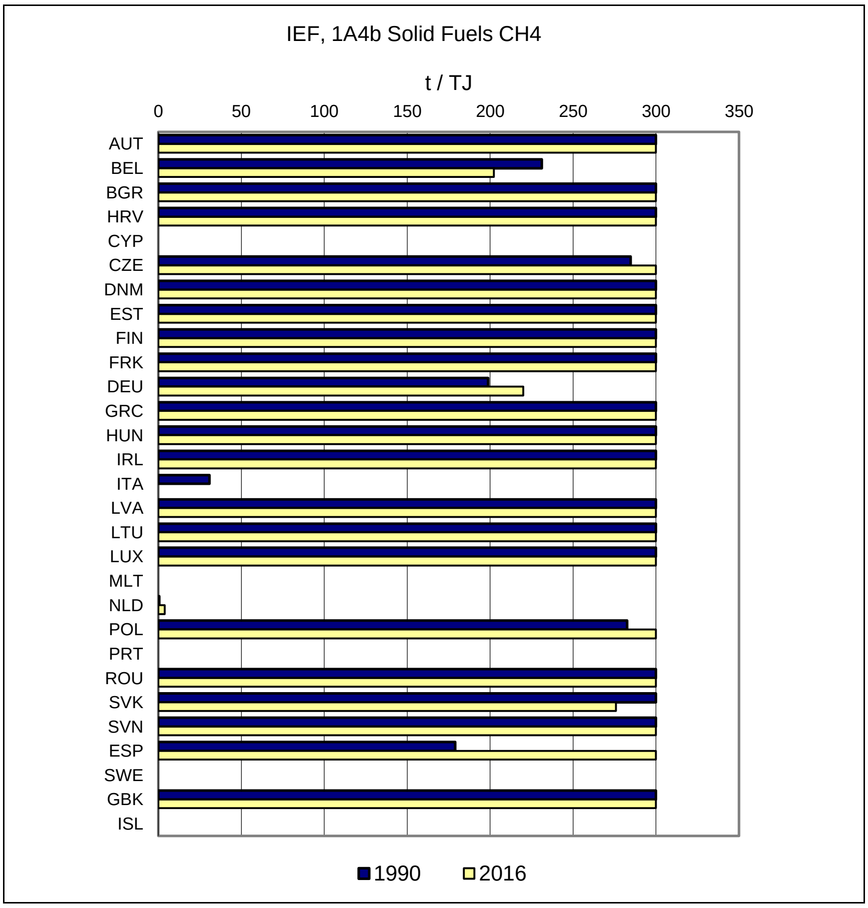


Table 3.95: 1A4b Residential, solid fuels: Implied Emission Factors for CH_4 (in kg/TJ)



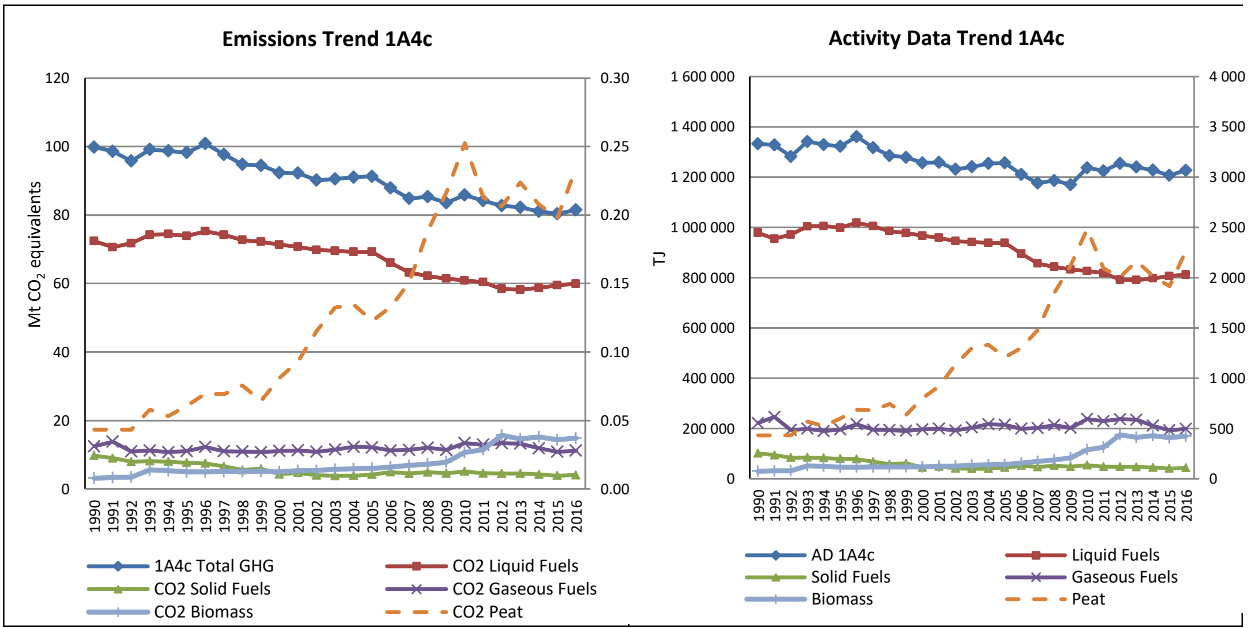


3.2.4.3 Agriculture/Forestry/Fisheries (1A4c)

In this chapter information about emission trends, Member States' contribution and activity data is provided for category 1A4c by fuels. CO_2 emissions from 1A4c Agriculture/Forestry/Fisheries accounted for 1.8% of total EU-28+ISL GHG emissions in 2016. Between 1990 and 2016, CO_2 emissions from 1A4c Agriculture/Forestry/Fisheries decreased by 20% in the EU-28+ISL (Table 3.96).

Figure 3.141 shows the emission trend within source category 1A4c, which is mainly dominated by CO_2 emissions from liquid fuels. Total GHG emissions decreased by 18%, mainly due to decreases in CO_2 emissions from liquid fuels (-17%).

Figure 3.141 1A4c Agriculture/Forestry/Fisheries: Total and CO_2 emission trends



Data displayed as dashed line refers to the secondary axis.

The five Member States, France, Poland, Italy, the Netherlands and Spain together contributed 64% to the emissions from this source in 2015. Spain and Poland were the Member States with the highest increase in absolute terms between 1990 and 2016, while the highest decreases were achieved in the Czech Republic, Germany and Greece.

Table 3.96 1A4c Agriculture/Forestry/Fisheries: Member States' contributions to CO_2 emissions and information on method applied and emission factor

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016		Method	Emission factor Informa-tion
	1990	2015	2016		kt CO2	%	kt CO2	%		
Austria	1 253	808	818	1.1%	-435	-35%	11	1%	D,T1,T2,T3	CS,D
Belgium	3 033	2 021	2 177	2.9%	-856	-28%	156	8%	CS,T1,T3	D
Bulgaria	1 652	465	429	0.6%	-1 224	-74%	-36	-8%	T1,T2	CS,D
Croatia	835	633	638	0.8%	-197	-24%	5	1%	T1	D
Cyprus	55	82	79	0.1%	24	43%	-3	-4%	T1	D
Czech Republic	3 790	1 197	1 213	1.6%	-2 577	-68%	16	1%	T1,T2	CS,D
Denmark	2 590	1 530	1 547	2.0%	-1 043	-40%	17	1%	M,T1,T2,T3	CS,D
Estonia	495	318	272	0.4%	-223	-45%	-46	-14%	T1,T2	CS,D
Finland	1 863	1 358	1 338	1.8%	-525	-28%	-20	-1%	M,T1,T2,T3	CS,D
France	11 357	11 008	11 012	14.6%	-345	-3%	4	0%	T1,T2	CS,D
Germany	10 270	5 977	6 114	8.1%	-4 156	-40%	137	2%	CS,T1,T2,T3	CS,D
Greece	2 893	499	431	0.6%	-2 462	-85%	-69	-14%	T1,T2	CS,D
Hungary	2 656	1 351	1 490	2.0%	-1 166	-44%	139	10%	T1,T2	CS,D
Ireland	747	530	548	0.7%	-199	-27%	18	3%	T1,T2	CS,D
Italy	8 352	6 933	7 008	9.3%	-1 344	-16%	75	1%	T2	CS
Latvia	1 588	387	415	0.5%	-1 174	-74%	27	7%	T1,T2	CS,D
Lithuania	1 483	195	204	0.3%	-1 279	-86%	9	5%	T2	CS
Luxembourg	34	23	23	0.0%	-11	-33%	0	1%	T1,T2	CS,D
Malta	4	11	12	0.0%	8	196%	1	6%	T1	D
Netherlands	9 846	9 016	9 033	12.0%	-813	-8%	17	0%	T1,T2	CS,D
Poland	8 507	9 303	9 875	13.1%	1 368	16%	572	6%	T1,T2	CS,D
Portugal	1 679	1 050	1 066	1.4%	-613	-36%	16	2%	T1,T2	CR,D
Romania	1 994	1 078	1 127	1.5%	-867	-43%	49	5%	T1,T2	CS,D
Slovakia	146	351	348	0.5%	202	138%	-3	-1%	T1,T2	CS,D
Slovenia	334	218	217	0.3%	-117	-35%	-1	0%	T1	D
Spain	8 678	11 312	11 406	15.1%	2 728	31%	94	1%	T1,T2,T3	S,D,M,OTH
Sweden	1 766	1 452	1 370	1.8%	-395	-22%	-81	-6%	T1,T2	CS
United Kingdom	5 978	4 745	4 781	6.3%	-1 197	-20%	36	1%	T1,T2,T3	CS,D
EU-28	**93 880**	**73 851**	**74 991**	**99%**	**-18 889**	**-20%**	**1 140**	**2%**	**-**	**-**
Iceland	738	618	516	0.7%	-222	-30%	-102	-16%	T1	D
United Kingdom (KP)	5 989	4 752	4 788	6.3%	-1 201	-20%	36	1%	T1,T2,T3	CS,D
EU-28 + ISL	**94 629**	**74 476**	**75 514**	**100%**	**-19 115**	**-20%**	**1 038**	**1%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'.

1A4c Agriculture/Forestry/Fisheries – Liquid Fuels (CO_2)

In 2016 CO_2 from liquid fuels had a share of 74% within source category 1A4c (compared to 72% in 1990). Between 1990 and 2016 CO_2 decreased by 17% (Table 3.97). Six Member States reported increasing emissions with the highest increases in absolute terms in Spain, Poland and Romania. Between 2015 and 2016 EU-28+ISL emissions increased by 1%. According to the methodology as described in chapter 3.2.4 about 63% of EU-28 emissions are calculated by using higher tier methods in 2016.

Table 3.97 1A4c Agriculture/Forestry/Fisheries, liquid fuels: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016		Method	Emission factor Informa-tion
	1990	2015	2016		kt CO2	%	kt CO2	%		
Austria	1 182	777	785	1.3%	-397	-34%	8	1%	T2	CS
Belgium	2 754	1 120	1 212	2.0%	-1 542	-56%	92	8%	T1	D
Bulgaria	1 498	401	364	0.6%	-1 134	-76%	-38	-9%	T1	D
Croatia	788	592	584	1.0%	-204	-26%	-8	-1%	T1	D
Cyprus	55	82	79	0.1%	24	43%	-3	-4%	T1	D
Czech Republic	1 655	1 045	1 041	1.7%	-613	-37%	-4	0%	T1	CS,D
Denmark	2 225	1 367	1 380	2.3%	-845	-38%	13	1%	T1,T2	CS,D
Estonia	476	313	256	0.4%	-220	-46%	-57	-18%	T1,T2	CS,D
Finland	1 777	1 188	1 137	1.9%	-641	-36%	-51	-4%	T1	CS
France	11 035	10 535	10 503	17.5%	-532	-5%	-32	0%	T1,T2	CS,D
Germany	6 926	5 236	5 306	8.9%	-1 620	-23%	70	1%	CS	CS
Greece	2 882	498	429	0.7%	-2 453	-85%	-69	-14%	T2	CS
Hungary	2 085	1 090	1 141	1.9%	-944	-45%	51	5%	T1	D
Ireland	747	530	548	0.9%	-199	-27%	18	3%	T1,T2	CS,D
Italy	8 300	6 601	6 694	11.2%	-1 606	-19%	93	1%	T2	CS
Latvia	701	342	365	0.6%	-335	-48%	24	7%	T2	CS
Lithuania	1 173	137	143	0.2%	-1 030	-88%	6	5%	T2	CS
Luxembourg	34	23	23	0.0%	-11	-33%	0	1%	NA	NA
Malta	4	11	12	0.0%	8	196%	1	6%	T1	D
Netherlands	2 517	1 857	1 860	3.1%	-656	-26%	4	0%	T1,T2	CS,D
Poland	4 709	5 589	5 928	9.9%	1 219	26%	340	6%	T1	D
Portugal	1 679	1 030	1 045	1.7%	-633	-38%	15	1%	T1	D
Romania	9	885	926	1.5%	917	9790%	41	5%	T1,T2	CS,D
Slovakia	104	277	259	0.4%	155	149%	-18	-6%	T2	CS
Slovenia	334	218	217	0.4%	-117	-35%	-1	0%	NA	NA
Spain	8 635	11 133	11 208	18.7%	2 573	30%	75	1%	T2,T3	D
Sweden	1 576	1 432	1 351	2.3%	-225	-14%	-81	-6%	T1	CS
United Kingdom	5 747	4 564	4 607	7.7%	-1 140	-20%	42	1%	T2	CS
EU-28	**71 606**	**58 872**	**59 404**	**99%**	**-12 202**	**-17%**	**532**	**1%**	**-**	**-**
Iceland	738	618	516	0.9%	-222	-30%	-102	-16%	NA	NA
United Kingdom (KP)	5 757	4 571	4 614	7.7%	-1 144	-20%	42	1%	T2	CS
EU-28 + ISL	**72 355**	**59 497**	**59 927**	**100%**	**-12 428**	**-17%**	**430**	**1%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'.

Figure 3.142 and

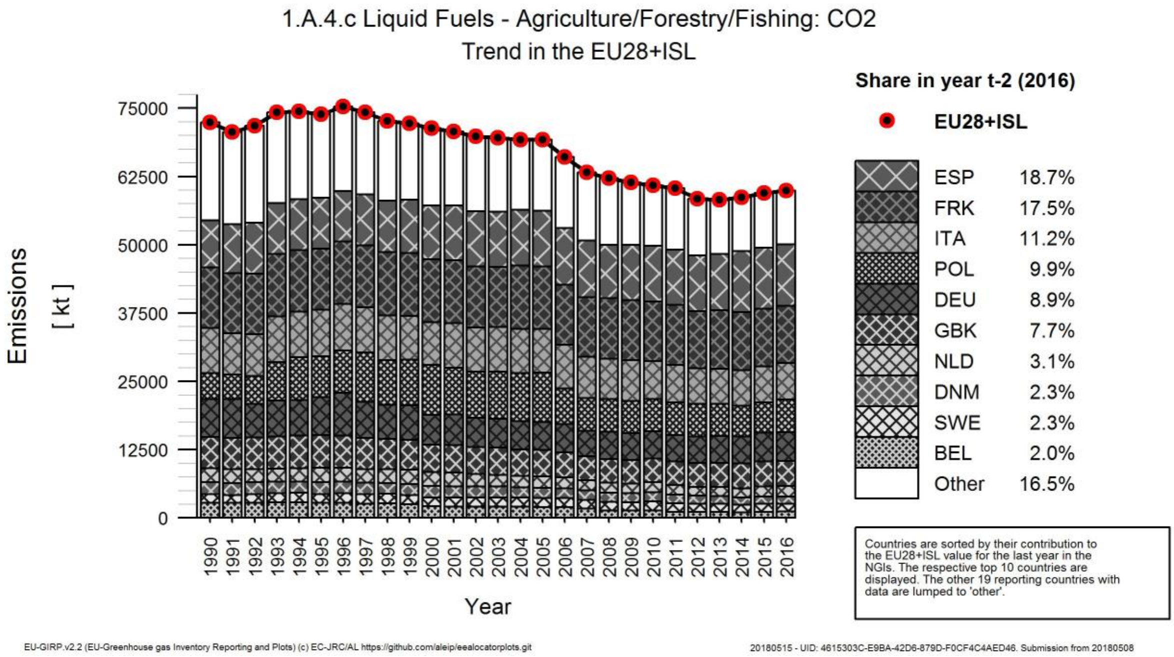


Figure 3.143 show CO_2 emissions and implied emission factors for EU-28+ISL as well as the share of the Member States with the highest contributions. The largest emissions are reported by France,

Germany, Italy, Poland and Spain; together they cause 66% of the CO_2 emissions from liquid fuels in 1A4c. Fuel consumption in the EU-28+ISL decreased by 17% between 1990 and 2016. The CO_2 implied emission factor for liquid fuels was 73.8 t/TJ in 2016.

Figure 3.142 1A4c Agriculture/Forestry/Fisheries, liquid fuels: Emission trend and share for CO_2

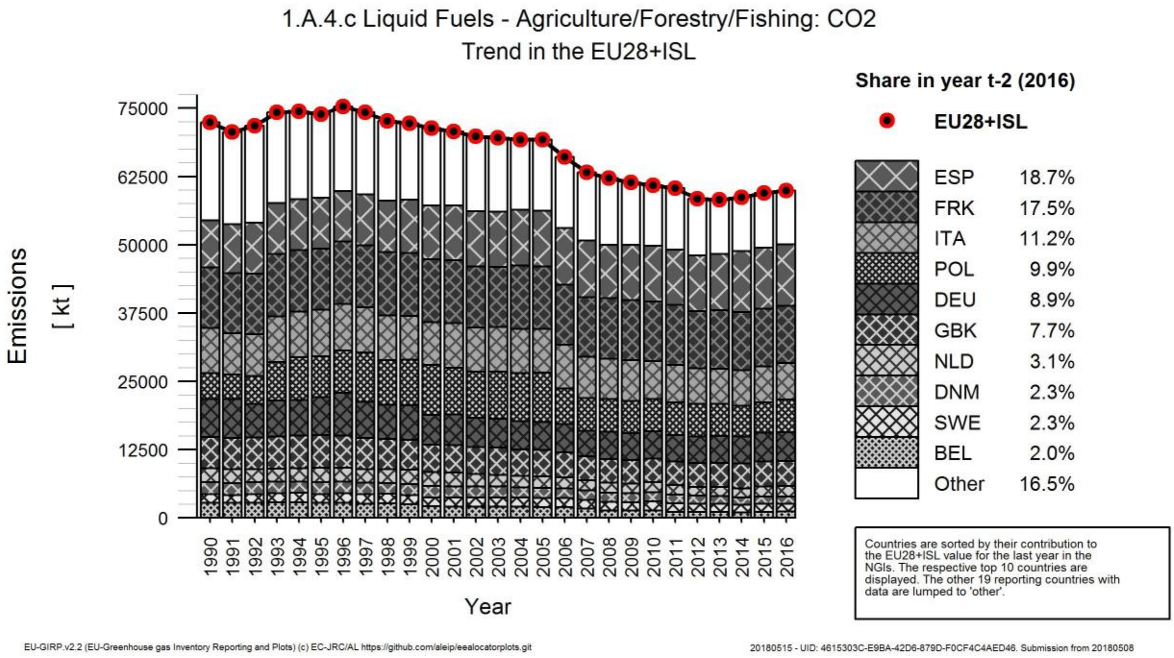
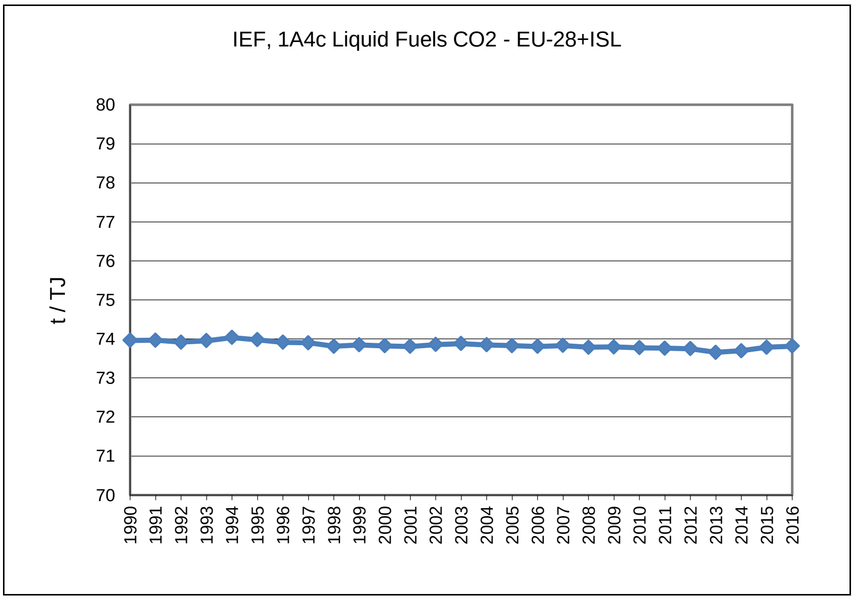
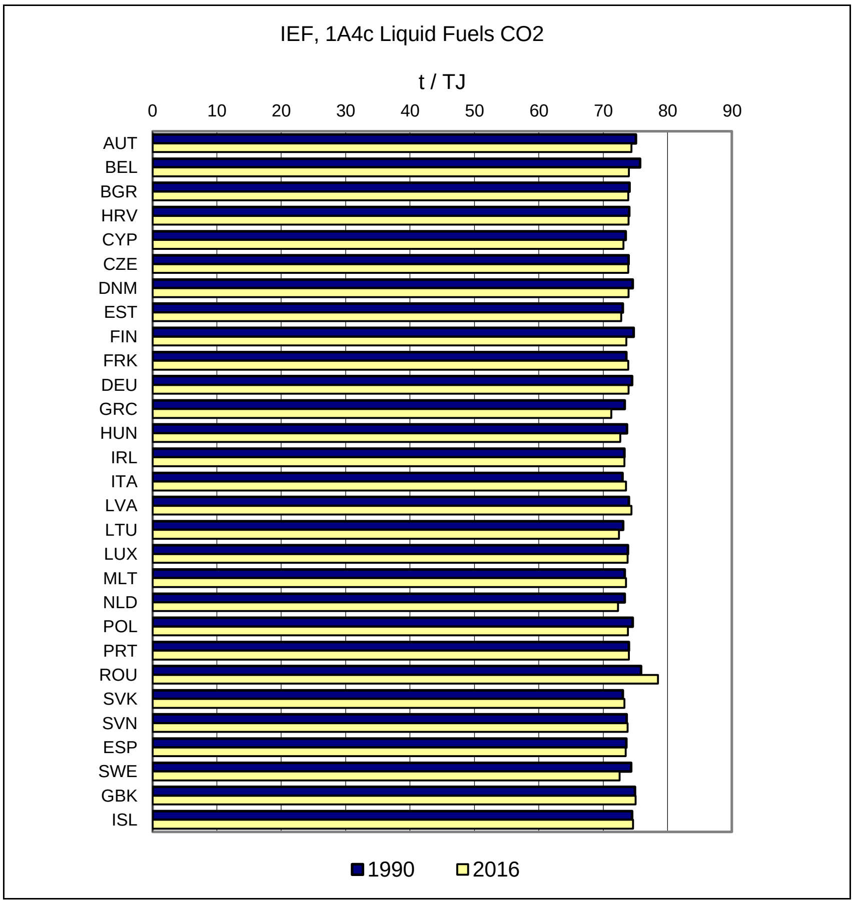


Figure 3.143 1A4c Agriculture/Forestry/Fisheries, liquid fuels: Implied Emission Factors for CO_2 (in t/TJ)





1A4c Agriculture/Forestry/Fisheries – Solid Fuels (CO_2)

In 2016 CO_2 from solid fuels had a share of 5% within source category 1A4c (compared to 10% in 1990). Between 1990 and 2016 CO_2 decreased by 58% (Table 3.98). Fourteen member states and Iceland reported CO_2 emissions from this source category as 'Not occurring' in 2016. All Member States except for Slovakia and Poland reported decreasing emissions between 1990 and 2016. Between 2015 and 2016 EU-28+ISL emissions increased by 6%, mainly due to increases reported by Poland. The strong decrease in 1990 to 1992 emissions is due to the reporting of Germany. According to the methodology as described in chapter 3.2.4 about 50% of EU-28 emissions are calculated by using higher tier methods in 2016.

Table 3.98 1A4c Agriculture/Forestry/Fisheries, solid fuels: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016		Method	Emission factor Informa-tion
	1990	2015	2016		kt CO2	%	kt CO2	%		
Austria	51	2	2	0.0%	-49	-97%	0	0%	T2	CS
Belgium	212	35	35	0.8%	-177	-84%	0	0%	T1	D
Bulgaria	151	27	31	0.8%	-120	-79%	4	13%	T1,T2	CS,D
Croatia	NO	NO	NO	-	-	-	-	-	NA	NA
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czech Republic	1 730	37	30	0.7%	-1 701	-98%	-7	-19%	T2	CS,D
Denmark	238	63	55	1.3%	-184	-77%	-8	-13%	T1	D
Estonia	16	NO	12	0.3%	-4	-27%	12	∞	T1,T2	CS,D
Finland	13	8	8	0.2%	-5	-36%	1	7%	T3	CS
France	NO	NO	NO	-	-	-	-	-	NA	NA
Germany	2 861	60	59	1.4%	-2 802	-98%	-1	-1%	CS	CS
Greece	11	2	2	0.0%	-9	-82%	0	32%	T2	CS
Hungary	134	2	2	0.0%	-132	-99%	0	-3%	T1,T2	CS,D
Ireland	NO	NO	NO	-	-	-	-	-	NA	NA
Italy	NO	NO	NO	-	-	-	-	-	NA	NA
Latvia	102	1	1	0.0%	-101	-99%	0	40%	T2	CS
Lithuania	148	8	9	0.2%	-139	-94%	1	9%	T2	CS
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	NO	NO	NO	-	-	-	-	-	NA	NA
Poland	3 773	3 651	3 874	94.0%	101	3%	223	6%	T1,T2	CS,D
Portugal	NO	NO	NO	-	-	-	-	-	NA	NA
Romania	65	NO	NO	-	-65	-100%	-	-	NA	NA
Slovakia	1	3	3	0.1%	1	88%	0	-10%	T2	CS
Slovenia	NO	NO	NO	-	-	-	-	-	NA	NA
Spain	37	NO	NO	-	-37	-100%	-	-	NA	NA
Sweden	157	NO	NO	-	-157	-100%	-	-	NA	NA
United Kingdom	50	NO	NO	-	-50	-100%	-	-	NA	NA
EU-28	**9 751**	**3 897**	**4 121**	**100%**	**-5 629**	**-58%**	**224**	**6%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	50	NO	NO	-	-50	-100%	-	-	NA	NA
EU-28 + ISL	**9 751**	**3 897**	**4 121**	**100%**	**-5 629**	**-58%**	**224**	**6%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'.

Figure 3.144 and

Figure **3.145** show CO_2 emissions and implied emission factors for EU-28+ISL as well as the share of the Member States with the highest contributions. Poland contributes to 94% of emissions in 2016. Fuel consumption in the EU-28+ISL decreased by 57% between 1990 and 2016. The CO_2 implied emission factor for solid fuels was 94.6 t/TJ in 2016.

Figure 3.144 1A4c Agriculture/Forestry/Fisheries, solid fuels: Emission trend and share for CO_2

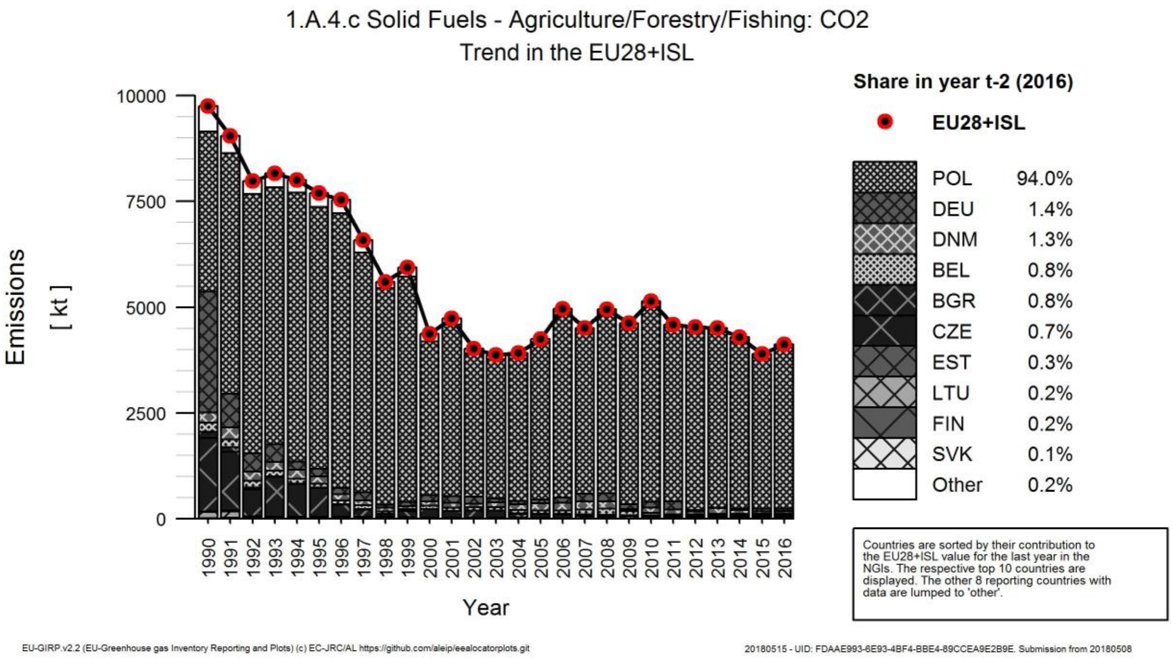
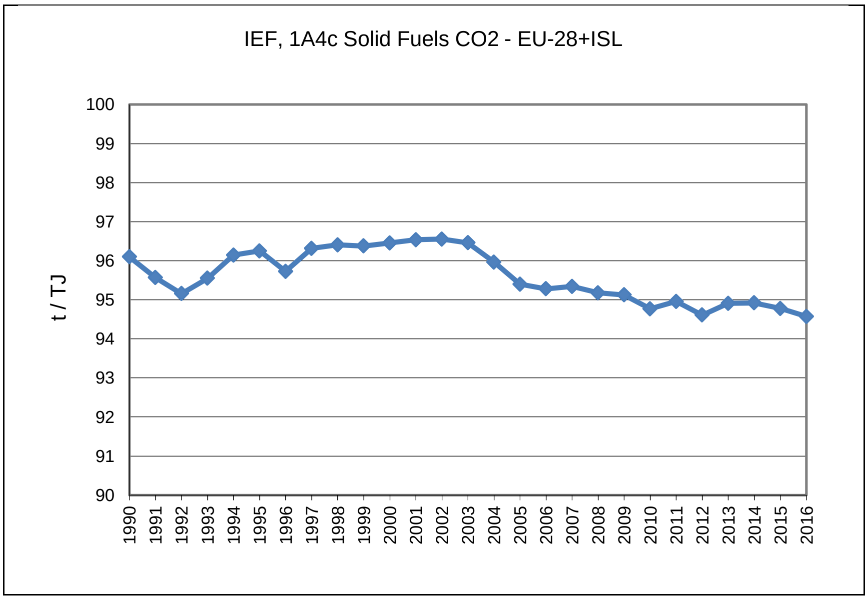
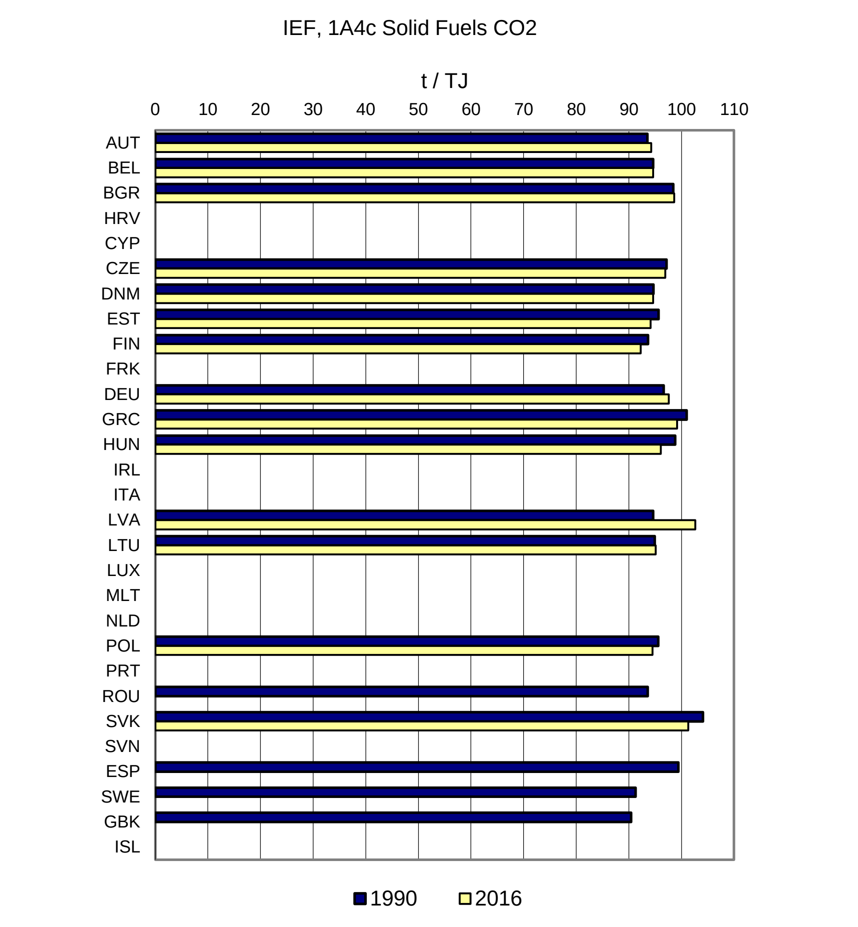


Figure 3.145 1A4c Agriculture/Forestry/Fisheries, solid fuels: Implied Emission Factors for CO_2 (in t/TJ)





1A4c Agriculture/Forestry/Fisheries –Gaseous Fuels (CO_2)

In 2016, CO_2 from gaseous fuels had a share of 14% within source category 1A4c (compared to 13% in 1990). Between 1990 and 2016 CO_2 emissions decreased by 10% (Table 3.99). The highest increase occurred in Spain (+3111%). Between 2015 and 2016 EU-28+ISL emissions increased by 3%. This source is dominated by the Netherlands were natural gas is used for greenhouse horticulture. According to the methodology as described in chapter 3.2.4 about xx% of EU-28 emissions are calculated by using higher tier methods in 2016.

Table 3.99 1A4c Agriculture/Forestry/Fisheries, gaseous fuels: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016		Method	Emission factor Informa-tion
	1990	2015	2016		kt CO2	%	kt CO2	%		
Austria	20	29	32	0.3%	11	56%	3	9%	T2	CS
Belgium	67	867	930	8.3%	863	1281%	64	7%	T1	D
Bulgaria	3	36	34	0.3%	31	935%	-2	-6%	T2	CS
Croatia	48	42	54	0.5%	7	14%	13	31%	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czech Republic	405	115	142	1.3%	-263	-65%	27	24%	T2	CS
Denmark	126	100	112	1.0%	-14	-11%	12	12%	T3	CS
Estonia	4	5	4	0.0%	1	21%	-1	-13%	T2	CS
Finland	32	2	2	0.0%	-30	-93%	0	14%	T1	CS
France	322	473	509	4.5%	187	58%	36	8%	T1,T2	CS,D
Germany	483	682	749	6.7%	266	55%	67	10%	CS	CS
Greece	IE,NO	NO,IE	NO,IE	-	-	-	-	-	NA	NA
Hungary	437	259	347	3.1%	-90	-21%	88	34%	T1	D
Ireland	NO	NO	NO	-	-	-	-	-	NA	NA
Italy	52	332	314	2.8%	262	509%	-18	-5%	T2	CS
Latvia	782	45	48	0.4%	-734	-94%	3	7%	T2	CS
Lithuania	162	48	50	0.4%	-112	-69%	2	3%	T2	CS
Luxembourg	NO	0	0	0.0%	0	∞	0	27%	T2	CS
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	7 329	7 159	7 173	63.9%	-156	-2%	14	0%	T1,T2	CS,D
Poland	25	63	72	0.6%	48	192%	9	14%	T2	CS
Portugal	NO	20	21	0.2%	21	∞	1	6%	T1	D
Romania	1 920	157	159	1.4%	-1 761	-92%	2	2%	T2	CS
Slovakia	41	72	86	0.8%	45	111%	15	20%	T2	CS
Slovenia	NO	NO	NO	-	-	-	-	-	NA	NA
Spain	6	179	198	1.8%	192	3111%	19	11%	T2	CS,D
Sweden	33	20	20	0.2%	-13	-40%	0	1%	T1	CS
United Kingdom	182	181	174	1.6%	-7	-4%	-7	-4%	T2	CS
EU-28	**12 480**	**10 884**	**11 231**	**100%**	**-1 249**	**-10%**	**347**	**3%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	182	181	174	1.6%	-7	-4%	-7	-4%	T2	CS
EU-28 + ISL	**12 480**	**10 884**	**11 231**	**100%**	**-1 249**	**-10%**	**347**	**3%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'.
Greece reports emissions from stationary combustion and off road machinery as 'NO' and emissions from fishing as 'IE.'

Figure 3.146 and

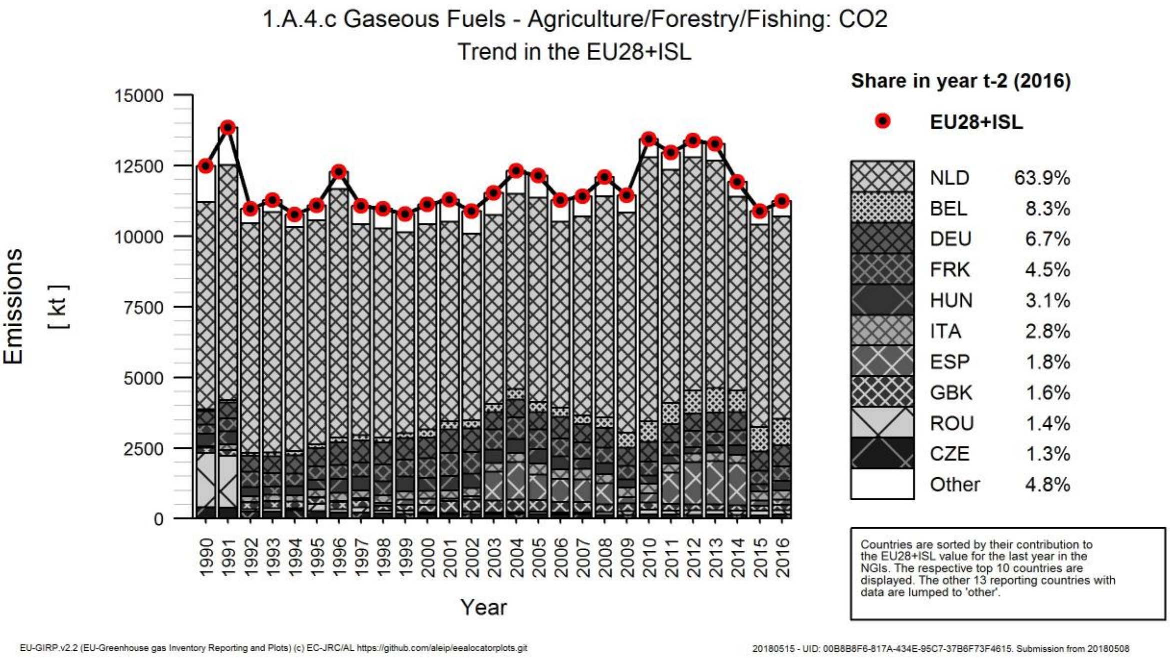


Figure 3.147 show CO_2 emissions and implied emission factors for EU-28+ISL as well as the share of the Member States with the highest contributions. The largest emissions are reported by the Netherlands, France and Germany, accounting for 79% of the CO_2 emissions from gaseous fuels in 1A4c. Fuel consumption in the EU-28+ISL decreased by 10% between 1990 and 2016. The CO_2 implied emission factor for gaseous fuels was 56.4 t/TJ in 2016.

Figure 3.146 1A4c Agriculture/Forestry/Fisheries, gaseous fuels: Emission trend and share for CO_2

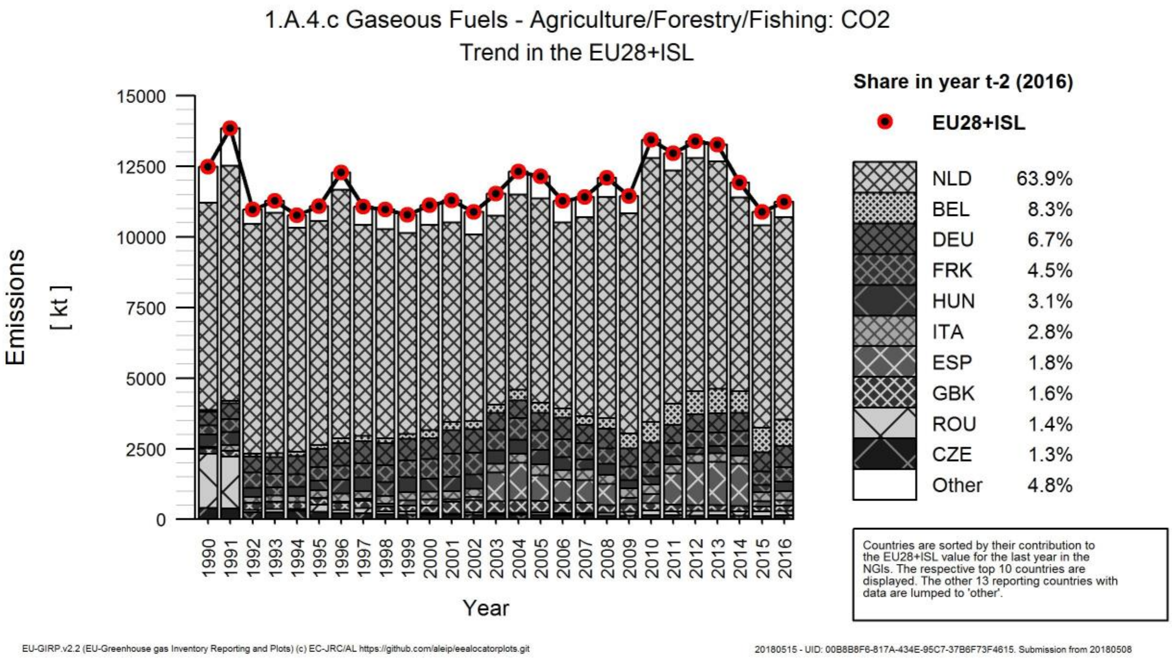
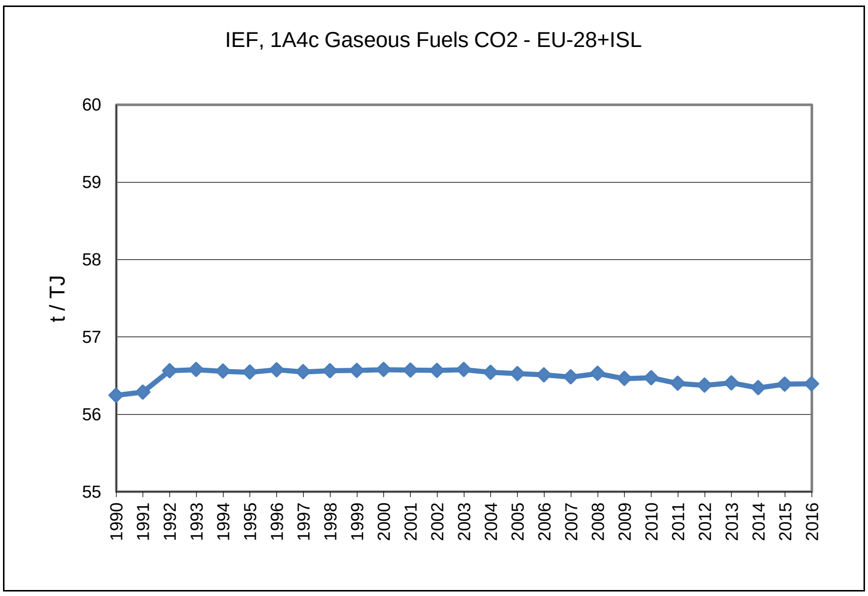
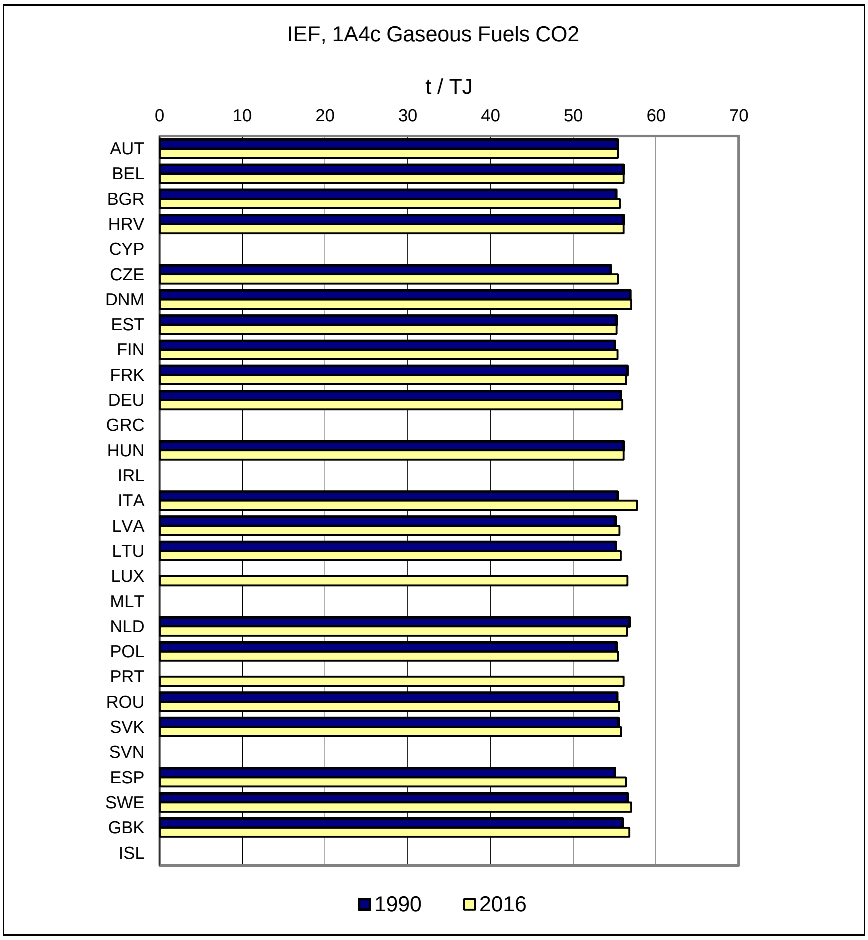


Figure 3.147 1A4c Agriculture/Forestry/Fisheries, gaseous fuels: Implied Emission Factors for CO_2 (in t/TJ)





3.2.5 Other (CRF Source Category 1A5)

Source category 1A5 Other includes emissions from stationary and mobile military fuel use including air craft. In 2016 category 1A5 contributed to 6 811 kt CO_2 equivalents of which 98.2% CO_2, 0.7% CH_4 and 1.1% N_2O.

Table 3.100: Key source categories for level and trend analyses and share of MS emissions using higher tier methods for sector 1A5 (Table excerpt)

Source category gas	Gg CO_2 equ.		Trend	Level		share of higher Tier
	1990	2016		1990	2016	
1.A.5.a Other Other Sectors: Solid Fuels (CO_2)	5983	9	T	0	0	NA
1.A.5.b Other Other Sectors: Liquid Fuels (CO_2)	14025	4598	T	L	0	NA

Table 3.101 provides an overview of Member States' source allocation to Source Category 1A5 Other as reported in CRF Table1.A(a)s4.

Table 3.101 1A5 Other: Member States' allocation of sources

Member State	Source allocation to 1A5 Other
Austria	Stationary: Emissions are 'Not occurring' Mobile: Military use
Belgium	Stationary: Emissions are 'Not occurring' Mobile: Military use
Bulgaria	Stationary: Other non-specified Mobile: Emissions are 'Not occurring'

Member State	Source allocation to 1A5 Other
Croatia	Emissions are 'Not occurring' or 'Included elsewhere'
Cyprus	Stationary: Other (not specified elsewhere) Mobile: aviation component
Czech Republic	Mobile; Other mobile sources not included elsewhere. Agriculture and Forestry and Fishing
Estonia	Mobile (no further specification)
Denmark	Mobile: Military use
Finland	Stationary: Other non-specified Mobile: other non-specified: Emissions are ‚Included elsewhere'
France	Emissions are 'Not occurring'
Germany	stationary_ Military use mobile: Military use
Greece	Mobile: Military use
Hungary	Mobile: Military use
Ireland	Emissions are 'Included elsewhere'
Iceland	Emissions are 'Not occurring'
Italy	Stationary: Emissions are 'Not occurring' Mobile (no further specification)
Latvia	Mobile (no further specification)
Lithuania	Mobile: Military use
Luxembourg	Stationary: Building and Plant Site Fuel Powered Machinery. Emissions are reported for 1990-2003 and 'Not occurring' from 2004 on. Mobile: Military Vehicles
Malta	Mobile: Military use of fuels
Netherlands	Stationary: Emissions are 'Not occurring' Mobile: military use
Poland	Stationary: Emissions are 'Included elsewhere' Mobile: Emissions are 'Not occurring'
Portugal	Stationary (no further specification): Emissions are reported for 1990-1994 and 'Not occurring' from 1995 on. Mobile: Military aviation
Romania	Stationary (no further specification) Mobile: Emissions are 'Not occurring'
Slovakia	Stationary: Other Mobile: Military use Jet Kerosene
Slovenia	Stationary: Emissions are 'Not occurring' Mobile: Military use of fuels
Spain	Mobile: Military use of fuels
Sweden	Stationary: Emissions are 'Not occurring' Mobile: Military use
United Kingdom	Stationary: Emissions are 'Included elsewhere' Mobile: Military aviation and naval shipping

Figure 3.148 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 71% between 1990 and 2016. Germany has the most influence to the overall trend, it reports minus 91% CO_2 emissions since 1990 and contributes to 51% 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 23% to CO_2 emissions in 2016. The United Kingdom reports military aircraft and naval vessels within this category.

Figure 3.148 1A5 Other: Total and CO_2 emission and activity trends

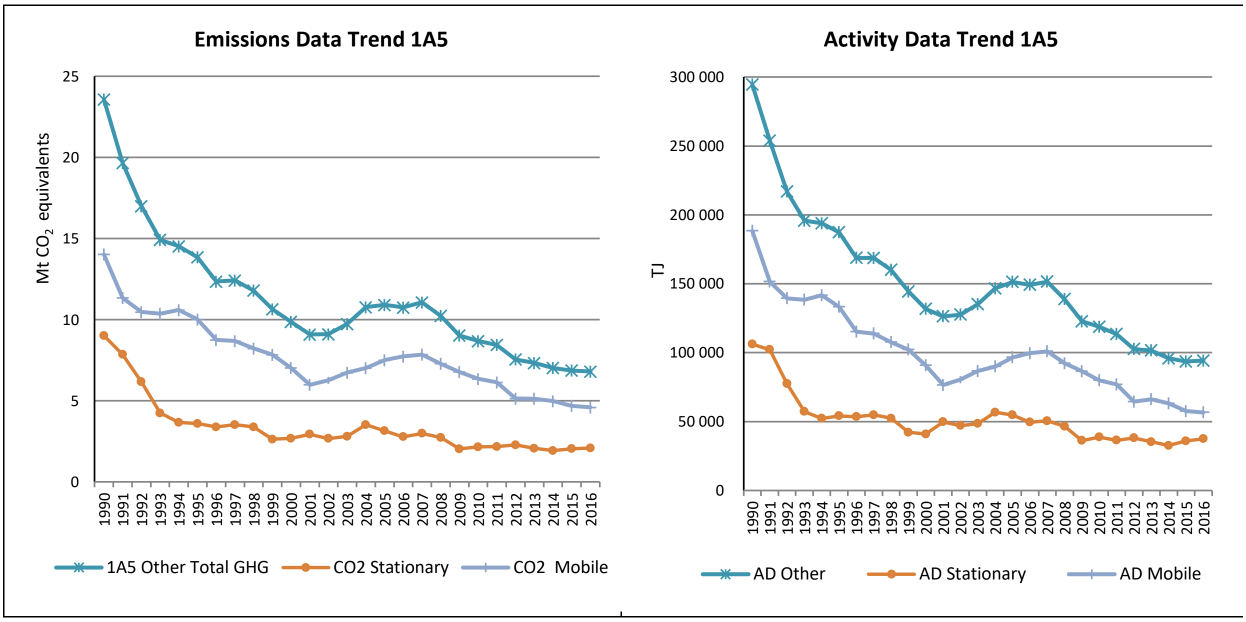


Table 3.102 shows total GHG and CO_2 emissions by Member State from 1A5. CO_2 emissions from 1A5 Other accounted for 0.16% of total EU-28+ISL GHG emissions in 2016. Between 1990 and 2015, CO_2 emissions from this source decreased by 70% in the EU-28+ISL. Between 1990 and 2015 the largest reduction in absolute terms was reported by Germany, which was partly due to reduced military operations after German reunification.

Table 3.102 1A5 Other: Member States' contributions to CO_2 emissions

Member State	GHG emissions in 1990 (kt CO2 equivalents)	GHG emissions in 2016 (kt CO2 equivalents)	CO2 emissions in 1990 (kt)	CO2 emissions in 2016 (kt)
Austria	36	51	35	50
Belgium	173	110	172	109
Bulgaria	30	50	30	50
Croatia	IE,NO	IE,NO	NO,IE	NO,IE
Cyprus	11	22	11	22
Czech Republic	NO	408	NO	395
Denmark	170	209	167	206
Estonia	44	49	43	48
Finland	1 136	1 119	1 124	1 108
France	NO	NO	NO	NO
Germany	12 138	1 022	11 797	1 016
Greece	IE,NO	201	NO,IE	199
Hungary	14	22	14	22
Ireland	IE	IE	IE	IE
Italy	1 143	533	1 071	515
Latvia	NE,NO	12	NO,NE	11
Lithuania	0	25	0	25
Luxembourg	3	0	3	0
Malta	3	3	3	3
Netherlands	320	165	314	162
Poland	IE,NO	IE,NO	NO,IE	NO,IE
Portugal	105	44	105	44
Romania	1 220	465	1 212	425
Slovakia	480	66	476	65
Slovenia	32	4	32	4
Spain	301	490	298	485
Sweden	863	179	846	176
United Kingdom	5 353	1 564	5 293	1 547
EU-28	**23 577**	**6 811**	**23 045**	**6 687**
Iceland	NO	NO	NO	NO
United Kingdom (KP)	5 353	1 564	5 293	1 547
EU-28 + ISL	**23 577**	**6 811**	**23 045**	**6 687**

Croatia reports that 'Military water-borne component is included in 1A3d and 'Military aviation component is included in 1A3a
Poland reports emissions from stationary combustion as 'IE' without specification of the allocation.
Ireland reports that emissions of military use stationary combustion are included in 1A4a and that emissions from 1.A.5.b military are included in 1.A.3
Abbreviations explained in the Chapter 'Units and abbreviations'.

Table 3.103 provides information on the contribution of Member States to EU-28 recalculations in CO_2 from 1A5 Other for 1990 and 2015 and main explanations for the largest recalculations in absolute terms.

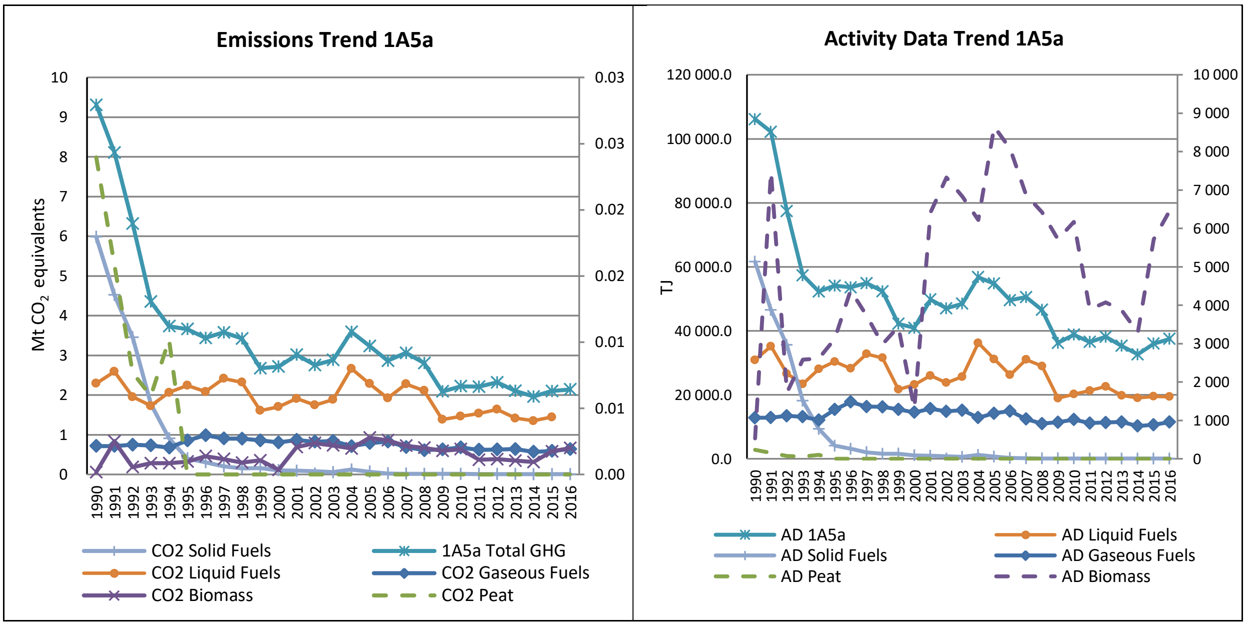
Table 3.1031A5 Other: Contribution of MS to EU-28 recalculations in CO_2 for 1990 and 2015 (difference between latest submission and previous submission in kt of CO_2 equivalents and percent)

	1990		2015		Main explanations
	kt CO_2 equiv.	**%**	**kt CO_2 equiv.**	**%**	
Austria	0	0.0	0	0.0	NA
Belgium	0	0.0	7	6.7	Flanders: actualization AD military aviation and update linked to the final version of the Walloon energy balance
Bulgaria	0	0.0	0	0.0	NA
Croatia	0	0.0	0	0.0	NA
Cyprus	0	0.0	0	0.0	NA
Czech Republic	0	0.0	0	0.0	NA
Denmark	0	0.0	0	0.0	NA
Estonia	0	0.0	0	0.0	NA
Finland	0	0.0	-18	-1.6	Updates in other categories are reflected here. Statistical corrections in total consumption of residual fuel oil and gasoil.
France	0	0.0	0	0.0	NA
Germany	0	0.0	2	0.2	1A5a: Revised calorific values and revised activity data (NIR 3.2.13.5). 1A5b: Revised activity data emission factors (NIR 3.2.14.5)
Greece	0	0.0	0	0.0	NA
Hungary	0	0.0	0	0.0	NA
Ireland	0	0.0	0	0.0	NA
Italy	1	0.1	0	0.1	No specific information provided.
Latvia	0	0.0	0	0.0	NA
Lithuania	0	0.0	0	0.0	NA
Luxembourg	0	0.0	0	-5.1	energy balance revised
Malta	0	0.0	0	0.0	NA
Netherlands	2	0.6	-14	-8.0	Recalculation with new EF's and changed diesel use
Poland	0	0.0	0	0.0	NA
Portugal	0	0.0	0	0.0	NA
Romania	0	0.0	32	7.7	Revised energy statistics, revised CO_2-emission factors (NIR 3.2.4.5)
Slovakia	63	15.3	15	32.1	Recalculation in military fuel consumption, completing of diesel oil and gasoline consumption.
Slovenia	0	0.0	0	0.0	NA
Spain	147	97.1	176	51.8	Method improvements for emission estimates in military transport
Sweden	0	0.0	0	0.0	Rounding error
United Kingdom	9	0.2	-323	-16.3	Revision to reported MOD fuel for military aircraft; revision to MOD naval shipping data & revision to gas oil emission factors for naval shipping as a result of the introduction of the BEIS shipping improvements model
EU28	221	1.0	-121	-1.8	
Iceland	0	0.0	0	0.0	NA
United Kingdom (KP)	9	0.2	-323	-16.3	Revision to reported MOD fuel for military aircraft; revision to MOD naval shipping data & revision to gas oil emission factors for naval shipping as a result of the introduction of the BEIS shipping improvements model
EU28+ISL	221	1.0	-121	-1.8	

3.2.5.1 Stationary (1A5a)

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 0.05% of total EU-28+ISL GHG emissions in 2016. Figure 3.149 shows the emission trend within the categories 1A5a, which is mainly dominated by CO_2 emissions from solid and liquid fuels for 1990 to 1993 and dominated by liquid and gaseous fuels after from 1994 on. The reduction in the early 1990s was driven by CO_2 from solid fuels. Total emissions decreased by 70%, mainly due to decreases in emissions from solid fuels (-100%) and liquid fuels (-37%).

Figure 3.149 1A5a Stationary: Total and CO_2 emission and activity trends



Data displayed as dashed line refers to the secondary axis.

Only six Member States (Bulgaria, Cyprus, Germany, Finland, Romania and Slovakia) reported emissions from this key source in 2016 (Table 3.104). Between 1990 and 2016 Germany reported the highest absolute decrease. Portugal reports emissions from 1990 to 1994 only. Luxembourg reports emissions 1990 to 2003 only. This led to an EU-28+ISL decrease of 77% in GHG emissions. Between 2015 and 2016 CO_2 emissions increased by 2%.

Table 3.104 1A5a Stationary: Member States' contributions to CO_2 emissions and information on method applied and emission factor

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016		Method	Emission factor Informa-tion
	1990	2015	2016		kt CO2	%	kt CO2	%		
Austria	NO	NO	NO	-	-	-	-	-	NA	NA
Belgium	NO	NO	NO	-	-	-	-	-	NA	NA
Bulgaria	30	62	50	2.4%	20	68%	-12	-20%	T1,T2	CS,D
Croatia	NO	NO	NO	-	-	-	-	-	NA	NA
Cyprus	11	19	19	0.9%	8	74%	0	0%	T1	D
Czech Republic	NO	NO	NO	-	-	-	-	-	NA	NA
Denmark	NO	NO	NO	-	-	-	-	-	NA	NA
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	1 124	1 078	1 108	53.0%	-15	-1%	30	3%	T1	CS
France	NO	NO	NO	-	-	-	-	-	NA	NA
Germany	6 227	390	438	21.0%	-5 789	-93%	48	12%	CS	CS
Greece	NO	NO	NO	-	-	-	-	-	NA	NA
Hungary	NO	NO	NO	-	-	-	-	-	NA	NA
Ireland	IE	IE	IE	-	-	-	-	-	NA	NA
Italy	NO	NO	NO	-	-	-	-	-	NA	NA
Latvia	NO	NO	NO	-	-	-	-	-	NA	NA
Lithuania	NO	NO	NO	-	-	-	-	-	NA	NA
Luxembourg	3	NO	NO	-	-3	-100%	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	NO	NO	NO	-	-	-	-	-	NA	NA
Poland	IE	IE	IE	-	-	-	-	-	NA	NA
Portugal	8	NO	NO	-	-8	-100%	-	-	NA	NA
Romania	1 212	454	425	20.4%	-786	-65%	-28	-6%	T1,T2	CS,D
Slovakia	406	46	49	2.3%	-357	-88%	3	7%	T2	CS
Slovenia	NO	NO	NO	-	-	-	-	-	NA	NA
Spain	NO,IE	NO,IE	NO,IE	-	-	-	-	-	NA	NA
Sweden	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom	IE	IE	IE	-	-	-	-	-	NA	NA
EU-28	**9 020**	**2 049**	**2 089**	**100%**	**-6 931**	**-77%**	**40**	**2%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	IE	IE	IE	-	-	-	-	-	NA	NA
EU-28 + ISL	**9 020**	**2 049**	**2 089**	**100%**	**-6 931**	**-77%**	**40**	**2%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'.
Spain reports, that military reference activity data are not separated from civil data and that those emissions are estimated together in 1A4ai by applying the same methodology.
The United Kingdom reports, that stationary combustion for military purposes is not reported separately in UK energy statistics and that it is allocated under 1A4a.
Ireland reports that emissions of military use stationary combustion are included in 1A4a.

1A5a Stationary – Solid Fuels (CO_2)

In 2016 CO_2 from solid fuels had a share of 0.4% within source category 1A5a (compared to 64% in 1990). Between 1990 and 2016, CO_2 decreased by nearly 100% (Table 3.105). In 2016 only Germany and Slovakia reported emissions for this key category. The main reason for the strong decline of emissions in the early 1990s was the closure of military barracks after the German reunification and the phase out of coal use for combustion in buildings.

Spain reports, that military reference activity data are not separated from civil data and that those emissions are estimated together in 1A4ai by applying the same methodology.

The United Kingdom reports, that stationary combustion for military purposes is not reported separately in UK energy statistics and that it is allocated under 1A4a.

Ireland reports that emissions of military use stationary combustion are included in 1A4a.

Table 3.105 1A5a Stationary, solid fuels: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016	
	1990	2015	2016		kt CO2	%	kt CO2	%
Austria	NO	NO	NO	-	-	-	-	-
Belgium	NO	NO	NO	-	-	-	-	-
Bulgaria	30	NO	NO	-	-30	-100%	-	-
Croatia	NO	NO	NO	-	-	-	-	-
Cyprus	NO	NO	NO	-	-	-	-	-
Czech Republic	NO	NO	NO	-	-	-	-	-
Denmark	-	-	-	-	-	-	-	-
Estonia	NO	NO	NO	-	-	-	-	-
Finland	1	NO	NO	-	-1	-100%	-	-
France	NO	NO	NO	-	-	-	-	-
Germany	4 553	7	7	70.5%	-4 546	-100%	0	1%
Greece	NO	NO	NO	-	-	-	-	-
Hungary	NO	NO	NO	-	-	-	-	-
Ireland	IE	IE	IE	-	-	-	-	-
Italy	NO	NO	NO	-	-	-	-	-
Latvia	NO	NO	NO	-	-	-	-	-
Lithuania	NO	NO	NO	-	-	-	-	-
Luxembourg	NO	NO	NO	-	-	-	-	-
Malta	NO	NO	NO	-	-	-	-	-
Netherlands	NO	NO	NO	-	-	-	-	-
Poland	IE	IE	IE	-	-	-	-	-
Portugal	8	NO	NO	-	-8	-100%	-	-
Romania	1 174	NO	NO	-	-1 174	-100%	-	-
Slovakia	216	3	3	29.5%	-213	-99%	0	-13%
Slovenia	NO	NO	NO	-	-	-	-	-
Spain	IE	IE	IE	-	-	-	-	-
Sweden	NO	NO	NO	-	-	-	-	-
United Kingdom	IE	IE	IE	-	-	-	-	-
EU-28	**5 983**	**10**	**9**	**100%**	**-5 973**	**-100%**	**0**	**-4%**
Iceland	NO	NO	NO	-	-	-	-	-
United Kingdom (KP)	IE	IE	IE	-	-	-	-	-
EU-28 + ISL	**5 983**	**10**	**9**	**100%**	**-5 973**	**-100%**	**0**	**-4%**

Abbreviations explained in the Chapter 'Units and abbreviations'.

Note: The information on methodologies and emission factors is not available from the CRF/XML on fuels level.

Figure 3.150 shows CO_2 emissions for EU-28 and the Member States. Germany accounts for 71% of EU-28 CO_2 emissions from this source category. Fuel combustion in the EU-28+ISL decreased by 99.8% between 1990 and 2016. The CO_2 implied emission factor for solid fuels was 100.0 t/TJ in 2016.

Figure 3.150 1A5a Stationary, solid fuels: Emission trend and share for CO_2

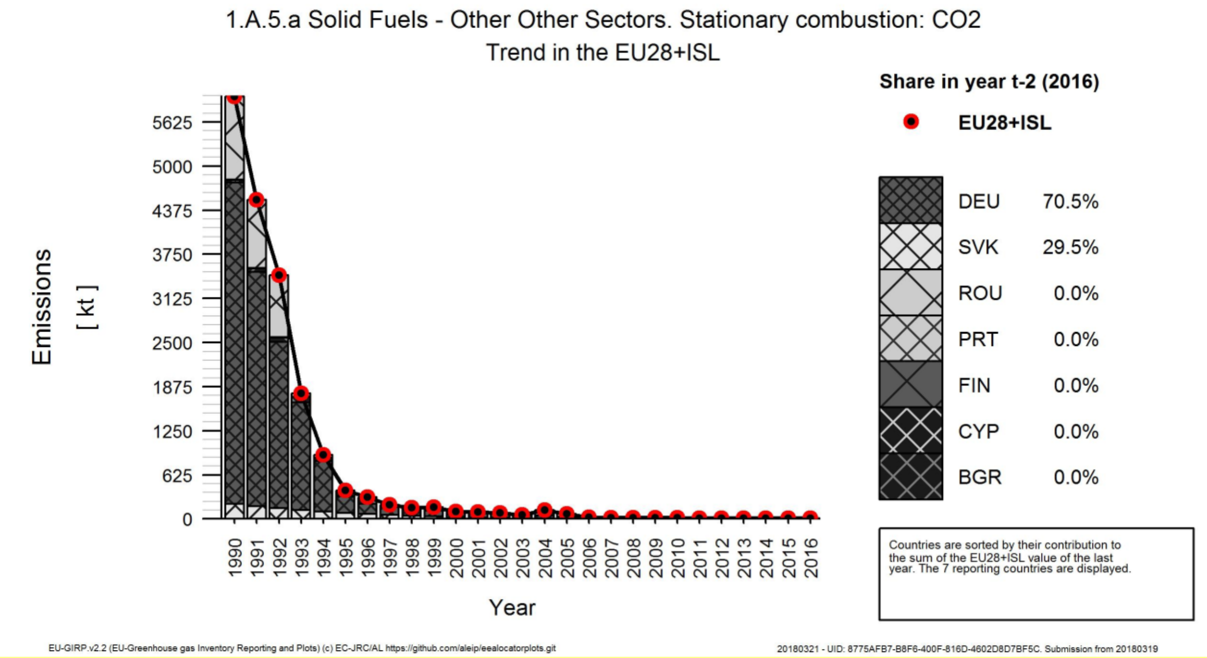
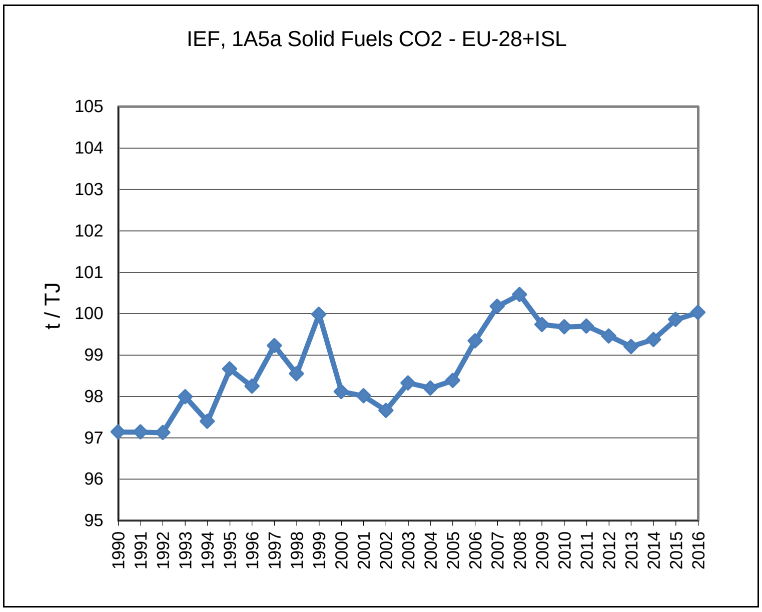
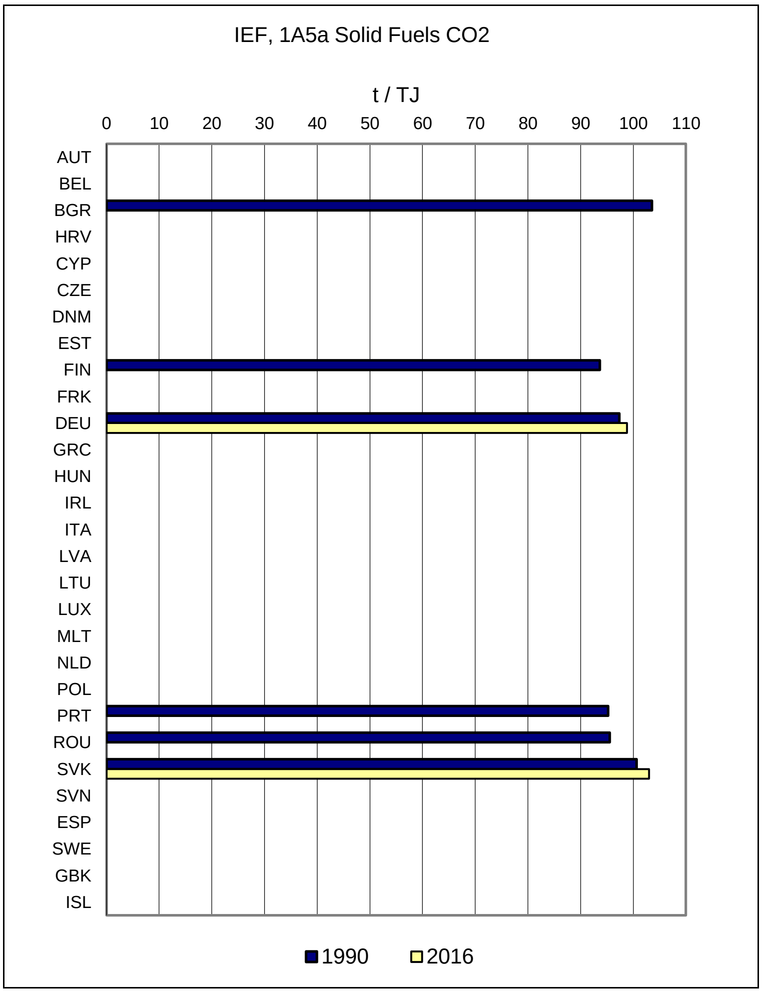


Figure 3.151 1A5a Stationary, solid fuels: Implied Emission Factors for CO_2 (in t/TJ)

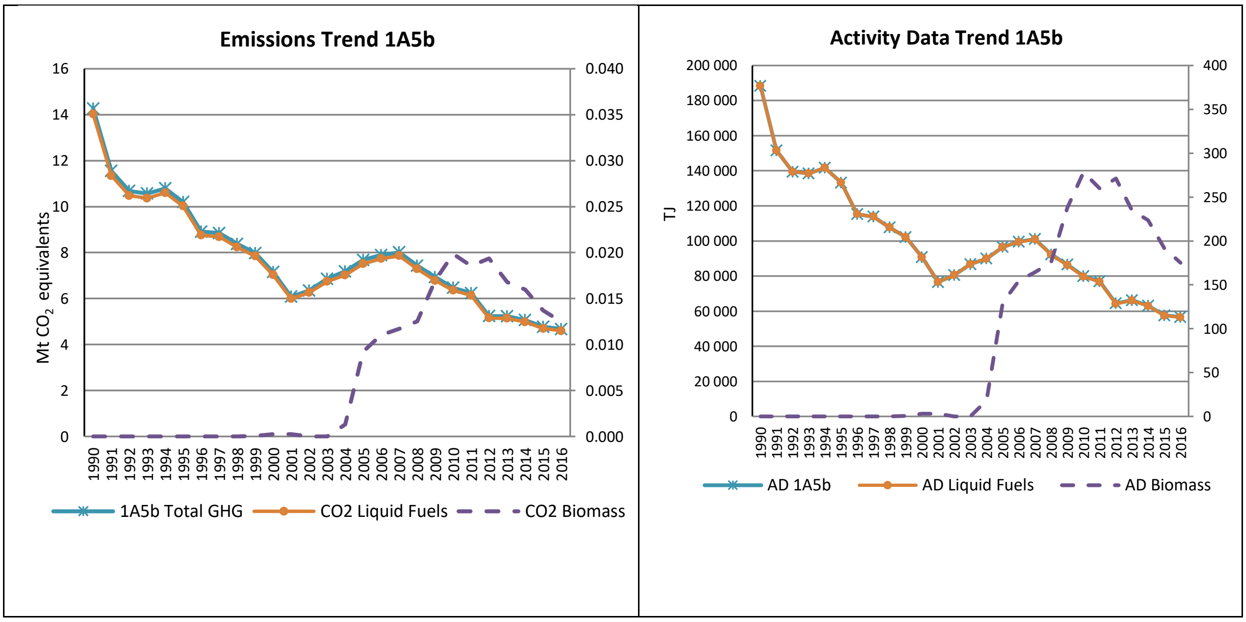




3.2.5.2 Mobile (1A5b)

In this chapter information about emission trends, Member States' contribution and activity data is provided for category 1A5b by fuels. CO_2 emissions from 1A5b Mobile accounted for 0.1% of total EU-28+ISL GHG emissions in 2016. Figure 3.152 shows the emission trend within the category 1A5b, which is dominated by CO_2 emissions from liquid fuels. Total CO_2 emissions decreased by 67%.

Figure 3.152 1A5b Mobile: Total and CO_2 emission trends



Data displayed as dashed line refers to the secondary axis.

Eight Member States and Iceland reported emissions as 'Not occurring' or 'Included elsewhere'. The United Kingdom had the highest emissions in 2016 and – together with Germany - decreased the most in absolute terms between 1990 and 2016. Between 2015 and 2016 the United Kingdom had the highest absolute decrease. The EU-28+ISL emissions decreased by 2% between 2015 and 2016 (Table 3.106).

Croatia reports emissions from military aviation in category 1A3a and emissions from military naval vessels under category 1A3d.

Ireland reports that emissions from mobile military sources are included in 1A3.

Table 3.106 1A5b Mobile: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016		Method	Emission factor Informa-tion
	1990	2015	2016		kt CO2	%	kt CO2	%		
Austria	35	49	50	1.1%	15	42%	1	1%	T1,T2	CS,D
Belgium	172	106	109	2.4%	-63	-37%	3	3%	T1	D
Bulgaria	NO	NO	NO	-	-	-	-	-	NA	NA
Croatia	NO,IE	NO,IE	NO,IE	-	-	-	-	-	NA	NA
Cyprus	NO	3	3	0.1%	3	∞	0	0%	T1	D
Czech Republic	NO	369	395	8.6%	395	∞	26	7%	T1	D
Denmark	167	197	206	4.5%	39	24%	10	5%	CR,T2	CS
Estonia	43	27	48	1.0%	4	9%	21	77%	T2	CS
Finland	NO,IE	NO,IE	NO,IE	-	-	-	-	-	NA	NA
France	NO	NO	NO	-	-	-	-	-	NA	NA
Germany	5 570	588	578	12.6%	-4 993	-90%	-10	-2%	CS,D,M	CS,D,M
Greece	NO,IE	206	199	4.3%	199	∞	-7	-4%	T1	D
Hungary	14	18	22	0.5%	7	52%	4	21%	T1	D
Ireland	IE	IE	IE	-	-	-	-	-	NA	NA
Italy	1 071	459	515	11.2%	-556	-52%	56	12%	T2	CS
Latvia	NO,NE	10	11	0.2%	11	∞	2	19%	T1	D
Lithuania	0	36	25	0.5%	25	6812%	-11	-31%	T2	CS
Luxembourg	0	0	0	0.0%	0	-10%	0	0%	T1,T2	CS,D
Malta	3	4	3	0.1%	1	37%	-1	-17%	T1	D
Netherlands	314	161	162	3.5%	-152	-48%	1	1%	T2	CS
Poland	NO	NO	NO	-	-	-	-	-	NA	NA
Portugal	96	76	44	1.0%	-52	-54%	-32	-42%	-	-
Romania	NO	NO	NO	-	-	-	-	-	NA	NA
Slovakia	70	17	16	0.3%	-54	-77%	-1	-6%	T1,T2	D
Slovenia	32	4	4	0.1%	-28	-89%	0	-2%	T1	D
Spain	298	517	485	10.6%	188	63%	-31	-6%	T1	D,M
Sweden	846	188	176	3.8%	-670	-79%	-12	-7%	NA	NA
United Kingdom	5 293	1 662	1 547	33.6%	-3 746	-71%	-115	-7%	T1	CS
EU-28	**14 025**	**4 697**	**4 598**	**100%**	**-9 427**	**-67%**	**-99**	**-2%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	5 293	1 662	1 547	33.6%	-3 746	-71%	-115	-7%	T1	CS
EU-28 + ISL	**14 025**	**4 697**	**4 598**	**100%**	**-9 427**	**-67%**	**-99**	**-2%**	**-**	**-**

Finland reports emissions from military activities in category 1A5a for reasons of confidentiality.
Ireland reports emission from military activities in category 1A3.
Croatia reports emissions from military aviation in category 1A3a and emissions from military naval vessels under category 1A3d.
Abbreviations explained in the Chapter 'Units and abbreviations'.

1A5b Mobile – Liquid Fuels (CO_2)

In 2016, CO_2 from liquid fuels had a share of 98% within source category 1A5b (compared to 98% in 1990). Between 1990 and 2016 CO_2 decreased by 67% (Table 3.107). Twenty one Member States reported emissions in 2016 while other Member States report emissions as 'Not occurring' or 'Included Elsewhere'. The highest decrease in absolute terms was achieved in Germany (-90%) and the United Kingdom (-71%), while the Czech Republic had the largest increases.

Table 3.107 1A5b Mobile, liquid fuels: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016	
	1990	2015	2016		kt CO2	%	kt CO2	%
Austria	35	49	50	1.1%	15	42%	1	1%
Belgium	172	106	109	2.4%	-63	-37%	3	3%
Bulgaria	NO	NO	NO	-	-	-	-	-
Croatia	IE	IE	IE	-	-	-	-	-
Cyprus	NO	3	3	0.1%	3	∞	0	0%
Czech Republic	NO	369	395	8.6%	395	∞	26	7%
Denmark	167	197	206	4.5%	39	24%	10	5%
Estonia	43	27	48	1.0%	4	9%	21	77%
Finland	IE	IE	IE	-	-	-	-	-
France	NO	NO	NO	-	-	-	-	-
Germany	5 570	588	578	12.6%	-4 993	-90%	-10	-2%
Greece	IE	206	199	4.3%	199	∞	-7	-4%
Hungary	14	18	22	0.5%	7	52%	4	21%
Ireland	IE	IE	IE	-	-	-	-	-
Italy	1 071	459	515	11.2%	-556	-52%	56	12%
Latvia	NE	10	11	0.2%	11	∞	2	19%
Lithuania	0	36	25	0.5%	25	6812%	-11	-31%
Luxembourg	0	0	0	0.0%	0	-10%	0	0%
Malta	3	4	3	0.1%	1	37%	-1	-17%
Netherlands	314	161	162	3.5%	-152	-48%	1	1%
Poland	NO	NO	NO	-	-	-	-	-
Portugal	96	76	44	1.0%	-52	-54%	-32	-42%
Romania	NO	NO	NO	-	-	-	-	-
Slovakia	70	17	16	0.3%	-54	-77%	-1	-6%
Slovenia	32	4	4	0.1%	-28	-89%	0	-2%
Spain	298	517	485	10.6%	188	63%	-31	-6%
Sweden	846	188	176	3.8%	-670	-79%	-12	-7%
United Kingdom	5 293	1 662	1 547	33.6%	-3 746	-71%	-115	-7%
EU-28	**14 025**	**4 697**	**4 598**	**100%**	**-9 427**	**-67%**	**-99**	**-2%**
Iceland	NO	NO	NO	-	-	-	-	-
United Kingdom (KP)	5 293	1 662	1 547	33.6%	-3 746	-71%	-115	-7%
EU-28 + ISL	**14 025**	**4 697**	**4 598**	**100%**	**-9 427**	**-67%**	**-99**	**-2%**

Finland reports emissions from military activities in category 1A5a for reasons of confidentiality.
Ireland reports emission from military activities in category 1A3.
Croatia reports emissions from military aviation in category 1A3a and emissions from military naval vessels under category 1A3d.
*Information on methods and emission factors are identical with those described in Table **3.106** as emissions from this source only occur in liquid fuels*
Abbreviations explained in the Chapter 'Units and abbreviations'.

Figure 3.153 shows CO_2 emissions for EU-28 and the Member States. The largest emissions are reported by Germany, Italy, Spain and the United Kingdom; together they cause 68% of the CO_2 emissions from liquid fuels in 1A5b. Fuel consumption in the EU-28+ISL decreased by 70% between 1990 and 2016. The CO_2 implied emission factor for liquid fuels was 81.3 t/TJ in 2016. The IEF is comparably high because Spain reports activity data as confidential. This also explains the increasing trend of the EU IEF because the share of Spain in EU emissions increased from 2 % in 1990 to 11 % in 2016.

Figure 3.153 1A5b Mobile, liquid fuels: Emission trend and share for CO_2

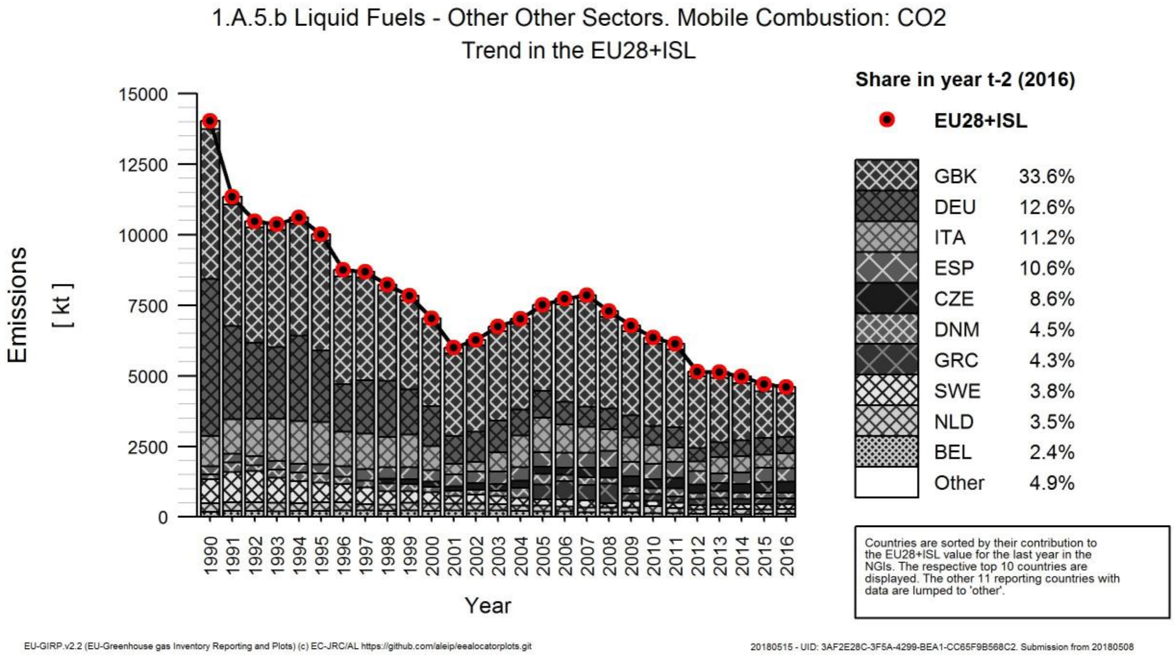
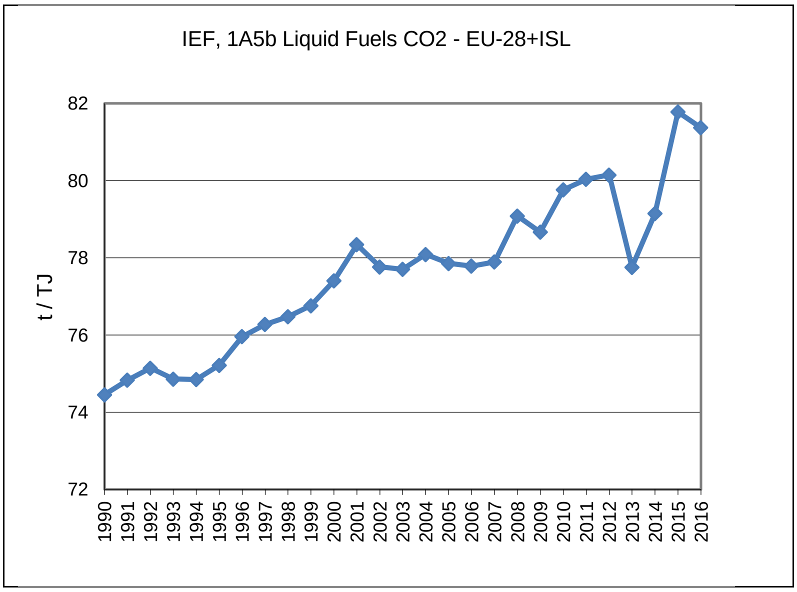
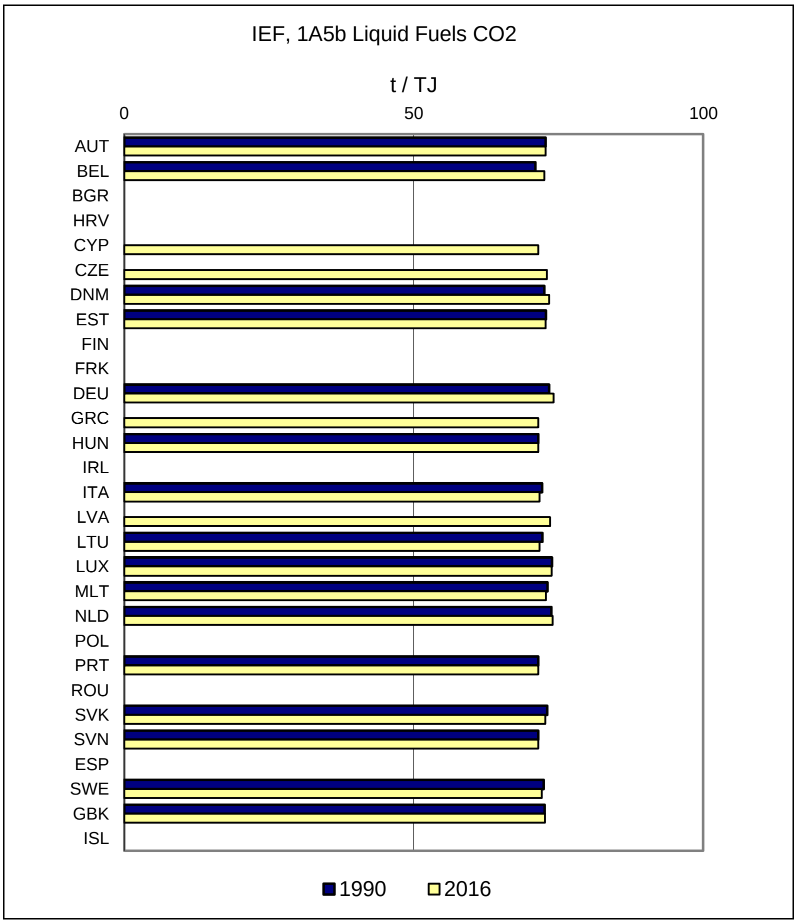


Figure 3.154 1A5b Mobile, liquid fuels: Implied Emission Factors for CO_2 (in t/TJ)



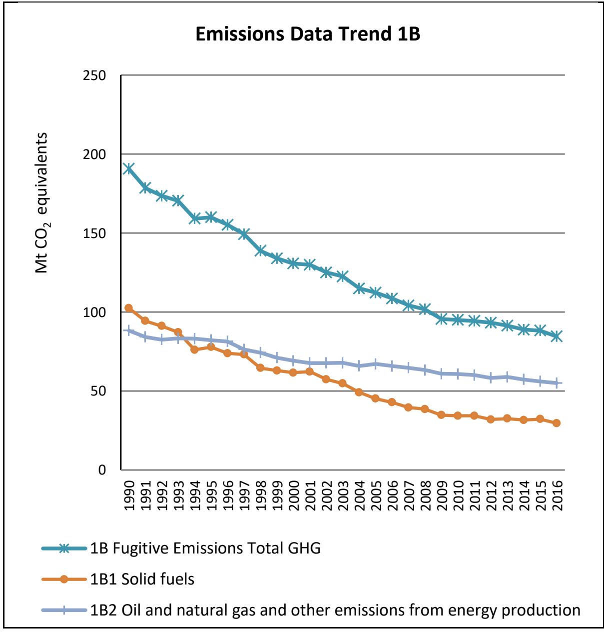

IEF, 1A5b Liquid Fuels CO2
t / TJ
0
50
100
AUT
BEL
BGR
HRV
CYP
CZE
DNM
EST
FIN
FRK
DEU
GRC
HUN
IRL
ITA
LVA
LTU
LUX
MLT
NLD
POL
PRT
ROU
SVK
SVN
ESP
SWE
GBK
ISL
1990
2016

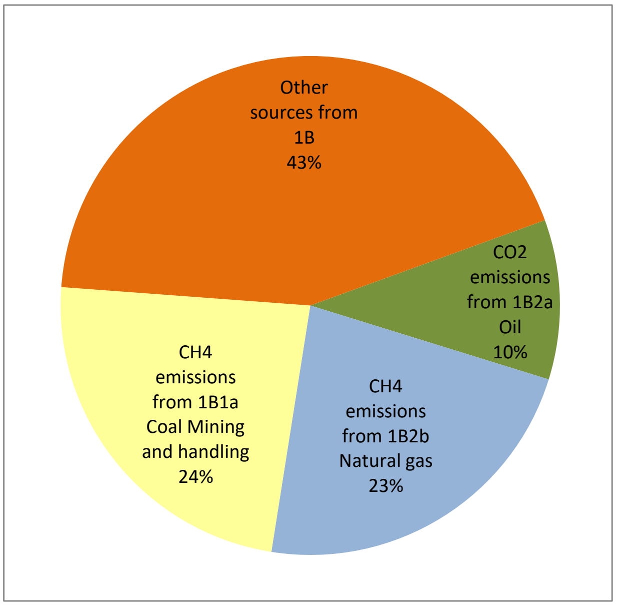
3.2.6 Fugitive emissions from fuels (CRF Source Category 1.B)

This chapter describes gaseous or volatile emissions which occur during extraction, handling and consumption of fossil fuels. In the 2006 IPCC Guidelines 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 (2006 IPCC Guidelines).

In 2016, in terms of CO_2 equivalents, about 70.6% of emissions from source category 1.B were fugitive CH_4 emissions while 29.3% were fugitive CO_2 emissions. Together, they represent 2 % of total GHG emissions in the EU-28+ISL. Fugitive GHG emissions have been steadily declining (Figure 3.155). Between 1990 and 2016, the total fugitive GHG emissions decreased by 56 %. This was mainly due to the decrease in underground mining activities: CH_4 emissions from underground mining activities have decreased by 75 % since 1990 (Figure 3.158) and decreases in CH_4 emissions from category 1B1a i underground mines are responsible for 65 % of the total decrease of fugitive emissions. Between 1990 and 2016, GHG emissions from 1.B.1 Solid Fuels decreased by 71 % Figure 3.156), while emissions from 1.B.2 Oil and Natural Gas decreased only by 38 % (Figure 3.156). While emissions from these two sources (1.B.1 Solid Fuels and 1.B.2 Oil and Natural Gas) each were responsible for roughly 50 % of total fugitive emissions in 1990, fugitive emissions from 1.B.1 Solid Fuels represented only 35 % of total fugitive emissions in 2016 (Figure 3.155).

Figure 3.155 1.B Fugitive Emission from Fuel: GHG Emissions trend and proportion of fugitive emissions within source category





Fugitive emissions includes four key sources:

Table 3.108: Key source categories for level and trend analyses and share of MS emissions using higher tier methodsin sector 1.B (table excerpt)

Source category gas	kt CO_2 equ.		Trend	Level		share of higher Tier
	1990	2016		1990	2016	
1.B.1.a Coal Mining and Handling: Operation (CH_4)	95180	26327	T	L	L	68%
1.B.2.a Oil: Operation (CO_2)	9104	11456	T	L	L	80%
1.B.2.b Natural Gas: Operation (CH_4)	51404	25141	T	L	L	73%
1.B.2.c Venting and Flaring: Operation (CO_2)	8723	6180	0	L	L	86%

The two largest key sources (CH_4 emissions from 1.B.1.a Coal Mining and Handling and 1.B.2.b Natural Gas) account together for 61 % of total fugitive GHG emissions (Figure 3.155).

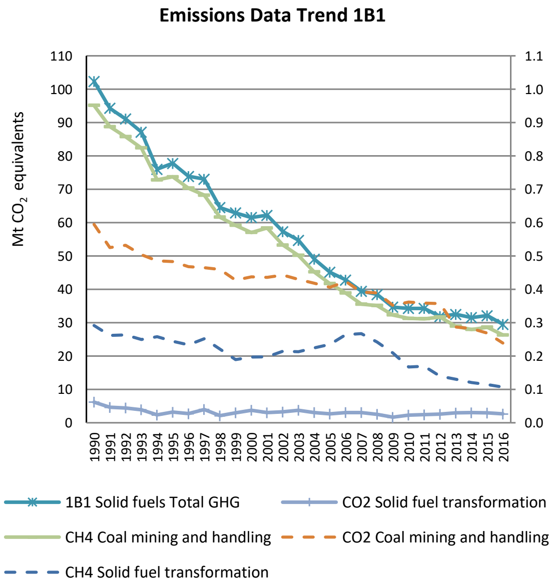
3.2.6.1 Fugitive emissions from Solid Fuels (1.B.1)

In the 2006 IPCC Guidelines fugitive emissions from solid fuels are defined as the intentional or unintentional release of greenhouse gases that may occur during the extraction, processing and delivery of fossil fuels to the point of final use. Combustion emissions from colliery methane recovered and used are excluded here and reported under Fuel Combustion Emissions. Coal mining data reported to the IEA include also peat extraction, which is not included in the CRF. Five member States (Denmark, Estonia, Finland, Latvia and Lithuania) have peat extraction but no coal mining.

In 2016 fugitive emissions from solid fuels accounted for 0.7 % of the total GHG emissions in the EU-28+ISL and 35 % of total fugitive emissions:

- 89 % of fugitive emissions from solid fuels were CH_4 emissions from coal mining. The emissions arise due to 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.
- 9 % of fugitive emissions from solid fuels were emissions due to solid fuel transformation
- Since 1990 fugitive CH_4 emissions from 1.B.1 Solid fuels have been steadily decreasing, caused by the reduction of coal mining activities

Figure 3.156 1.B.1 Fugitive Emissions from Solid Fuels: Trend



Note: Data displayed as dashed line refers to the secondary axis.

In 2016 four countries, Poland, Germany Czech Republic and the UK represented 89 % of total fugitive GHG emissions from solid fuels (Table 3.109).

Table 3.109 1.B.1 Fugitive Emissions from Solid Fuels: Member States Contribution

Member State	GHG emissions in 1990 (kt CO2 equivalents)	GHG emissions in 2016 (kt CO2 equivalents)	CO2 emissions in 1990 (kt)	CO2 emissions in 2016 (kt)	N2O emissions in 1990 (kt CO2 equivalents)	N2O emissions in 2016 (kt CO2 equivalents)	CH4 emissions in 1990 (kt CO2 equivalents)	CH4 emissions in 2016 (kt CO2 equivalents)
Austria	333	NA,IE,NO	NO,IE,NA	NO,IE,NA	NO,IE,NA	NO,IE,NA	333	NO,IE,NA
Belgium	433	42	0	NO	NO,NA	NO,NA	432	42
Bulgaria	2 047	824	NO	NO	NO	NO	2 047	824
Croatia	60	NA,NO	NO	NO	NO,NA	NO,NA	60	NO
Cyprus	NO	NO	NO	NO	NO	NO	NO	NO
Czech Republic	10 779	3 421	456	156	NA,NO	NO,NA	10 323	3 264
Denmark	NO	NO	NO	NO	NO	NO	NO	NO
Estonia	NO	NO	NO	NO	NO	NO	NO	NO
Finland	NO	NO	NO	NO	NO	NO	NO	NO
France	4 810	16	NO,NA	NO,NA	NO,NE	NO,NE	4 810	16
Germany	27 386	3 187	1 833	707	NO,NA	NO,NA	25 553	2 481
Greece	1 130	711	NO	NO	NA,NO	NO,NA	1 130	711
Hungary	896	54	7	NO,IE,NA	NO,NA,IE	NO,IE,NA	889	54
Ireland	56	19	NO	NO	NO	NO	56	19
Italy	132	42	0	NO,NA	NA	NA	132	42
Latvia	NA,NO	NA,NO	NO	NO	NO,NA	NO,NA	NO	NO
Lithuania	NO	NO	NO	NO	NO	NO	NO	NO
Luxembourg	NO	NO	NO	NO	NO	NO	NO	NO
Malta	NO	NO	NO	NO	NO	NO	NO	NO
Netherlands	121	77	110	72	NO,IE	NO,IE	11	5
Poland	23 891	18 559	2 561	1 523	NA	NA	21 330	17 036
Portugal	91	8	NO	NO	NO	NO	91	8
Romania	3 899	907	NA,NO	NO,NA	NA,NO	NO,NA	3 899	907
Slovakia	699	330	19	19	NO	NO	680	311
Slovenia	459	358	98	128	NO,NA	NO,NA	361	230
Spain	1 638	90	18	6	NO,NE,NA	NO,NE,NA	1 620	84
Sweden	5	10	5	10	0	0	0	0
United Kingdom	23 525	855	1 699	349	0	0	21 827	506
EU-28	**102 391**	**29 509**	**6 807**	**2 970**	**0**	**0**	**95 584**	**26 539**
Iceland	NO	NO	NO	NO	NO	NO	NO	NO
United Kingdom (KP)	23 526	855	1 699	349	0	0	21 827	507
EU-28 + ISL	**102 391**	**29 509**	**6 807**	**2 970**	**0**	**0**	**95 584**	**26 539**

Abbreviations explained in the Chapter 'Units and abbreviations'
Austria includes emissions from 1.B.1.b – production of coke oven coke – in 1.A.2.a Iron and Steel
Hungary reports fugitive methane emissions released during coal mining and handling under sector 1.A.2. Fugitive emissions from solid fuel transformation are included in sector 1.A.1.c.

Between 1990 and 2016 fugitive CH_4 emissions from solid fuels decreased by 71% (Table 3.110). Large reductions (in absolute terms) were observed in Czech Republic, Germany, and in the United Kingdom, while emissions actually increased in Sweden (+89%) (Table 3.109).

CH_4 from Coal Mining (1.B.1.a)

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).
- abandoned underground mines

CH_4 emissions from 1.B.1.a coal-mining accounted for 0.6 % of total GHG emissions in 2016 and for 31 % of all fugitive emissions in the EU-28+ISL. CH_4 emissions from this source decreased by 72 % in the EU-28+ISL between 1990 and 2016 and also a decrease by -8 % between 2015 and 2016 due to decreases in Germany, the Czech Republic, Greece and the United Kingdom (Table 3.110). In 2016 Poland, Germany and the Czech Republic accounted together for 86 % of CH_4 emissions from 1.B.1.a. They had substantially reduced their emissions between 1990 and 2016 due to the decline of coal mining (Figure 3.90).

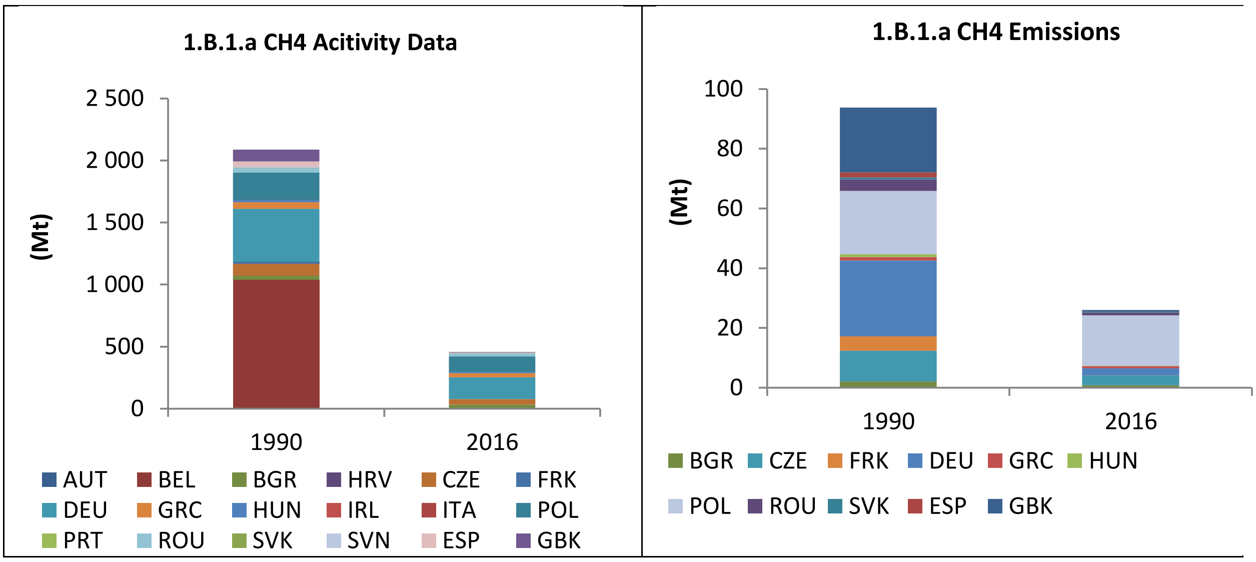
Table **3.110** shows that 68 % of EU-28 emissions are calculated using higher tier methods. In cases where member states report a mix of Tier 1 and higher Tier methods (CZE, HUN, POL) only emissions from subcategories of sector 1.B.1.a were taken into account, where the member states actually apply a higher tier method.

Table 3.110 1.B.1.a Coal Mining: Member States contribution to CH_4 emissions

Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016		Method	Emission factor Informa-tion
	1990	2015	2016		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	333	NO,NA	NO,NA	-	-333	-100%	-	-	NA	NA
Belgium	396	42	42	0.2%	-354	-89%	0	-1%	D	D
Bulgaria	2 031	979	821	3.1%	-1 210	-60%	-158	-16%	OTH,T1	D,OTH
Croatia	60	NO	NO	-	-60	-100%	-	-	NA	NA
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czech Republic	10 322	3 581	3 260	12.4%	-7 063	-68%	-322	-9%	T1,T2	CS,D
Denmark	NO	NO	NO	-	-	-	-	-	NA	NA
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	NO	NO	NO	-	-	-	-	-	NA	NA
France	4 780	10	10	0.0%	-4 770	-100%	0	0%	T2,T3	CS,PS
Germany	25 494	3 037	2 426	9.2%	-23 069	-90%	-611	-20%	T2,T3	CS
Greece	1 130	1 007	711	2.7%	-419	-37%	-296	-29%	T1	D
Hungary	889	57	54	0.2%	-835	-94%	-3	-5%	T1,T2	CS,D
Ireland	56	20	19	0.1%	-36	-65%	0	-2%	T1	D
Italy	53	20	17	0.1%	-35	-67%	-2	-12%	T2	D
Latvia	NO	NO	NO	-	-	-	-	-	NA	NA
Lithuania	NO	NO	NO	-	-	-	-	-	NA	NA
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	NO	NO	NO	-	-	-	-	-	NA	NA
Poland	21 217	16 856	16 930	64.3%	-4 287	-20%	75	0%	T1,T2	D
Portugal	91	9	8	0.0%	-82	-91%	0	-2%	NO	NO
Romania	3 857	1 005	907	3.4%	-2 951	-76%	-98	-10%	T1	D
Slovakia	680	319	310	1.2%	-370	-54%	-9	-3%	T2	CS
Slovenia	361	218	230	0.9%	-131	-36%	11	5%	T2,T3	CS,D,PS
Spain	1 620	105	84	0.3%	-1 537	-95%	-22	-21%	CS,T2	CS
Sweden	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom	21 809	1 375	500	1.9%	-21 309	-98%	-875	-64%	T2,T3	CS
EU-28	**95 180**	**28 638**	**26 327**	**100%**	**-68 853**	**-72%**	**-2 311**	**-8%**	-	-
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	21 809	1 375	500	1.9%	-21 309	-98%	-875	-64%	T2,T3	CS
EU-28 + ISL	**95 180**	**28 638**	**26 327**	**100%**	**-68 853**	**-72%**	**-2 311**	**-8%**	-	-

Abbreviations explained in the Chapter 'Units and abbreviations'.
According to the MS NIR Poland calculates emissions from this source with a Tier3 approach

Figure 3.157 1.B.1.a Coal Mining and Handling: Contribution of MS to CH_4 Emission and Activity Data



CH_4 from Underground mines (1.B.1.a.1)

In 2016 82% of fugitive emissions from coal mines were due to underground mines. Within the EU-28 coal mining in underground mines decreased substantially between 1990 and 2016 (-76 %) (Figure 3.158). Largest decreases of CH_4 emissions in absolute terms were observed in Germany (-91 %) and the United Kingdom (-98 %). In Germany, emissions from this source have been decreasing due to decreases in utilizable extracted quantities and increases in pit-gas utilization since 2001 (DEU NIR 2018). The decreasing trend in the United Kingdom is caused by the closure of deep-mining collieries, which led to a reduction from 188 small deep-mining collieries in the year 1990 to 5 in 2016 (GBE NIR 2018).

Poland and Germany, which are contributing 72% and 11% of methane emissions to this source, respectively, apply a Tier 3 method based on direct measurements and calculations. (POL NIR 2018; DEU NIR 2018). A Tier 2 method including country specific emission factors is applied by the Czech Republic, which is contributing almost 9% of methane emissions to this source (CZE NIR 2018) (Table **3.111**). For detailed information on Member States methodologies please see Annex III.

Table 3.111 1.B.1.a.1 Coal Mining – underground mining: Member States contribution to CH_4 emissions

Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016		Method	Emission factor Informa-tion
	1990	2015	2016		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	299	NO,NA	NO,NA	-	-299	-100%	-	-	NA	NA
Belgium	396	42	42	0.2%	-354	-89%	0	-1%	D	D
Bulgaria	1 425	208	147	0.7%	-1 279	-90%	-61	-29%	OTH,T1	D,OTH
Croatia	60	NO	NO	-	-60	-100%	-	-	NA	NA
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czech Republic	7 544	2 241	1 904	8.8%	-5 640	-75%	-337	-15%	T1,T2	CS,D
Denmark	NO	NO	NO	-	-	-	-	-	NA	NA
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	NO	NO	NO	-	-	-	-	-	NA	NA
France	4 734	10	10	0.0%	-4 724	-100%	0	0%	T2,T3	CS,PS
Germany	25 396	2 988	2 379	11.0%	-23 018	-91%	-610	-20%	T3	CS
Greece	NO	NO	NO	-	-	-	-	-	NA	NA
Hungary	889	57	54	0.2%	-835	-94%	-3	-5%	T1,T2	CS,D
Ireland	56	20	19	0.1%	-36	-65%	0	-2%	T1	D
Italy	20	20	17	0.1%	-3	-14%	-2	-12%	T2	D
Latvia	NO	NO	NO	-	-	-	-	-	NA	NA
Lithuania	NO	NO	NO	-	-	-	-	-	NA	NA
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	NO	NO	NO	-	-	-	-	-	NA	NA
Poland	19 743	15 481	15 618	72.0%	-4 125	-21%	137	1%	T1,T2	D
Portugal	91	9	8	0.0%	-82	-91%	0	-2%	NO	NO
Romania	3 233	450	406	1.9%	-2 827	-87%	-43	-10%	NA	NA
Slovakia	680	319	310	1.4%	-370	-54%	-9	-3%	T2	CS
Slovenia	361	218	230	1.1%	-131	-36%	11	5%	T2,T3	CS,D,PS
Spain	1 620	102	84	0.4%	-1 536	-95%	-19	-18%	CS,T2	CS
Sweden	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom	21 616	1 313	455	2.1%	-21 161	-98%	-858	-65%	T2,T3	CS
EU-28	**88 162**	**23 476**	**21 683**	**100%**	**-66 479**	**-75%**	**-1 793**	**-8%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	21 616	1 313	455	2.1%	-21 161	-98%	-858	-65%	T2,T3	CS
EU-28 + ISL	**88 162**	**23 476**	**21 683**	**100%**	**-66 479**	**-75%**	**-1 793**	**-8%**	**-**	**-**

Note: According to the MS NIR Poland calculates emissions from this source with a Tier3 approach

Figure 3.158 1.B.1.a.1.i Mining activities - Underground Mines: Emission trend and share for EU-28 and the emitting countries of CH_4

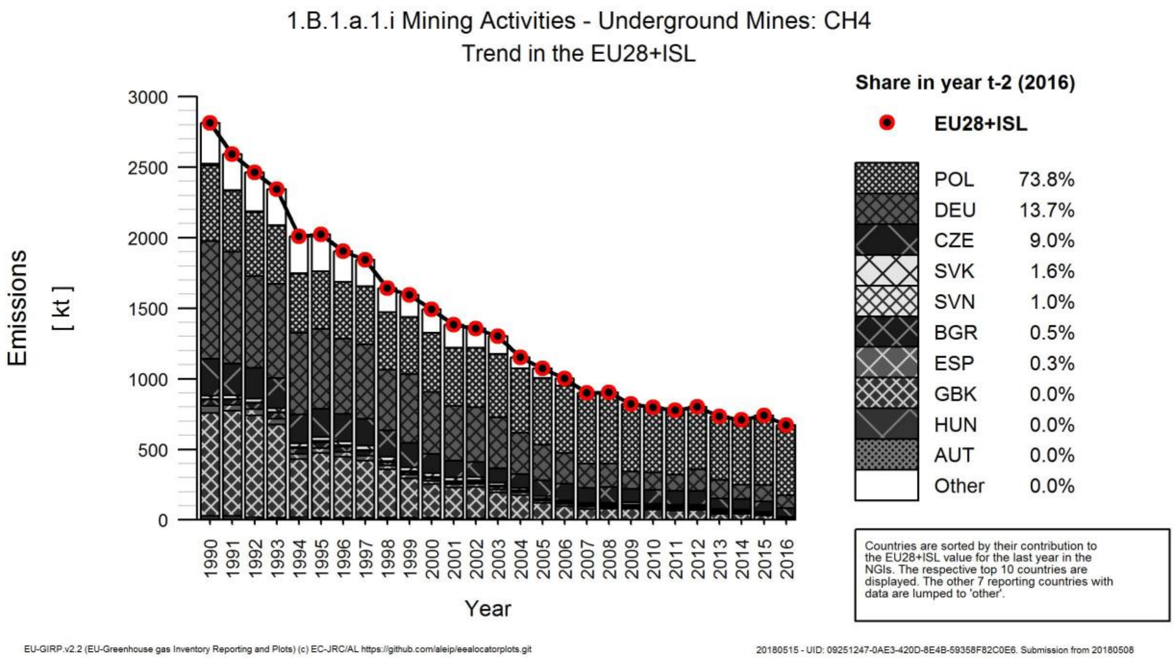
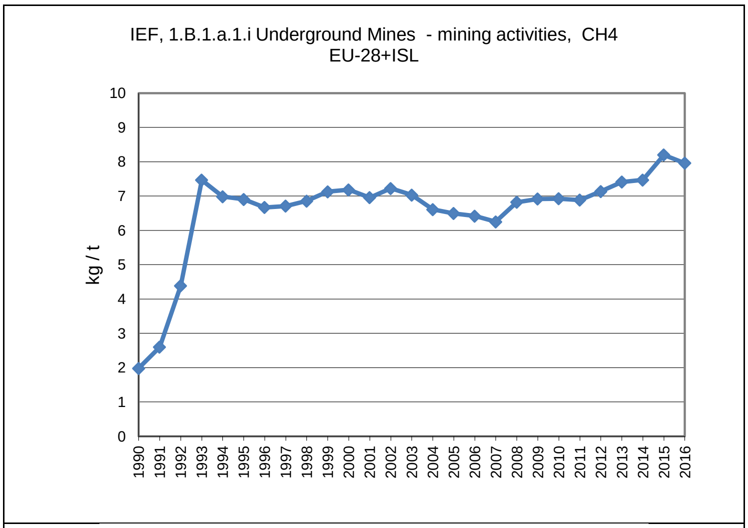
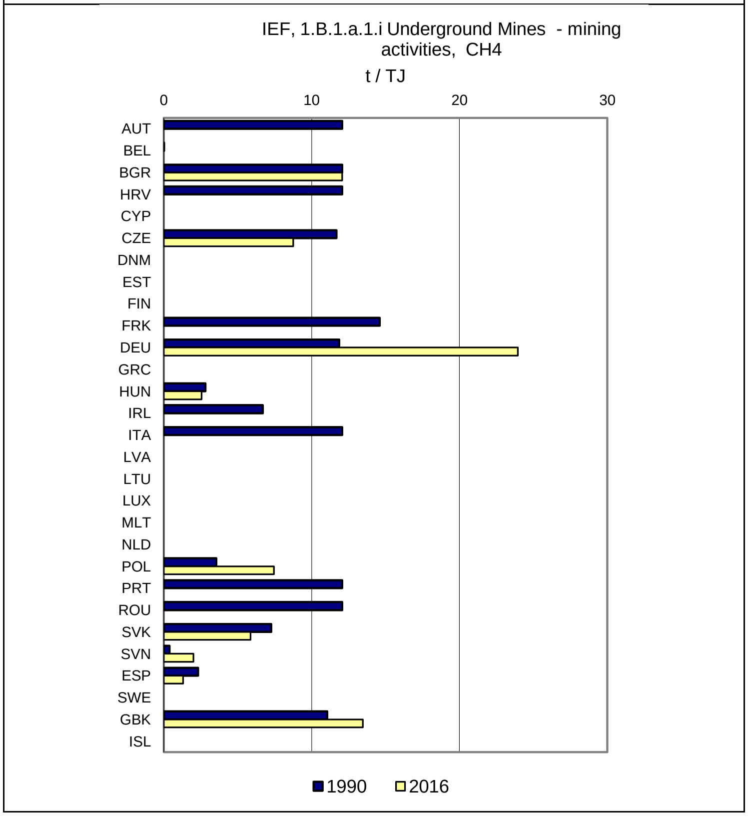


Figure 3.159 shows the implied emission factor of EU28+ISL and also the implied emission factor for each Member State for CH_4 emissions in 1B1a1i – underground mines, mining activities, which are responsible for 76 % of total GHG emissions from 1.B.1.a.1.

The steep increase of the EU IEF (upper figure) is caused by the strong decrease of emissions from this source in Belgium, who was applying a low IEF to calculate CH_4 emissions from this source. Belgium caused 73% of CH_4 emissions in 1990 and showed a sharp decrease until they stopped in 1993.

Figure 3.159: 1.B.1.a.1.i Mining activities – Underground mines - Implied Emission Factors for CH_4 (in kg/t)





CH_4 from Surface mines (1.B.1.a.2)

In 2016, only 17% of emissions from coal mining originate from surface mining. Overall, the coal production from surface mines decreased by 34 % between 1990 and 2016 (Figure 3.160).

Czech Republic shows largest decreases of methane emissions in absolute terms between 1990 and 2016 (-1 423 kt CO_2 equ.), which is caused by the closure of mines (CZE NIR 2018).

Together, Czech Republic and Poland account for 57% of emissions from this source. Both apply a Tier 1 methodology with a default emission factor as methane emissions from surface mining represents only a minor source of methane emissions from coal mining – in Poland, 8 % of total emissions from coal mining arise from category 1.B.1.a.2, the share in Czech Republic is 40%. For detailed information on Member States methodologies please see Annex III. (Table **3.112**).

Table 3.112 1.B.1.a.2 Coal Mining – surface mining: Member States contribution to CH_4 emissions

Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016		Method	Emission factor Informa-tion
	1990	2015	2016		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	34	NO	NO	-	-34	-100%	-	-	NA	NA
Belgium	NO	NO	NO	-	-	-	-	-	NA	NA
Bulgaria	606	771	674	14.5%	68	11%	-97	-13%	T1	D
Croatia	NO	NO	NO	-	-	-	-	-	NA	NA
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czech Republic	2 778	1 340	1 355	29.2%	-1 423	-51%	15	1%	T1	D
Denmark	NO	NO	NO	-	-	-	-	-	NA	NA
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	NO	NO	NO	-	-	-	-	-	NA	NA
France	47	NO	NO	-	-47	-100%	-	-	NA	NA
Germany	98	49	47	1.0%	-51	-52%	-2	-4%	T2	CS
Greece	1 130	1 007	711	15.3%	-419	-37%	-296	-29%	T1	D
Hungary	NO	IE	IE	-	-	-	-	-	NA	NA
Ireland	NO	NO	NO	-	-	-	-	-	NA	NA
Italy	33	NO	NO	-	-33	-100%	-	-	NA	NA
Latvia	NO	NO	NO	-	-	-	-	-	NA	NA
Lithuania	NO	NO	NO	-	-	-	-	-	NA	NA
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	NO	NO	NO	-	-	-	-	-	NA	NA
Poland	1 474	1 375	1 312	28.3%	-161	-11%	-62	-5%	T1	D
Portugal	NO	NO	NO	-	-	-	-	-	NA	NA
Romania	624	555	500	10.8%	-124	-20%	-55	-10%	T1	D
Slovakia	NO	NO	NO	-	-	-	-	-	NA	NA
Slovenia	NO	NO	NO	-	-	-	-	-	NA	NA
Spain	1	3	NA	-	-1	-100%	-3	-100%	NA	NA
Sweden	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom	193	62	44	1.0%	-148	-77%	-18	-29%	T2	CS
EU-28	**7 018**	**5 162**	**4 644**	**100%**	**-2 373**	**-34%**	**-518**	**-10%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	193	62	44	1.0%	-148	-77%	-18	-29%	T2	CS
EU-28 + ISL	**7 018**	**5 162**	**4 644**	**100%**	**-2 373**	**-34%**	**-518**	**-10%**	**-**	**-**

Figure 3.160 1.B.1.a.2.i Mining activities - Surface Mines: Emission trend and share for the emitting countries of CH_4

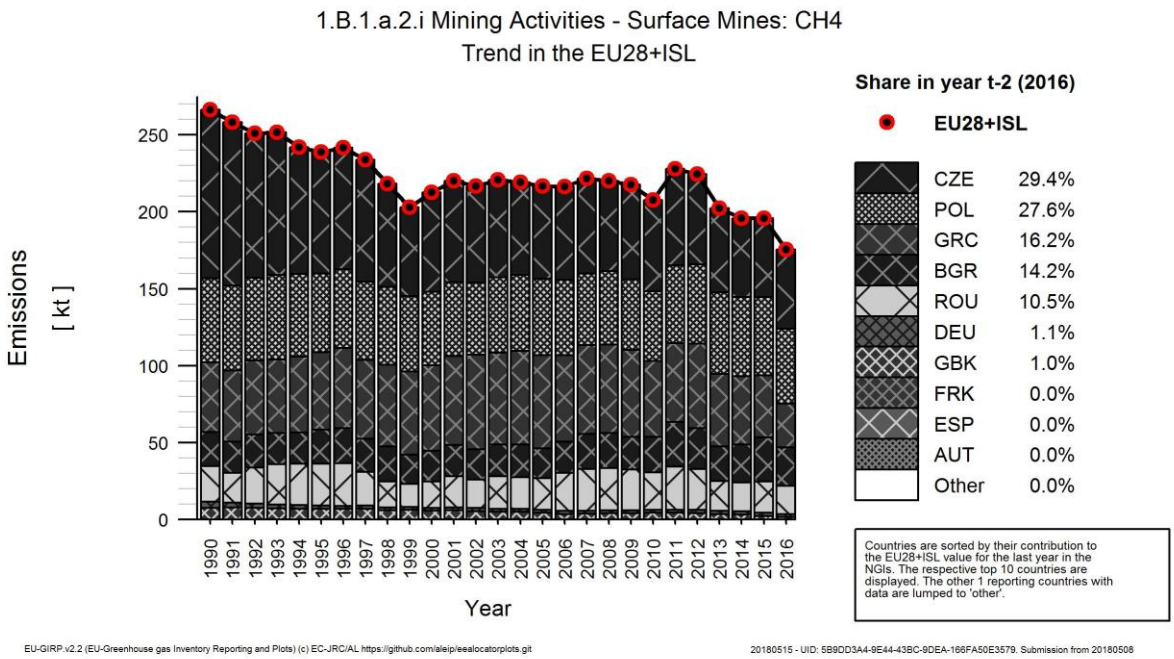


Figure **3.155** shows the Implied Emission factor of EU28+ISL and also the implied Emission factor for each Member State for CH_4 emissions in 1.B.1.a.2.i – mining activities from surface mines, which are responsible for 94 % of total GHG emissions from 1.B.1.a.2.

CZE applies the high default emission factor from the IPCC 2006 Guidelines which explains the outlier in Figure **3.161** (lower figure).

Figure 3.161: 1.B.1.a.2.i Mining activities – Surface mines - Overview of outliers of Implied Emission Factors for CH_4 (in kg/t)

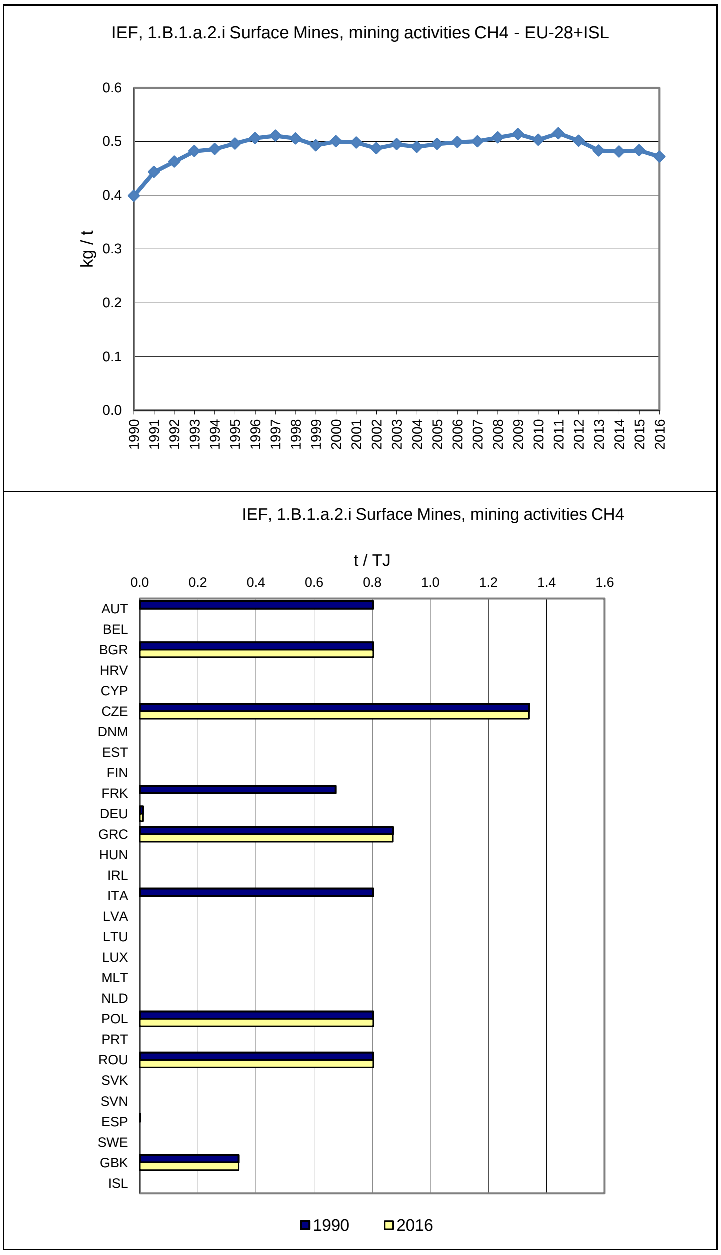


Table 3.113 provides information on the contribution of Member States to EU-28+ISL recalculations in CH_4 from 1.B.1 Solid fuels for 1990 and 2015.

Table 3.1131.B.1 Fugitive Emissions from Solid Fuels: Contribution of MS to EU-28+ISL recalculations in CH_4 for 1990 and 2015 (difference between latest submission and previous submission in kt of CO_2 equivalents and percent)

	1990		2015		Main explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
Austria	-	-	-	-	NA
Belgium	33	8.3	36	599.2	In the Walloon region, correction of a mistake in the previous submission
Bulgaria	-	-	-1	-0.1	For category 1.B.1.a.2.1 Fugitive emissions from surface mines, the previous emission factor of 1.2 m3/t was changed to 1.5 m3/t (IPCC GPG 2000, p.2.75), following a recommendation of the ERT during the Centralized review in 2012. For the 2014 submission the EF was changed back to 1.2 m3/t following the adoption of the 2006 IPCC Guidelines.
Croatia	-	-	-	-	NA
Cyprus	-	-	-	-	NA
Czech Republic	-	-	-	-	NA
Denmark	-	-	-	-	NA
Estonia	-	-	-	-	NA
Finland	-	-	-	-	NA
France	-	-	-	-	NA
Germany	-	-	-	-	NA
Greece	-	-	-	-	NA
Hungary	-	-	-	-	NA
Ireland	-	-	-	-	NA
Italy	-	-	-8	-15.7	Update of activity data
Latvia	-	-	-	-	NA
Lithuania	-	-	-	-	NA
Luxembourg	-	-	-	-	NA
Malta	-	-	-	-	NA
Netherlands	-	-	-	-	NA
Poland	-	-	57	0.3	energy balance based on Eurostat database
Portugal	2	2.8	-	-	CH_4 emission factors have been updated to the 2006 IPCC Guidelines.
Romania	-	-	-	-	NA
Slovakia	-	-	-	-	NA
Slovenia	-	-	-	-	NA
Spain	-	-	-49	-31.8	Update of the activity variable of category 1.B1a in year 2015
Sweden	-	-	-	-	NA
United Kingdom	-0.0002	-0.0	-0.0002	-0.0	change to derivation of emission factors to use a time series of GCVs and single values for density conversions
EU28	35	0.0	35	0.1	
Iceland	-	-	-	-	NA
United Kingdom (KP)	-0.0002	-0.0	-0.0002	0.0	change to derivation of emission factors to use a time series of GCVs and single values for density conversions
EU28+ISL	35	0.0	35	0.1	

Emissions from Other (1.B.1.c)

Two member states report CH_4 emissions in this sector, three are also reporting CO_2 emissions, one member state is reporting N_2O emissions.. The description of the subcategories are presented in Table 3.114.

Table 3.114 Description of subcategories in sector 1.B.1c for CO_2- and CH_4-emissions for reporting Member States

Member state	Emission	Subcategory
Poland	CO_2, CH_4	emissions from Coke Oven Gas Subsystem
Slovenia	CO_2	SO_2 scrubbing
Sweden	CO_2, CH_4, N_2O	Flaring of gas

3.2.6.2 Fugitive emissions from oil and natural gas (1.B.2)

Fugitive emissions from oil and natural gas correspond to the total fugitive emissions from oil and natural gas activities. Fugitive emissions may arise from equipment leaks, evaporation losses, venting, flaring and accidental releases (2006 IPCC Guidelines).

Fugitive emissions from 1.B.2 Oil and natural gas include all emissions from exploration, production, processing, transport, and handling of oil and natural gas. They account for 1.3 % of the total GHG emissions in 2016 and for 65 % (Figure 3.162) of all fugitive emissions in the EU-28+ISL.

Of all fugitive emissions from oil and natural gas, in 2016:

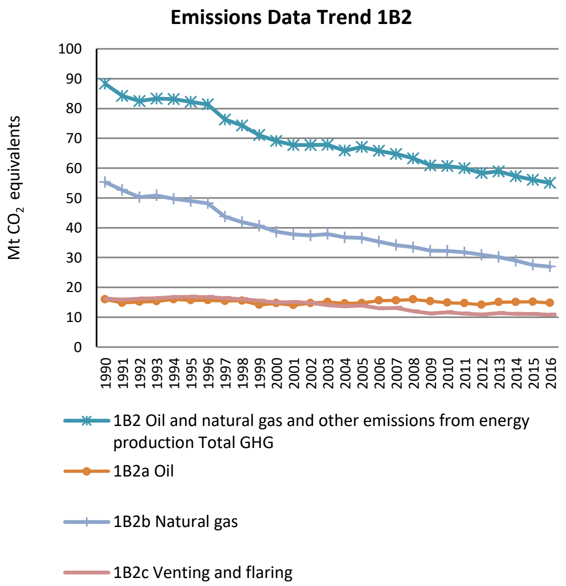
- 46 % were CH_4 emissions from natural gas (exploration, production, processing, transport and distribution)
- 21 % were CO_2 emissions from oil (exploration, production, transport, refining and storage and distribution)
- 4 % were CH_4 emissions due to Other emissions

This source category includes three key categories:

Table 3.115: Key source categories for level and trend analyses and share of MS emissions using higher tier methods in sector 1.B.2 (table excerpt)

Source category gas	kt CO_2 equ. 1990	kt CO_2 equ. 2016	Trend	Level 1990	Level 2016	share of higher Tier
1.B.2.a Oil: Operation (CO_2)	9104	11456	T	L	L	80%
1.B.2.b Natural Gas: Operation (CH_4)	51404	25141	T	L	L	73%
1.B.2.c Venting and Flaring: Operation (CO_2)	8723	6180	0	L	L	86%

Figure 3.162 1.B.2-Fugitive Emissions Oil and Natural Gas: Trend



Fugitive emissions from oil and natural gas occur in all Member States but Malta (Table 3.116). Total greenhouse gas emissions from 1.B.2 decreased by 38 % between 1990 and 2016 (Figure **3.162**). This trend was mainly due to the reduction of fugitive CH_4 emissions from natural gas activities, which decreased by 51 % over that period.

In 2016, 59% of all fugitive GHG emissions from oil and natural gas were emitted by four countries: Germany, Italy, Romania and the United Kingdom (Table 3.116). The largest reductions (in absolute terms) were observed in the Romania and in the United Kingdom (both mainly CH_4 emissions), while emissions increased most in Poland (mainly CH_4 emissions) (Table 3.116).

Table 3.116 1.B.2 Fugitive emissions from oil and natural gas: Member States' contributions

Member State	GHG emissions in 1990 (kt CO2 equivalents)	GHG emissions in 2016 (kt CO2 equivalents)	CO2 emissions in 1990 (kt)	CO2 emissions in 2016 (kt)	N2O emissions in 1990 (kt CO2 equivalents)	N2O emissions in 2016 (kt CO2 equivalents)	CH4 emissions in 1990 (kt CO2 equivalents)	CH4 emissions in 2016 (kt CO2 equivalents)
Austria	369	392	102	131	NA,NO,IE	NO,IE,NA	266	261
Belgium	805	601	85	78	NO,IE,NA	NO,IE,NA	720	523
Bulgaria	274	210	4	6	0	0	270	204
Croatia	1 050	492	680	288	1	0	369	203
Cyprus	0	0	0	0	NE,NO	NO	0	0
Czech Republic	1 082	610	2	5	0	0	1 080	605
Denmark	517	419	341	273	53	46	123	100
Estonia	50	17	0	0	NO	NO	50	17
Finland	123	138	111	104	1	1	11	33
France	6 181	4 183	4 362	2 957	26	14	1 793	1 213
Germany	10 581	6 770	2 234	1 704	1	0	8 346	5 066
Greece	79	116	43	9	0	0	36	106
Hungary	1 750	789	478	134	1	0	1 271	655
Ireland	156	22	0	2	NO	NO	156	20
Italy	12 745	7 178	4 013	2 483	12	9	8 720	4 686
Latvia	248	117	0	0	NO	NO	248	117
Lithuania	266	308	1	4	0	0	265	304
Luxembourg	19	32	0	0	NO	NO	19	32
Malta	NA,NO	NA,NO	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA
Netherlands	2 707	1 635	775	1 027	NO,IE,NA	NO,IE,NA	1 932	608
Poland	1 040	4 374	41	1 843	0	1	999	2 530
Portugal	122	1 163	119	1 105	2	3	1	55
Romania	25 537	9 727	1 177	913	3	2	24 357	8 812
Slovakia	1 714	1 359	5	1	0	0	1 708	1 358
Slovenia	50	38	0	0	0	0	50	38
Spain	2 199	4 412	1 749	3 777	0	0	450	636
Sweden	384	730	292	667	0	1	92	63
United Kingdom	18 164	9 015	5 778	4 115	41	36	12 345	4 863
EU-28	**88 212**	**54 846**	**22 391**	**21 626**	**142**	**113**	**65 679**	**33 107**
Iceland	62	152	61	149	NA,NO	NO,NA	1	4
United Kingdom (KP)	18 164	9 015	5 778	4 115	41	36	12 345	4 863
EU-28 + ISL	**88 274**	**54 999**	**22 452**	**21 775**	**142**	**113**	**65 680**	**33 110**

Abbreviations explained in the Chapter 'Units and abbreviations'.
AUT: N_2O emissions from venting and flaring are included in 1.A.1.b (petroleum refining)
BEL: N_2O emissions are reported in 1.A.1.b (petroleum refining)
NLD: N_2O emissions from gas transmission are included in 1.A.3.e.i (pipeline transport gaseous fuels)

CO_2 and CH_4 from Oil (1.B.2.a)

Fugitive emissions from oil correspond to fugitive emissions from all sources associated with the exploration, production, transmission, upgrading and refining of crude oil and the distribution of crude oil products (2006 IPCC Guidelines).

CO_2 emissions from 1.B.2.a 'Fugitive emissions from oil' account for 0.3 % of total EU-28+ISL GHG emissions in 2016 and for 14 % of all fugitive emissions. Between 1990 and 2016, CO_2 emissions from this source increased by 26 % in the EU-28+ISL (Table 3.117). By contrast, during the same period 1990-2016, CH_4 emissions of this source category were reduced by 51 %.

Together France, Italy and Spain accounted for 68 % of the EU-28+ISL total CO_2 emissions of 1.B.2.a 'Fugitive CO_2 emissions from oil' (Table 3.117, Figure 3.163). Main contributor to these emissions in all countries is subcategory 1.B.2.a.4 (Oil – Refining/Storage). Spain is applying a Tier 2 methodology with a plant specific emission factor in this subcategory. Italy also applies a Tier 2 methodology for CO_2 emissions from oil refining and storage, while the emission factor is country specific. France uses specific emission factors provided by the plant operator, for other processes, emissions are derived directly from annual emission reports (FRK NIR 2018). For detailed information on Member States methodologies please see Annex III. Table **3.117** shows that 80 % of EU-28 emissions are calculated using higher tier methods. In cases where member states report a mix of Tier 1 and higher Tier methods (FRK, ITA, ROU, ESP) only emissions from subcategories of sector 1.B.2.a were taken into account for the calculation, where the member states actually apply a higher tier method. Countries that report a Tier 1 method but a country specific or plant specific emission factor (HUN, SVK) were calculated as a Tier 2 method, according to the IPCC 2006 Guidelines. [

During the period 1990-2016, the largest decreases in CO_2 emissions (in absolute terms) were observed in Italy and the United Kingdom. (Table 3.117). Decreasing CO_2 emissions in Italy are mainly driven by the reduction in crude oil losses in refineries (ITA NIR 2018). In the UK, CO_2 emissions from this source decline mainly due to a decrease of 88% of CO_2 emissions in oil exploration (1.B.2.a.1).

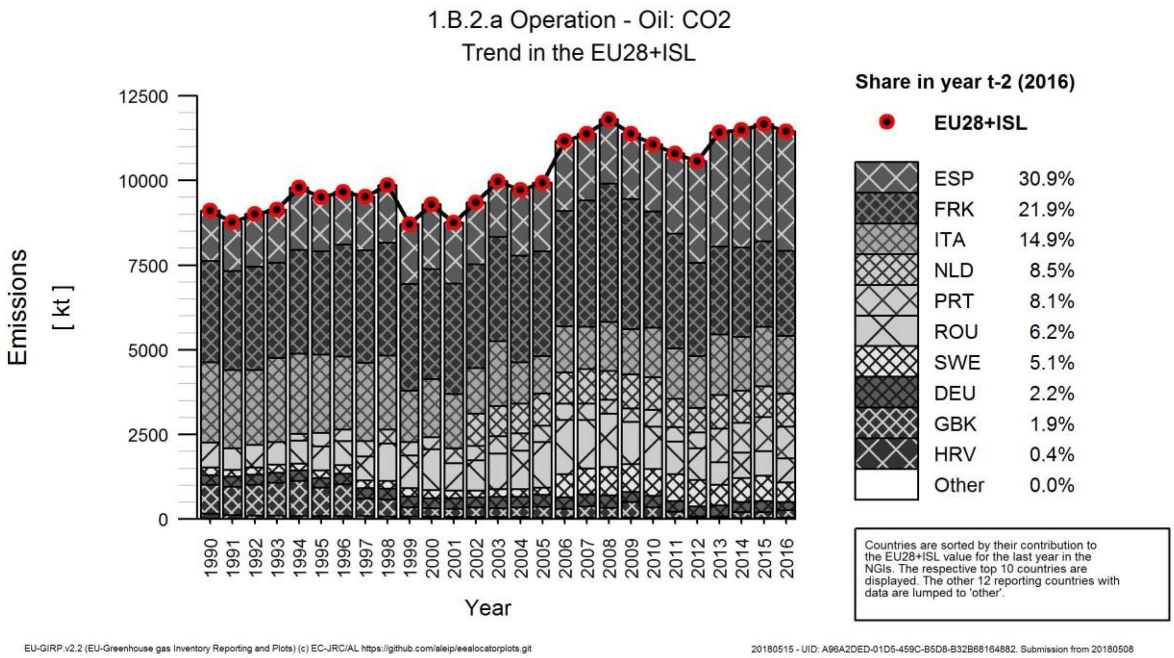
Largest increases between 1990-2018 are reported in the Netherlands, Portugal and Spain (Table 3.117). In all three countries, increases are mainly driven by increases in CO_2 emissions from subcategory 1.B.2.a.4 (Oil – Refining/Storage).

Table 3.117 1.B.2.a Fugitive CO_2 emissions from oil: Member States' contributions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016		Method	Emission factor Informa-tion
	1990	2015	2016		kt CO2	%	kt CO2	%		
Austria	0.004	0.005	0.004	0.0%	0	11%	-0.0003	-6%	T1	D
Belgium	0.01	0.02	0.02	0.0%	0	27%	-0.0001	-1%	T1	D
Bulgaria	1	0	0	0.0%	0	-60%	-0.01	-4%	T1	D
Croatia	158	39	43	0.4%	-115	-73%	4	10%	T1	D
Cyprus	NO,NE	NO,NE	NO,NE	-	-	-	-	-	NA	NA
Czech Republic	0.02	0.05	0.04	0.0%	0.02	105%	-0.005	-10%	T1	D
Denmark	5	1	0	0.0%	-5	-100%	-1	-99%	T3	D,PS
Estonia	NO,NA	NO,NA	NO,NA	-	-	-	-	-	NA	NA
Finland	NO	NO	NO	-	-	-	-	-	NA	NA
France	2 983	2 522	2 508	21.9%	-475	-16%	-14	-1%	T1,T2,T3	CS,D,PS
Germany	283	315	249	2.2%	-33	-12%	-65	-21%	T2	CS
Greece	0.00004	0.000003	0.00001	0.0%	-0.00003	-77%	0.00001	184%	T1	D
Hungary	5	1	0.5	0.004%	-5	-90%	-0.1	-14%	T1	CS
Ireland	NO	NO	NO	-	-	-	-	-	NA	NA
Italy	2 368	1 767	1 706	14.9%	-662	-28%	-61	-3%	T1,T2	CS,D
Latvia	NO,NA	NA,NO	NO,NA	-	-	-	-	-	NA	NA
Lithuania	0	1	1	0.01%	1	388%	-0.1	-13%	T1	D
Luxembourg	NO,NA	NO,NA	NO,NA	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	0.02	902	975	8.5%	975	5419713%	73	8%	T1	D
Poland	0.1	0.2	0.2	0.002%	0	333%	0	-1%	T1	CS,D
Portugal	0.5	1 001	931	8.1%	931	192266%	-70	-7%	D	D
Romania	746	730	708	6.2%	-38	-5%	-22	-3%	T1,T2	CS,D
Slovakia	0.03	0.01	0.01	0.0001%	-0.02	-72%	-0.001	-11%	T1	CS
Slovenia	0.01	0.02	0.02	0.0002%	0.01	137%	-0.0002	-1%	T1	D
Spain	1 477	3 449	3 538	30.9%	2 061	140%	89	3%	T1,T2	D,PS
Sweden	219	757	580	5.1%	360	164%	-177	-23%	T3	PS
United Kingdom	859	172	216	1.9%	-644	-75%	44	25%	T2	CS,PS
EU-28	**9 104**	**11 657**	**11 456**	**100%**	**2 352**	**26%**	**-201**	**-2%**	**-**	**-**
Iceland	0.002	0.002	0.003	0.0%	0.001	40%	0.0003	12%	T1	D
United Kingdom (KP)	859	172	216	1.9%	-644	-75%	44	25%	T2	CS,PS
EU-28 + ISL	**9 104**	**11 657**	**11 456**	**100%**	**2 352**	**26%**	**-201**	**-2%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'.

Figure 3.163 1.B.2.a Oil: Emission trend and share for the emitting countries of CO_2



CH_4 emissions from 1.B.2.a ‘Fugitive emissions from oil’ account for 0.1 % of total EU-28+ISL GHG emissions in 2015 and for 4 % of all fugitive emissions. Between 1990 and 2016, CH_4 emissions from this source decreased by 51 % in the EU-28+ISL (Table 3.117).

Together Romania, Italy and Germany accounted for 85 % of the EU-28+ISL total CH_4 emissions of 1.B.2.a ‘Fugitive CH_4 emissions from oil’ (Table 3.118). In Romania main contributions to CH_4 emissions come from subcategory 1.B.2.a.2 (Oil – Production). Emissions are estimated using a Tier 1 methodology with a default emission factor for developing countries. The EU is in consultation with Romania to refine the methodology for the estimation of emissions from this source. The main contributor to methane emissions for category 1.B.2.a in Italy is also subcategory 1.B.2.a.2 (Oil – Production), where a Tier 2 methodology with a country specific emission factor is used. CH_4 emissions from Germany arise mainly from subcategory 1.B.2.a.4 (Oil – Refining/Storage), a Tier 2 methodology with a country specific emission factor is applied. For detailed information on Member States methodologies please see Annex III.

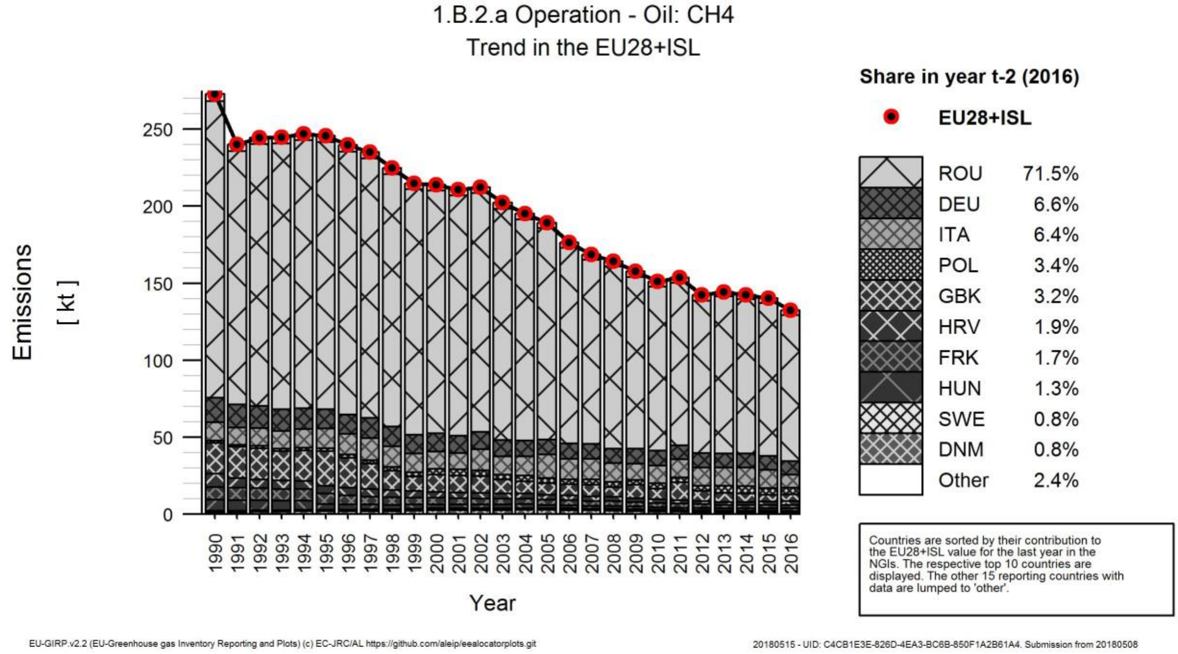
During the period 1990-2016, the largest decreases in CH_4 emissions (in absolute terms) were observed in the United Kingdom and Romania, caused by significant decreases in oil production (-52% in Romania, -78% in the UK). In the same period of time emissions increased most in Poland due to an increase of 323% in oil production (Table 3.118).

Table 3.118 1.B.2.a Fugitive CH_4 emissions from oil: Member States’ contributions

Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016		Method	Emission factor Informa-tion
	1990	2015	2016		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	7	8	8	0.2%	0	4%	-1	-8%	T1	D
Belgium	11	7	7	0.2%	-4	-39%	-0.2	-2%	CS,D	CS,D
Bulgaria	9	6	6	0.2%	-4	-40%	0.1	1%	T1	D
Croatia	221	56	62	1.9%	-159	-72%	6	10%	T1	D
Cyprus	0.1	NO,NE	NO,NE	-	-0.1	-100%	-	-	NA	NA
Czech Republic	23	6	5	0.1%	-18	-79%	-1	-23%	T1,T2	CS,D
Denmark	31	29	26	0.8%	-5	-17%	-3	-12%	T2,T3	,D,OTH,PS
Estonia	NO,NA	NO,NA	NO,NA	-	-	-	-	-	NA	NA
Finland	6	8	9	0.3%	3	42%	1	15%	T1	D
France	206	58	57	1.7%	-149	-72%	-1	-2%	T1,T2,T3	CS,D,PS
Germany	404	228	218	6.6%	-186	-46%	-10	-4%	T2	CS
Greece	10	14	15	0.5%	5	53%	1	7%	T1	D
Hungary	179	39	43	1.3%	-135	-76%	4	11%	T1	CS
Ireland	0.2	0.4	0.4	0.0%	0.2	77%	-0.02	-4%	T1	D
Italy	295	292	211	6.4%	-84	-28%	-81	-28%	T1,T2	CS,D
Latvia	NO,NA	NA,NO	NO,NA	-	-	-	-	-	NA	NA
Lithuania	4	3	3	0.1%	-1	-27%	-0.1	-2%	T1	D
Luxembourg	NO,NA	NO,NA	NO,NA	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	20	12	14	0.4%	-7	-33%	1	12%	T1,T1b	CS,D
Poland	34	115	113	3.4%	79	232%	-2	-1%	T1	CS,D
Portugal	0.002	0.002	0.002	0.0%	0.001	32%	-0.00001	0%	CR,OTH	CR,OTH
Romania	4 811	2 480	2 367	71.5%	-2 444	-51%	-113	-5%	T1	D
Slovakia	15	9	8	0.2%	-7	-46%	-1	-6%	T1	CS
Slovenia	0.3	NO,NA	NO,NA	-	-0.3	-100%	-	-	NA	NA
Spain	4	4	4	0.1%	0.2	6%	0.02	1%	T1	D
Sweden	25	27	26	0.8%	1	5%	-1	-4%	T1,T2	CS,D,PS
United Kingdom	500	104	106	3.2%	-394	-79%	2	2%	T2	CS,PS
EU-28	**6 817**	**3 505**	**3 308**	**100%**	**-3 509**	**-51%**	**-198**	**-6%**	**-**	**-**
Iceland	0.5	1	1	0.0%	0.2	40%	0.1	12%	T1	D
United Kingdom (KP)	500	104	106	3.2%	-394	-79%	2	2%	T2	CS,PS
EU-28 + ISL	**6 817**	**3 506**	**3 308**	**100%**	**-3 509**	**-51%**	**-197**	**-6%**	**-**	**-**

Abbreviations explained in the Chapter ‘Units and abbreviations’.

Figure 3.164: 1.B.2.a Oil: Emission trend and share for the emitting countries of CO_2



CH_4 from Natural gas (1.B.2.b)

Fugitive emissions from natural gas correspond to emissions from all fugitive sources associated with the exploration, production, processing, transmission, storage and distribution of natural gas (associated and non-associated gas) (2006 IPCC Guidelines).

CH_4 emissions from 1.B.2.b ‘Fugitive emissions from natural gas’ account for 0.6 % of total EU-28+ISL GHG emissions in 2016 and for 30 % of all fugitive emissions in the EU-28+ISL. Between 1990 and 2016, CH_4 emissions from this source decreased by 51 % (Table 3.119).

In 2016, 73% of the EU-28+ISL CH_4 emissions from 1.B.2.b were emitted by four Member States: Germany, Italy, Romania and the United Kingdom (Table 3.119, Figure 3.165). In Germany, Italy and the United Kingdom, methane emissions are mainly contributed by natural gas distribution (1.B.2.b.5). Germany and the United Kingdom apply a Tier 3 methodology with country specific emission factors, while Italy uses a Tier 2 methodology and country specific emission factors to estimate emissions. Emissions from natural gas production (1.B.2.b.2) and other operations on natural gas (1.B.2.b.6) are the main sources for CH_4 emissions in Romania in this category. The country applies a Tier 1 methodology with default emission factors for developing countries. The EU is in consultation with Romania to refine the methodology for the estimation of emissions from this source. For detailed information on Member States methodologies please see Annex III. Table 3.119 shows that 73 % of EU-28 emissions are calculated using higher tier methods. In cases where member states report a mix of Tier 1 and higher Tier methods (AUT, HRV, FIN, PRT, ESP) only emissions from subcategories of sector 1.B.2.b were taken into account for the calculation, where the member states actually apply a higher tier method. Countries that report a Tier 1 method but a country specific or plant specific emission factor (HUN, SVK) were calculated as a Tier 2 method, according to the IPCC 2006 Guidelines.

The emission decreases between 1990 and 2016 observed in Romania (-69 %), the United Kingdom (-63 %), Germany (-39 %) and in Italy (-46 %) contributed most significantly to the overall reduction in the EU-28+ISL between 1990 and 2016. The decrease was mainly caused by improvement of technology (United Kingdom), the improvement of pipeline network (Germany), the reduction of losses in gas distribution (Italy) and the decrease in production (Romania).

Table 3.119 1.B.2.b Fugitive CH_4 emissions from natural gas: Member States' contributions

Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016		Method	Emission factor Informa-tion
	1990	2015	2016		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	259	254	253	1.0%	-6	-2%	-1	-1%	T1,T2	CS,D
Belgium	709	529	515	2.0%	-193	-27%	-14	-3%	CS	CS
Bulgaria	246	183	192	0.8%	-54	-22%	9	5%	T1	D
Croatia	148	146	141	0.6%	-7	-5%	-5	-3%	T1,T2	D
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czech Republic	1 045	570	571	2.3%	-474	-45%	1	0%	T1,T2	CS
Denmark	61	48	47	0.2%	-14	-23%	-1	-1%	T2,T3	CS,D
Estonia	50	16	17	0.1%	-33	-66%	2	10%	T1	D
Finland	4	29	24	0.1%	20	465%	-5	-17%	T1,T2	CS,D,PS
France	1 512	1 111	1 133	4.5%	-379	-25%	22	2%	T2,T3	CS,PS
Germany	7 940	4 792	4 845	19.3%	-3 095	-39%	53	1%	T2,T3	CS
Greece	9	66	69	0.3%	60	651%	4	5%	T1	D
Hungary	735	424	479	1.9%	-256	-35%	54	13%	T1	CS
Ireland	156	23	20	0.1%	-136	-87%	-3	-12%	CS,T2	CS
Italy	8 235	4 552	4 417	17.6%	-3 818	-46%	-135	-3%	T2	CS
Latvia	177	87	101	0.4%	-77	-43%	14	16%	T3	CS
Lithuania	261	290	300	1.2%	39	15%	10	3%	T2	CS
Luxembourg	19	35	32	0.1%	12	64%	-3	-8%	T1	D
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	421	323	314	1.2%	-107	-26%	-10	-3%	T3	CS
Poland	678	1 046	1 075	4.3%	397	59%	29	3%	T1	D
Portugal	NO	53	53	0.2%	53	∞	0	0%	CR,NO,OTH	CR,NO,OTH
Romania	16 933	5 614	5 200	20.7%	-11 733	-69%	-414	-7%	T1	D
Slovakia	1 103	805	865	3.4%	-239	-22%	60	7%	T1	CS
Slovenia	42	30	32	0.1%	-10	-24%	2	6%	T1	D
Spain	425	614	627	2.5%	202	48%	13	2%	CS,T1	CS,D
Sweden	67	36	37	0.1%	-31	-45%	1	2%	T2,T3	CS,PS
United Kingdom	10 168	3 857	3 783	15.0%	-6 386	-63%	-74	-2%	T2,T3	CS,PS
EU-28	**51 404**	**25 533**	**25 141**	**100%**	**-26 263**	**-51%**	**-392**	**-2%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	10 168	3 857	3 783	15.0%	-6 386	-63%	-74	-2%	T2,T3	CS,PS
EU-28 + ISL	**51 404**	**25 533**	**25 141**	**100%**	**-26 263**	**-51%**	**-392**	**-2%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'.

Figure 3.165 1.B.2.b Natural Gas: Emission trend and share for the emitting countries of CH_4

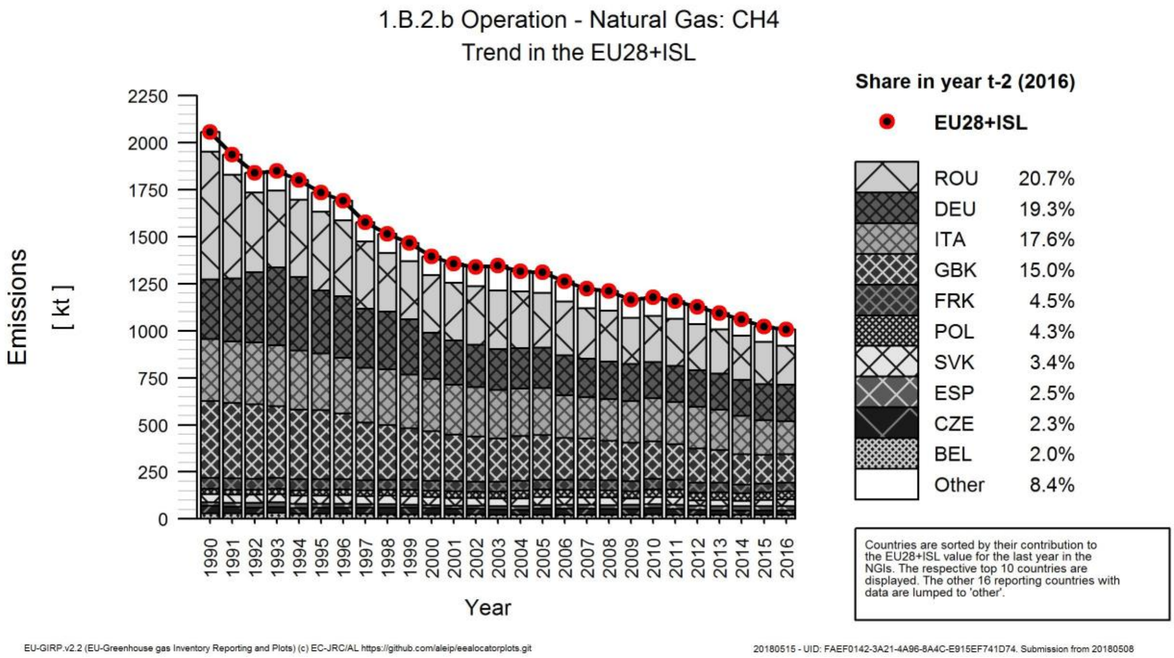


Table 3.120 provides an overview on activity data description and emission factors for all member states for sector 1.B.2.b. CRF Tables do not include activity data for sector 1.B.2 because member states use different types of activity data which cannot be aggregated.

Table 3.120 1.B.2.b Fugitive CH_4 emissions from natural gas: Information on activity data, emission factors by Member State

1.B.2.b Fugitive CH_4 Emissions from Natural gas			1990					2016				
Member State		GHG source category	Activity data			Implied emission factor (kg/unit)	CH_4 emissions (kt)	Activity data			Implied emission factor (kg/unit)	CH_4 emissions (kt)
			Description	Unit	Value			Description	Unit	Value		
AUT	Austria	**Natural Gas**					**10.36**					**10.12**
		1. Exploration	Mm3 natural gas	Mm3	248.09	IE	IE	Mm3 natural gas	Mm3	179.47	IE	IE
		2. Production	Mm3 natural gas	Mm3	1288.00	4478.94	5.77	Mm3 natural gas	Mm3	1253.00	3712.69	4.65
		3. Processing	Mm3 natural gas	Mm3	1288.00	NA	NA	Mm3 natural gas	Mm3	1253.00	NA	NA
		4. Transmission and storage	km pipeline length	km	3628.00	718.43	2.61	km pipeline length	km	7231.26	543.94	3.93
		5. Distribution	km distribution network length	km	11672.00	170.22	1.99	km distribution network length	km	30214.95	50.66	1.53
		6. Other	Mm3 natural gas stored	Mm3	1500.00	NO	NO	Mm3 natural gas stored	Mm3	5519.40	NO	NO
BEL	Belgium	**Natural Gas**					**28.35**					**20.62**
		1. Exploration		PJ	NO	NO	NO		PJ	NO	NO	NO
		2. Production		PJ	NO	NO	NO		PJ	NO	NO	NO
		3. Processing		PJ	NO	NO	NO		PJ	NO	NO	NO
		4. Transmission and storage		PJ	342.62	16575.78	5.68		PJ	583.46	10447.24	6.10
		5. Distribution		PJ	342.62	66163.74	22.67		PJ	583.46	24885.74	14.52
		6. Other		PJ	NO	NO	NO		PJ	NO	NO	NO
BGR	Bulgaria	**Natural Gas**					**9.82**					**7.68**
		2. Exploration		NA	IE	IE	IE		NA	IE	IE	IE
		3. Production	Indigenous production	106m3	14.00	1340.00	0.02	Indigenous production	106m3	93.00	1340.00	0.12
		4. Processing	Indigenous production	106m3	14.00	590.00	0.01	Indigenous production	106m3	93.00	590.00	0.05
		5. Transmission and storage	Transmission and storage	106m3	8789.55	273.62	2.41	Transmission and storage	106m3	14619.89	273.59	4.00
		6. Distribution	Inland consumption	106m3	6717.00	1100.00	7.39	Inland consumption	106m3	3180.00	1100.00	3.50
		7. Other		NO	NO	NO	NO		NO	NO	NO	NO
CYP	Cypre	**Natural Gas**					**NO**					**NO**

1.B.2.b Fugitive CH_4 Emissions from Natural gas			1990					2016				
Member State		GHG source category	Activity data			Implied emission factor (kg/unit)	CH_4 emissions (kt)	Activity data			Implied emission factor (kg/unit)	CH_4 emissions (kt)
			Description	Unit	Value			Description	Unit	Value		
		2. Exploration		NO	NO	NO	NO		NO	NO	NO	NO
		3. Production		NO	NO	NO	NO		NO	NO	NO	NO
		4. Processing		NO	NO	NO	NO		NO	NO	NO	NO
		5. Transmission and storage		NO	NO	NO	NO		NO	NO	NO	NO
		6. Distribution		NO	NO	NO	NO		NO	NO	NO	NO
		7. Other		NO	NO	NO	NO		NO	NO	NO	NO
CZE	Czech Republic	**Natural Gas**					**41.80**					**22.85**
		2. Exploration		PJ	NO	NO	NO		PJ	NO	NO	NO
		3. Production	(e.g. PJ gas produced)	PJ	7.84	39365.45	0.31	(e.g. PJ gas produced)	PJ	7.42	38649.05	0.29
		4. Processing		PJ	NO	NA	NA		PJ	NO	NA	NA
		5. Transmission and storage	(e.g. PJ gas consumed)	PJ	1357.98	9296.21	12.62	(e.g. PJ gas consumed)	PJ	1156.84	5442.87	6.30
		6. Distribution	(e.g. PJ gas consumed)	PJ	55.77	517563.35	28.86	(e.g. PJ gas consumed)	PJ	135.67	119893.57	16.27
		7. Other	(e.g. PJ gas consumed)	PJ	29.68	IE	IE	(e.g. PJ gas consumed)	PJ	185.27	IE	IE
DEU	Germany	**Natural Gas**					**317.60**					**193.81**
		3. Exploration	number of wells drilled	number	IE	IE	IE	number of wells drilled	number	IE	IE	IE
		4. Production	gas produced	1000 m³	15262000.00	0.38	5.80	gas produced	1000 m³	7873637.35	0.07	0.56
		5. Processing	gas produced	1000 m³	15262000.00	0.35	5.34	gas produced	1000 m³	7873637.35	0.05	0.41
		6. Transmission and storage	lenght of transmission pipelines	km	22696.00	1957.42	44.43	lenght of transmission pipelines	km	33357.00	2196.90	73.28
		7. Distribution	lenght of distribution pipelines	km	282612.00	824.05	232.89	lenght of distribution pipelines	km	510053.00	175.32	89.42
		8. Other	gas consumed	TJ	893519.00	32.62	29.15	gas consumed	TJ	1405522.00	21.44	30.13
DNM		**Natural Gas**					**2.43**					**1.88**

1.B.2.b Fugitive CH_4 Emissions from Natural gas			1990					2016				
Member State		GHG source category	Activity data			Implied emission factor (kg/unit)	CH_4 emissions (kt)	Activity data			Implied emission factor (kg/unit)	CH_4 emission s (kt)
			Description	Unit	Value			Description	Unit	Value		
		3. Exploration	Gas explored	m3	2892052.00	0.01	0.03	Gas explored	m3	NO	NO	NO
		4. Production	Gas produced	10^6 m3	5137.00	380.00	1.95	Gas produced	10^6 m3	4460.00	380.00	1.69
		5. Processing	Gas produced	10^6 m3	5137.00	NA	NA	Gas produced	10^6 m3	4460.00	NA	NA
		6. Transmission and storage	Gas transmission	10^6 m3	2739.00	69.45	0.19	Gas transmission	10^6 m3	4570.00	5.50	0.03
		7. Distribution	Gas distributed	10^6 m3	1749.06	145.93	0.26	Gas distributed	10^6 m3	2206.32	71.34	0.16
		8. Other	Incl. In transmission	m3	NO	NO	NO	Incl. In transmission	m3	NO	NO	NO
ESP	Spain	**Natural Gas**					**17.01**					**25.09**
		3. Exploration	Mm3 gas produced	Mm3	NO	NO	NO	Mm3 gas produced	Mm3	NO	NO	NO
		4. Production	Mm3 gas produced	Mm3	1314.69	461.95	0.61	Mm3 gas produced	Mm3	65.75	2096.40	0.14
		5. Processing	Mm3 gas produced	Mm3	1314.69	150.00	0.20	Mm3 gas produced	Mm3	65.75	150.00	0.01
		6. Transmission and storage	PJ gas (NCV)	PJ	198.09	5.90	0.00	PJ gas (NCV)	PJ	1049.97	2.80	0.00
		7. Distribution	PJ of gaseous fuels (natural gas, LPG, gas work gas or propanized air) distributed by networks	PJ	205.50	78857.88	16.21	PJ of gaseous fuels (natural gas, LPG, gas work gas or propanized air) distributed by networks	PJ	1061.14	23503.29	24.94
		8. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
EST	Estonia	**Natural Gas**					**2.01**					**0.68**
		4. Exploration	Exploration	NA	NO	NO	NO	Exploration	NA	NO	NO	NO
		5. Production	Production	NA	NO	NO	NO	Production	NA	NO	NO	NO
		6. Processing	Processing	NA	NO	NO	NO	Processing	NA	NO	NO	NO
		7. Transmission and storage	Amount of the transmission of Natural Gas	PJ	51.23	2217.60	0.11	Amount of the transmission of Natural Gas	PJ	17.41	2217.60	0.04
		8. Distribution	Amount of natural gas distributed	PJ	51.23	36960.00	1.89	Amount of natural gas distributed	PJ	17.41	36960.00	0.64
		9. Other	Other	NA	NO	NO	NO	Other	NA	NO	NO	NO
FIN		**Natural Gas**					**0.17**					**0.96**

1.B.2.b Fugitive CH_4 Emissions from Natural gas			1990					2016				
Member State		GHG source category	Activity data			Implied emission factor (kg/unit)	CH_4 emissions (kt)	Activity data			Implied emission factor (kg/unit)	CH_4 emission s (kt)
			Description	Unit	Value			Description	Unit	Value		
		4. Exploration		NO	NO	NO	NO		NO	NO	NO	NO
		5. Production		NO	NO	NO	NO		NO	NO	NO	NO
		6. Processing		NA	NO	NO	NO		NA	NA	NA	0.00
		7. Transmission and storage	PJ gas consumed	PJ	91.58	1856.22	0.17	PJ gas consumed	PJ	85.68	3956.00	0.34
		8. Distribution	PJ gas distributed	NO	NO	NO	NO	PJ gas distributed	NO	6.37	97406.61	0.62
		9. Other		NO	NO	NO	NO		NO	NO	NO	NO
FRK	France	**Natural Gas**					**60.47**					**45.31**
		4. Exploration	NO	PJ	NO	NO	NO	NO	PJ	NO	NO	NO
		5. Production	NO	PJ	IE	IE	IE	NO	PJ	IE	IE	IE
		6. Processing	Gas processed	PJ	309.00	2376.20	0.73	Gas processed	PJ	6.59	303.96	0.00
		7. Transmission and storage	Gas consumed	PJ	1089.91	24450.02	26.65	Gas consumed	PJ	1603.78	15400.24	24.70
		8. Distribution	Gas consumed	PJ	1089.91	30361.79	33.09	Gas consumed	PJ	1603.78	12849.51	20.61
		9. Other	NO	PJ	NO	NO	NO	NO	PJ	NO	NO	NO
GBK	United Kingdom	**Natural Gas**					**406.73**					**151.30**
		5. Exploration	Exploration drilling: fuel use	t	225517.62	15.66	3.53	Exploration drilling: fuel use	t	47706.25	45.00	2.15
		6. Production	Gas produced	PJ	1709.37	IE	IE	Gas produced	PJ	1497.88	IE	IE
		7. Processing	Gas produced	PJ	1709.37	12756.73	21.81	Gas produced	PJ	1497.88	1525.75	2.29
		8. Transmission and storage	Natural gas supply	GWh	387730.56	23.58	9.14	Natural gas supply	GWh	509595.79	4.56	2.32
		9. Distribution	Natural gas supply	GWh	387730.56	960.08	372.25	Natural gas supply	GWh	509595.79	283.65	144.54
		10. Other		NA	NO	NO	NO		NA	NO	NO	NO
GRC	[illegible]	**Natural Gas**					**0.37**					**2.77**

1.B.2.b Fugitive CH_4 Emissions from Natural gas			1990					2016				
Member State		GHG source category	Activity data			Implied emission factor (kg/unit)	CH_4 emissions (kt)	Activity data			Implied emission factor (kg/unit)	CH_4 emissions (kt)
			Description	Unit	Value			Description	Unit	Value		
		5. Exploration			NE	NE	NE			NE	NE	NE
		6. Production		mil_m3	123.00	1930.00	0.24		mil_m3	9.00	1930.00	0.02
		7. Processing		mil_m3	123.00	IE	IE		mil_m3	9.00	IE	IE
		8. Transmission and storage		mil m3	123.00	298.00	0.04		mil m3	4061.00	298.00	1.21
		9. Distribution		mil m3	86.24	1100.00	0.09		mil m3	1401.44	1100.00	1.54
		10. Other			IE	IE	IE			IE	IE	IE
HRV	Croatia	**Natural Gas**					**5.92**					**5.64**
		5. Exploration		1000000 m3	1982.30	194.00	0.38		1000000 m3	1647.20	194.00	0.32
		6. Production	gas produced	1000000 m3	1982.30	1340.76	2.66	gas produced	1000000 m3	1647.20	1340.76	2.21
		7. Processing	gas produced	1000000 m3	1982.30	592.00	1.17	gas produced	1000000 m3	1647.20	592.00	0.98
		8. Transmission and storage	marketable gas	1000000 m3	2686.60	480.00	1.29	marketable gas	1000000 m3	2611.40	480.00	1.25
		9. Distribution	utility sales	1000000 m3	379.30	1100.00	0.42	utility sales	1000000 m3	806.20	1100.00	0.89
		10. Other		NO	NO	NO	NO		NO	NO	NO	NO
HUN	Hungary	**Natural Gas**					**29.39**					**19.15**
		6. Exploration		NA	IE	IE	IE		NA	IE	IE	IE
		7. Production	Gas production (million m3)	million m3	4874.00	1340.00	6.53	Gas production (million m3)	million m3	1841.00	1340.00	2.47
		8. Processing	Sweet gas plants-raw gas feed (million m3)	million m3	1593.00	940.86	1.50	Sweet gas plants-raw gas feed (million m3)	million m3	663.88	919.54	0.61
		9. Transmission and storage	Marketable gas (million m3)	million m3	11278.00	674.50	7.61	Marketable gas (million m3)	million m3	10460.00	298.00	3.12
		10. Distribution	Utility sales (million m3)	million m3	12507.10	1100.00	13.76	Utility sales (million m3)	million m3	11773.76	1100.00	12.95
		11. Other		NO	NO	NO	NO		NO	NO	NO	NO
IRL		**Natural Gas**					**6.24**					**0.80**

1.B.2.b Fugitive CH_4 Emissions from Natural gas			1990					2016				
Member State		GHG source category	Activity data			Implied emission factor (kg/unit)	CH_4 emissions (kt)	Activity data			Implied emission factor (kg/unit)	CH_4 emissions (kt)
			Description	Unit	Value			Description	Unit	Value		
		6. Exploration	Natural gas exploration	PJ	IE	IE	IE	Natural gas exploration	PJ	IE	IE	IE
		7. Production		PJ	78.58	14330.75	1.13		PJ	104.37	3230.96	0.34
		8. Processing		PJ	IE	IE	IE		PJ	IE	IE	IE
		9. Transmission and storage		PJ	IE	IE	IE		PJ	IE	IE	IE
		10. Distribution		PJ	23.85	214519.35	5.12		PJ	74.21	6260.00	0.46
		11. Other		PJ	NO	NO	NO		PJ	NO	NO	NO
ISL	Iceland	**Natural Gas**					**NO**					**NO**
		6. Exploration	Natural gas exploration	PJ	NO	NO	NO	Natural gas exploration	PJ	NO	NO	NO
		7. Production		PJ	NO	NO	NO		PJ	NO	NO	NO
		8. Processing		PJ	NO	NO	NO		PJ	NO	NO	NO
		9. Transmission and storage		PJ	NO	NO	NO		PJ	NO	NO	NO
		10. Distribution		PJ	NO	NO	NO		PJ	NO	NO	NO
		11. Other		PJ	NO	NO	NO		PJ	NO	NO	NO
ITA	Italy	**Natural Gas**					**329.41**					**176.69**
		6. Exploration	Wells explored	Number	36.00	158.15	0.01	Wells explored	Number	3.00	0.43	0.00
		7. Production	Gas produced	Mm3	17296.39	1726.36	29.86	Gas produced	Mm3	6021.01	906.05	5.46
		8. Processing	Gas produced	Mm3	17296.39	773.26	13.37	Gas produced	Mm3	6021.01	405.75	2.44
		9. Transmission and storage	Gas transported	Mm3	45683.58	822.12	37.56	Gas transported	Mm3	70630.00	427.54	30.20
		10. Distribution	Gas distributed	Mm3	20632.00	12049.98	248.62	Gas distributed	Mm3	32490.70	4265.56	138.59
		11. Other	other	NA	NO	NO	NO	other	NA	NO	NO	NO
LTU		**Natural Gas**					**10.42**					**11.99**

1.B.2.b Fugitive CH_4 Emissions from Natural gas			1990					2016				
Member State		GHG source category	Activity data			Implied emission factor (kg/unit)	CH_4 emissions (kt)	Activity data			Implied emission factor (kg/unit)	CH_4 emission s (kt)
			Description	Unit	Value			Description	Unit	Value		
		7. Exploration		NO	NO	NO	NO		NO	NO	NO	NO
		8. Production		NO	NO	NO	NO		NO	NO	NO	NO
		9. Processing		NO	NO	NO	NO		NO	NO	NO	NO
		10. Transmission and storage	Natural gas leakages	kt	2.01	977699.00	1.97	Natural gas leakages	kt	4.20	937845.00	3.94
		11. Distribution	Natural gas leakages	kt	8.65	977699.00	8.46	Natural gas leakages	kt	8.53	937845.00	8.00
		12. Other	Natural gas leakages	NO	NO	NO	NO	Natural gas leakages	NO	0.05	937845.00	0.05
LUX	Luxembourg	**Natural Gas**					**0.77**					**1.27**
		7. Exploration	gas exploration	NA	NO	NO	NO	gas exploration	NA	NO	NO	NO
		8. Production	gas produced	NA	NO	NO	NO	gas produced	NA	NO	NO	NO
		9. Processing	NO	NA	NO	NO	NO	NO	NA	NO	NO	NO
		10. Transmission and storage	gas consumed	TJ	17933.32	13.12	0.24	gas consumed	TJ	29685.08	13.00	0.39
		11. Distribution	gas consumed	TJ	17933.32	30.07	0.54	gas consumed	TJ	29685.08	29.79	0.88
		12. Other	NO	NA	NO	NO	NO	NO	NA	NO	NO	NO
LVA	Latvia	**Natural Gas**					**7.09**					**4.03**
		7. Exploration	Exploration	m3	NO	NO	NO	Exploration	m3	NO	NO	NO
		8. Production	Production	m3	NO	NO	NO	Production	m3	NO	NO	NO
		9. Processing	Processing	m3	NO	NO	NO	Processing	m3	NO	NO	NO
		10. Transmission and storage	Transmission and storage	m3	125172.00	0.69	0.09	Transmission and storage	m3	42962.00	0.68	0.03
		11. Distribution	Distribution	m3	694188.00	0.69	0.48	Distribution	m3	667422.00	0.68	0.46
		12. Other	Other	m3	12435406.00	0.52	6.53	Other	m3	5183290.00	0.68	3.54
MLT		**Natural Gas**					**NO**					**NO**

1.B.2.b Fugitive CH_4 Emissions from Natural gas			1990					2016				
Member State		GHG source category	Activity data			Implied emission factor (kg/unit)	CH_4 emissions (kt)	Activity data			Implied emission factor (kg/unit)	CH_4 emission s (kt)
			Description	Unit	Value			Description	Unit	Value		
		8. Exploration	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
		9. Production	gas produced	NO	NO	NO	NO	gas produced	NO	NO	NO	NO
		10. Processing	gas processed	no	NO	NO	NO	gas processed	no	NO	NO	NO
		11. Transmission and storage	gas consumed	NO	NO	NO	NO	gas consumed	NO	NO	NO	NO
		12. Distribution	gas consumed	NO	NO	NO	NO	gas consumed	NO	NO	NO	NO
		13. Other	gas consumed	NO	NO	NO	NO	gas consumed	NO	NO	NO	NO
NLD	Netherlands	**Natural Gas**					**16.84**					**12.55**
		8. Exploration		number	NA	IE	IE		number	NA	IE	IE
		9. Production		PJ	2300.00	IE	IE		PJ	1502.00	IE	IE
		10. Processing		PJ	IE	IE	IE		PJ	IE	IE	IE
		11. Transmission and storage		PJ	2648.08	4121.34	10.91		PJ	3146.00	2183.09	6.87
		12. Distribution		10^3 km	99.98	59294.88	5.93		10^3 km	125.15	45368.60	5.68
		13. Other		PJ	NO	NO	NO		PJ	NO	NO	NO
POL	Poland	**Natural Gas**					**27.10**					**43.00**
		8. Exploration	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
		9. Production	Production	PJ	99.56	66879.91	6.66	Production	PJ	148.75	66879.91	9.95
		10. Processing		PJ	99.56	29950.57	2.98		PJ	148.75	29950.57	4.45
		11. Transmission and storage	gas consumed	PJ	374.21	13957.55	5.22	gas consumed	PJ	612.67	13957.55	8.55
		12. Distribution	gas consumed	PJ	374.21	31986.04	11.97	gas consumed	PJ	612.67	31986.04	19.60
		13. Other	NA	PJ	374.21	726.96	0.27	NA	PJ	612.67	726.96	0.45

PRT		**Natural Gas**					**NO**					**2.13**

1.B.2.b Fugitive CH_4 Emissions from Natural gas			1990					2016				
Member State		GHG source category	Activity data			Implied emission factor (kg/unit)	CH_4 emissions (kt)	Activity data			Implied emission factor (kg/unit)	CH_4 emission s (kt)
			Description	Unit	Value			Description	Unit	Value		
		9. Exploration		NO	NO	NO	NO		NO	NO	NO	NO
		10. Production		NO	NO	NO	NO		NO	NO	NO	NO
		11. Processing		NO	NO	NO	NO		NO	NO	NO	NO
		12. Transmission and storage		toe NG Transmitted	NO	NO	NO		toe NG Transmitted	4217.71	12.20	0.05
		13. Distribution		toe NG Distributed	NO	NO	NO		toe NG Distributed	1601.88	1295.30	2.07
		14. Other		NO	NO	NO	NO		NO	NO	NO	NO
ROU	Romania	**Natural Gas**					**677.32**					**208.00**
		9. Exploration	gas produced		IE	IE	IE	gas produced		IE	IE	IE
		10. Production	gas produced	106m3	28336.00	12190.00	345.42	gas produced	106m3	9811.00	12190.00	119.60
		11. Processing	gas produced and processed	106m3	28336.00	250.00	7.08	gas produced and processed	106m3	9811.00	250.00	2.45
		12. Transmission and storage	gas produced	106m3	35667.00	633.00	22.58	gas produced	106m3	13131.00	549.94	7.22
		13. Distribution	gas supplied	106m3	35667.00	1800.00	64.20	gas supplied	106m3	11287.00	1800.00	20.32
		14. Other	gas consumed	PJ	923.61	257728.79	238.04	gas consumed	PJ	281.68	207393.61	58.42
SVK	Slovakia	**Natural Gas**					**44.14**					**34.59**
		9. Exploration		NA	NO	NO	NO		NA	NO	NO	NO
		10. Production	Production/Processing	mil m3	444.00	2300.00	1.02	Production/Processing	mil m3	92.00	2300.00	0.21
		11. Processing		mil m3	444.00	1030.00	0.46		mil m3	92.00	1030.00	0.09
		12. Transmission and storage	Transfer	mil m3	73600.00	480.00	35.33	Transfer	mil m3	60600.00	480.00	29.09
		13. Distribution	Distribution	mil m3	6666.00	1100.00	7.33	Distribution	mil m3	4716.00	1100.00	5.19
		14. Other	Storage	mil m3	1.00	25.00	0.00	Storage	mil m3	246.00	25.00	0.01
SVN		**Natural Gas**					**1.70**					**1.29**

1.B.2.b Fugitive CH_4 Emissions from Natural gas			1990					2016				
Member State		GHG source category	Activity data			Implied emission factor (kg/unit)	CH_4 emissions (kt)	Activity data			Implied emission factor (kg/unit)	CH_4 emissions (kt)
			Description	Unit	Value			Description	Unit	Value		
		10. Exploration	NA	1000 m3	NO	NO	NO	NA	1000 m3	NO	NO	NO
		11. Production	Gas production	1000 m3	23631.00	12.19	0.29	Gas production	1000 m3	4812.00	1.34	0.01
		12. Processing	NA	1000 m3	NO	NO	NO	NA	1000 m3	NO	NO	NO
		13. Transmission and storage	Marketable gas	1000 m3	892000.60	0.48	0.43	Marketable gas	1000 m3	866003.06	0.38	0.33
		14. Distribution	Utility sale	1000 m3	892000.60	1.10	0.98	Utility sale	1000 m3	866003.06	1.10	0.95
		15. Other	NA	1000 m3	NO	NO	NO	NA	1000 m3	NO	NO	NO
SWE	Sweden	**Natural Gas**					**2.69**					**1.47**
		10. Exploration	Gas produced		NO	NO	NO	Gas produced		NO	NO	NO
		11. Production	Gas produced		NO	NO	NO	Gas produced		NO	NO	NO
		12. Processing	Gas produced		NO	NO	NO	Gas produced		NO	NO	NO
		13. Transmission and storage	Length of transmission pipelines	KM	NA	NA	0.05	Length of transmission pipelines	KM	NA	NA	0.08
		14. Distribution	Length of distribution pipelines	KM	NA	NA	2.65	Length of distribution pipelines	KM	NA	NA	1.39
		15. Other			NO	NO	NO			NO	NO	NO

3.2.6.3 CO_2 Emissions from Venting and Flaring (1.B.2.c)

Fugitive Emissions from this source correspond to Emissions from venting and flaring of associated gas and waste gas/vapour streams at oil and gas facilities.

CO_2 emissions from 1.B.2.c – Venting and Flaring – account for 0.1% of total EU-28+ISL GHG emissions in 2016 and for 7 % of all fugitive emissions in the EU28+ISL. Between 1990 and 2016 CO_2 emissions from this source decreased by 29%.

All but four Member states (Austria, Estonia, Luxembourg, Malta) - are reporting CO_2 emissions in this category.

In 2016, almost 58% of the EU-28+ISL CO_2 emissions from 1.B.2.c were emitted by the UK (*Table 3.121*, Figure 3.166)Main source for CO_2 emissions from this category in the UK is the flaring of oil, which is estimated by applying a Tier 2 methodology with country specific and plant specific emission factors. Table 3.121 shows that 86 % of EU-28 emissions are calculated using higher tier methods. In cases where member states report a mix of Tier 1 and higher Tier methods (FRK, ESP) only emissions from subcategories of sector 1.B.2.b were taken into account for the calculation, where the member states actually apply a higher tier method. Countries that report a Tier 1 method but a country specific or plant specific emission factor (HUN, SVK) were calculated as a Tier 2 method, according to the IPCC 2006 Guidelines.

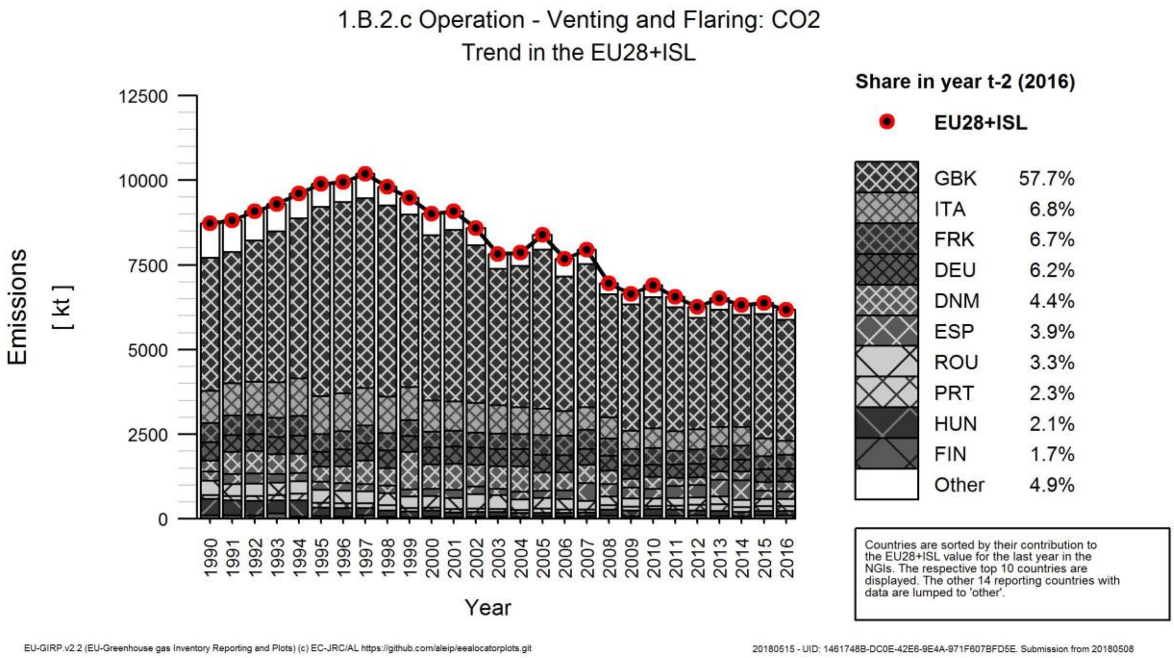
The emission decreases between 1990 and 2016 observed in the Netherlands (-93%), Italy (-56%), the UK (-9%), Hungary (-72%) and Romania (-52 %) contributed most significantly to the overall reduction in the EU-28+ISL between 1990 and 2016.

Table 3.121: 1.B.2.c Fugitive CO_2 emissions from Other emissions: Member States' contributions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016		Method	Emission factor Informa-tion
	1990	2015	2016		kt CO2	%	kt CO2	%		
Austria	IE	IE	IE	-	-	-	-	-	NA	NA
Belgium	84	88	78	1.3%	-6	-7%	-10	-11%	T3	PS
Bulgaria	3	6	5	0.1%	2	64%	-0.5	-9%	T1	D
Croatia	0.002	0.0001	0.0002	0.0%	-0.002	-90%	0.0001	91%	T1	D
Cyprus	0.04	0.1	0.1	0.0%	0.02	60%	0.005	8%	T1	D
Czech Republic	2	5	5	0.1%	3	138%	-0.5	-9%	T1	D
Denmark	328	247	273	4.4%	-55	-17%	27	11%	T3	PS
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	111	109	104	1.7%	-7	-6%	-4	-4%	CS	CS
France	560	391	413	6.7%	-147	-26%	23	6%	T1,T2,T3	CS,D,PS
Germany	544	382	382	6.2%	-162	-30%	-1	0%	T2	CS
Greece	43	3	9	0.1%	-34	-79%	6	180%	T1	D
Hungary	471	130	132	2.1%	-339	-72%	2	2%	T1,T3	CS
Ireland	NO	0.4	1	0.0%	1	∞	1	279%	CS,T3	CS,PS
Italy	956	528	420	6.8%	-535	-56%	-108	-20%	T1	D
Latvia	0.003	0.002	0.002	0.0%	-0.001	-42%	-0.0004	-20%	T3	CS
Lithuania	1	4	3	0.0%	2	430%	-0.5	-13%	T1	D
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	774	57	52	0.8%	-723	-93%	-5	-9%	T2	PS
Poland	39	61	64	1.0%	25	64%	4	6%	T1	D
Portugal	118	135	143	2.3%	25	21%	8	6%	NO	NO
Romania	424	214	203	3.3%	-221	-52%	-11	-5%	T1	D
Slovakia	5	1	1	0.0%	-4	-81%	0	-7%	T1	CS
Slovenia	0.2	0.01	0.01	0.0%	-0.2	-95%	0	38%	T1	D
Spain	272	244	238	3.9%	-34	-12%	-6	-2%	CS,T1,T2	CS,D,PS
Sweden	70	90	87	1.4%	17	24%	-4	-4%	T2,T3	CS,PS
United Kingdom	3 920	3 674	3 566	57.7%	-354	-9%	-108	-3%	T2	CS,PS
EU-28	**8 723**	**6 368**	**6 180**	**100%**	**-2 543**	**-29%**	**-188**	**-3%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	3 920	3 674	3 566	57.7%	-354	-9%	-108	-3%	T2	CS,PS
EU-28 + ISL	**8 723**	**6 368**	**6 180**	**100%**	**-2 543**	**-29%**	**-188**	**-3%**	**-**	**-**

Note: Austria includes CO_2 emissions from venting and flaring in 1.A.1b Petroleum refining

Figure 3.166: 1.B.2.c Venting and Flaring: Emission trend and share for the emitting countries of CO_2



3.2.6.4 CH_4 Emissions from Other (1.B.2.d)

Fugitive emissions from other correspond to emissions from geo thermal energy production and all other energy production that is not included in categories 1.B.1 and 1.B.2..

Six countries report CO_2 emissions in this sector, four are reporting CH_4 emissions, three countries also report N_2O emissions. The description of the subcategories is presented in Table 3.122.

Table 3.122 Description of subcategories in sector 1.B.2.d for CO_2-, N_2O- and CH_4-emissions for reporting Member States

Member state	Emission	Subcategory
Finland	CO_2, CH_4	Distribution of town gas
Greece	CO_2, N_2O	LPG transport
Hungary	CH_4, CO_2	Groundwater extraction and CO_2 mining
Iceland	CH_4, CO_2	Geothermal Energy
Italy	CH_4, CO_2, N_2O	Flaring in refineries
Portugal	CO_2	Geothermal
United Kingdom	N_2O	Natural gas exploration: N_2O emissions

Table 3.123 and Table 3.124 provide information on the contribution of countries to EU-28+ISL recalculations in CO_2 and CH_4 from 1.B.2 'Oil and natural gas' for 1990 and 2015 and main explanations for the largest recalculations in absolute terms.

Table 3.1231.B.2 Fugitive CO_2 emissions from Oil and natural gas: Contribution of MS to EU recalculations in CO_2 for 1990 and 2015 (difference between latest submission and previous submission in kt of CO_2 equivalents and percent)

	1990		2015		Main explanations
	kt CO_2 equiv.	**%**	**kt CO_2 equiv.**	**%**	
Austria	-	-	-53	-24.5	Recalculations in CO_2 emissions in the category 1.B.2.b.2 (production) for the years 2003–2015 are due to revision of data reported by the Association of the Austrian Petroleum Industry).Since 2003 emissions from this source were erroneously reported including not only fugitive emissions but also pyrogenic emissions by one company. This error was corrected and led to a total reduction of CO_2e emissions from this source of −52.5 kt CO_2e in 2015 (cumulative 680 kt CO_2e between 2003 and 2015).
Belgium	-	-	-0.0001	-0.0001	Minor recalculation
Bulgaria	0.00002	0.001	0.00003	0.001	For category 1.B.2.b.4 Fugitive emissions from gas transmission, the previous emission factor of 1340 kgCH_4/km was changed to 2500 kgCH_4/km (IPCC GPG 2000, Table 2.16, p.2.86), following a recommendation of the ERT during the Centralized review in 2012. For the latest submission the calculation approach was changed to rely on transited gas quantities following the adoption of the 2006 IPCC Guidelines. Another new category was included in the emission inventory as a result of the 2016 review cycle ERT recommendations from – Storage of natural gas. Data from the Ministry of Energy and Bulgartransgaz (the operator of the Chiren natural gas storage facility) regarding the quantities of natural gas extracted, has been used for the emission estimates for the entire time series. The default EFs from Table 4.2.4 of the 2006 IPCC Guidelines (volume 2, chapter 4) have been applied.
Croatia	-	-	-	-	NA
Cyprus	0.04	100.0	0.05	100.0	Activity data has been estimated for the years 1990-1992 for lubricants. This has caused recalculations to the sector.
Czech Republic	-	-	-	-	NA
Denmark	0	0.1	0	0.2	Due to an overall update of the data model for fugitive emissions, a large number of minor changes have been made in the 2018 emission inventory. To ensure consistency between the underlying spreadsheets in the fugitive model holding detailed input data, and the output from the Danish inventory system, rounding of activity data and emission factors have been optimised leading to minor changes of the resulting fugitive emissions. Changes due to rounding have been introduced for exploration of oil and gas, loading of oil, distribution of natural gas and town gas, venting in gas storage and treatment, flaring in refineries and offshore in oil production. For loading of ships onshore and offshore and for storage of crude oil the ac-tivity data has been changed from oil pro-duced to oil loaded onshore and offshore, and to oil transported in pipeline, respectively. The implied emission factors have been changed correspondingly. Emissions from storage of crude oil has been reallocated from 1B2a3 Oil Transport to 1B2a4 Oil Refining/storage.
Estonia	-	-	-	-	NA

	1990		2015		Main explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
Finland	-	-	0	0.3	Preliminary activity data corrected.
France	32	0.7	-15	-0.5	1.B.2.a.1 : Addition of CO_2, CH_4 and N_2O emissions from oil exploration in the inventory 1.B.2.b.5 : Modification of the composition of natural gas consumed in France using compositions and imports of natural gas by deposit
Germany	0.2	0.1	0.4	0.2	Transport of natural gas The data for the gas network development plan (Netzentwicklungsplan Gas; NEP) (NEP, 2016) include a number of instances of double-counting in the pipeline-length category. These were corrected in the framework of a report (Grosse, 2017). Use of natural gas In the 2016 ESD Review, it was noted that the activity data for industrial consumers had remained identical throughout recent previous years. This was tied to the underlying statistics; the most recent data in those statistics, which come from the German Association of Energy and Water Industries (BDEW) (136. Gasstatistik 2014 (2014 gas statistics of the BDEW)), (Kiesel, 2016)), date from two years earlier than the reporting time. The resulting gap is bridged with data from the working group (AGEB); those data are used as the activity data. These changes are the main reasons for the recalculations listed in Table 180.
Greece	-	-	-	-	NA
Hungary	-	-	0.02	0.01	revised IEA statistics
Ireland	-	-	-0.00001	-0.002	Minor recalculation
Italy	0.00002	0.000001	1	0.1	Recalculations lightly affected emission estimates of the sector for 2014 and 2015. The recalculations are due to the updated data, as for liquid fuel distribution, and some typo, as for amounts of solid fuels storage and production. Consequently the calculation of CO_2 and CH_4 emissions has been revised for solid fuels and oil & natural gas sources.
Latvia	-	-	-	-	NA
Lithuania	-	-	0.00001	0.0002	For the first time fugitive emissions due to liquefaction and gasification at LNG terminal are included for 2015.
Luxembourg	-	-	-	-	NA
Malta	-	-	-	-	NA
Netherlands	-	-	-356	-27.1	error correction refineries,reallocation to 1.A.1.b
Poland	-0.01	-0.02	-0.001	-0.00004	energy balance based on Eurostat database
Portugal	0.00001	0.00001	0.00001	0.000001	1.B.2.a.3: This subsector methodology, activity data and emission factors have been revised. 1.B.2.b: This sector has undergone a profound revision, having substantially altered the calculation methodology. The emissions of this category have been considerably reduced.
Romania	-	-	9	1.0	CO_2 emissions were recalculated for 2015 year taking into account the final data associated to the CS EF (CRF 1B2a category). CO_2 and CH_4 emission values for 1989-2015 period have been updated because additional activity data related to storage of natural gas has been added (CRF 1B2b category); for CH_4 emission values it was necessary to reallocate the activity data and emissions in CRF

	1990		2015		Main explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
					1.B.2.b.6 category because new activity data and emissions from CRF 1.B.2.d have been coming; activity data and emissions have been reallocated to CRF 1.B.2.b.6 category from CRF Other (please specify)(1.B.2.d) category.
Slovakia	-	-	-	-	NA
Slovenia	-	-	-	-	NA
Spain	-10	-0.6	2	0.1	Incorporation of new data on fuel consumption in hydrogen plants from refineries for the period 2004-2016, following consultation with industry. Fuels involved: natural gas, nafta and GLP
Sweden	-	-	59	7.4	Re-allocation of emissions from the energy sector (LNG for hydrogen production)
United Kingdom	-0	-0.0	26	0.6	DUKES revisions; update to data for gas leakage (previously rolled)
EU28	22	0.1	-321	-1.4	
Iceland	-0	-0.0	3	1.7	Added emissions from one geothermal plant that had been omitted previously
United Kingdom (KP)	-0	-0.0	26	0.6	DUKES revisions; update to data for gas leakage (previously rolled)
EU28+ISL	22	0.1	-318	-1.4	

Table 3.1241.B.2 Fugitive CH_4 emissions from Oil and natural gas: Contribution of MS to EU-28+ISL recalculations in CH_4 for 1990 and 2015 (difference between latest submission and previous submission in kt of CO_2 equivalents and percent)

	1990		2015		Main explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
Austria	-	-	-	-	
Belgium	-	-	0.002	0.0004	Minor recalculation
Bulgaria	0.1	0.1	0.2	0.1	For category 1.B.2.b.4 Fugitive emissions from gas transmission, the previous emission factor of 1340 $kgCH_4/km$ was changed to 2500 $kgCH_4/km$ (IPCC GPG 2000, Table 2.16, p.2.86), following a recommendation of the ERT during the Centralized review in 2012. For the latest submission the calculation approach was changed to rely on transited gas quantities following the adoption of the 2006 IPCC Guidelines. As a result of ERT recommendation during the 2013 review cycle, the emission inventory was improved by adding emission estimates for category 1.B.2.a.iii. Oil transport. Another new category was included in the emission inventory as a result of the ERT recommendations from the 2016 review cycle – Storage of natural gas. Data from the Ministry of Energy and Bulgartransgaz (the operator of the Chiren natural gas storage facility) regarding the quantities of natural gas extracted, has been used for the emission estimates.

	1990		2015		Main explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
Croatia	-	-	-	-	NA
Cyprus	0.2	246 545.2	0.1	100.0	The emissions have been recalculated for the period 1990-2004 due to a mistake identified during the UNFCCC review of the 2017 submission
Czech Republic	-	-	-	-	NA
Denmark	-0.003	-0.003	-0.004	-0.004	Due to an overall update of the data model for fugitive emissions, a large number of minor changes have been made in the 2018 emission inventory. To ensure consistency between the underlying spreadsheets in the fugitive model holding detailed input data, and the output from the Danish inventory system, rounding of activity data and emission factors have been optimised leading to minor changes of the resulting fugitive emissions. Changes due to rounding have been introduced for exploration of oil and gas, loading of oil, distribution of natural gas and town gas, venting in gas storage and treatment, flaring in refineries and offshore in oil production. For loading of ships onshore and offshore and for storage of crude oil the ac-tivity data has been changed from oil pro-duced to oil loaded onshore and offshore, and to oil transported in pipeline, respectively. The implied emission factors have been changed correspondingly. Emissions from storage of crude oil has been reallocated from 1B2a3 Oil Transport to 1B2a4 Oil Refining/storage.
Estonia	-	-	-	-	NA
Finland	-	-	-0.02	-0.05	Preliminary activity data corrected.
France	17	1.0	4	0.3	1.B.2.a.1 : Addition of CO_2, CH_4 and N_2O emissions from oil exploration in the inventory 1.B.2.b.5 : Modification of the composition of natural gas consumed in France using compositions and imports of natural gas by deposit
Germany	0.00001	0.0000001	-34	-0.7	Update of activity data
Greece	-	-	-	-	NA
Hungary	-	-	1	0.2	revised IEA statistics
Ireland	-	-	0.0004	0.002	Minor recalculation
Italy	0.1	0.001	8	0.2	Update of activity data
Latvia	-	-	-	-	NA
Lithuania	-	-	0.4	0.1	Fugitive emissions due to liquefaction and gasification at LNG terminal are included for 2015.
Luxembourg	-	-	-	-	NA
Malta	-	-	-	-	NA
Netherlands	-	-	-	-	NA
Poland	-23	-2.2	-1	-0.03	energy balance based on Eurostat database
Portugal	-26	-98.0	-35	-39.0	Revision of methodology, activity data and emission factors.

	1990		2015		Main explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
Romania	-7	-0.03	-1	-0.01	CO_2 and CH_4 emission values for 1989-2015 period have been updated because additional activity data related to storage of natural gas has been added (CRF 1B2b category); for CH_4 emission values it was necessary to reallocate the activity data and emissions in CRF 1.B.2.b.6 category because new activity data and emissions from CRF 1.B.2.d have been coming; activity data and emissions have been reallocated to CRF 1.B.2.b.6 category from CRF Other (please specify)(1.B.2.d) category.
Slovakia	-	-	-	-	NA
Slovenia	-	-	-	-	NA
Spain	-167	-27.0	-70	-10.1	Method improvements for emission estimates for natural gas exploration and distribution activities
Sweden	-0.3	-0.4	1	1.1	One year delay of activity data for fuel transport (1B2a iii). Minor corrections for gasoline distribution./Re-allocation of some emissions from venting to transmission and storage.
United Kingdom	0.1	0.001	-80	-1.6	Addition of methane from gasification sources and also a correction to PI data based on operator data
EU28	-205	-0.3	-206	-0.6	
Iceland	-0	-7.4	-0	-1.1	Minor changes in CH_4 estimates
United Kingdom (KP)	0.1	0.001	-80	-1.6	Addition of methane from gasification sources and also a correction to PI data based on operator data
EU28+ISL	-205	-0.3	-206	-0.6	

3.2.7 CO_2 capture and storage (1.C)

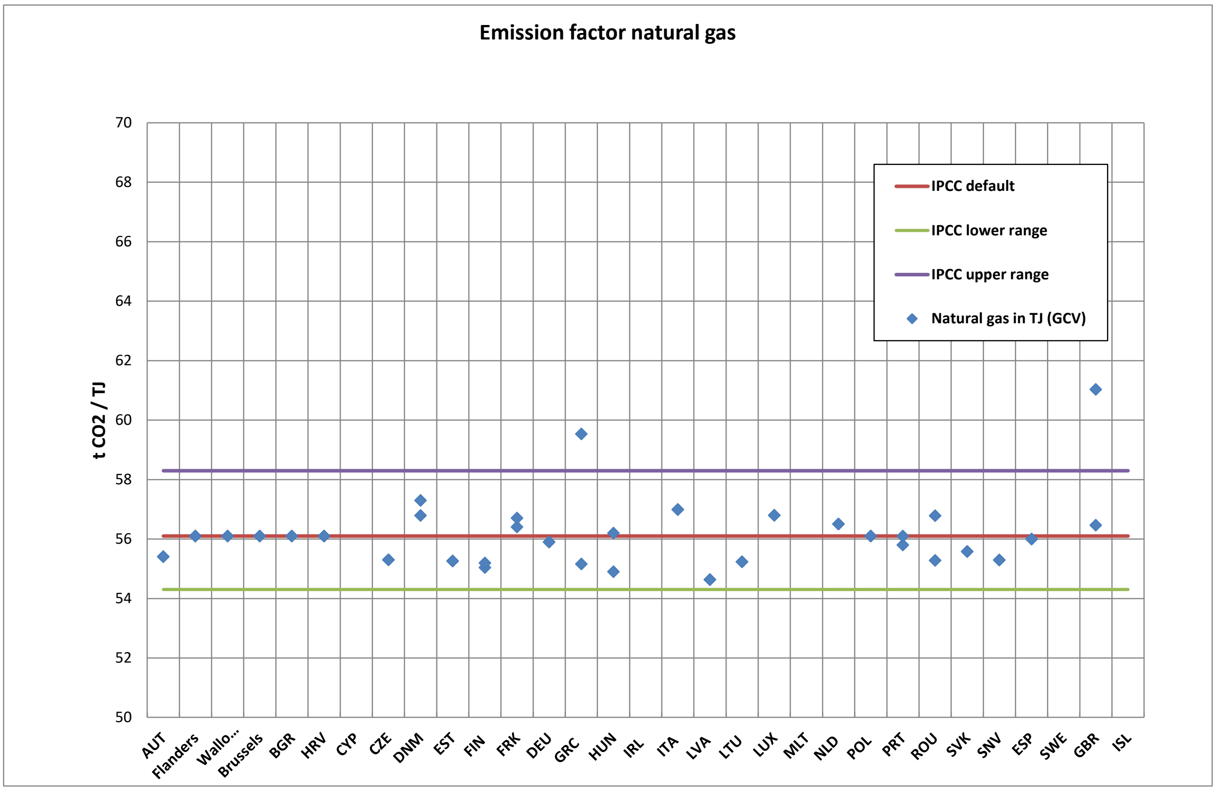
CO_2 capture and storage is not an EU key category (see Annex 1.1). Finland is the only member state reporting CO_2 emissions in this category for the years 1993 to 2016.

The amount of CO_2 captured reflects the CO_2 captured in pulp and paper mills in Finland, where precipitated calcium carbonate (PCC) is formed and then used in the paper and paperboard industry. The final use of the CO_2 captured is considered as long-term storage except if the products are combusted. The resulting fossil CO_2 emissions from combustion of products containing PCC are taken into account in the corresponding categories in the greenhouse gas inventory of Finland. A detailed description of the methodology is provided in Finland's NIR.

CO_2 emissions from 1C 'CO_2 capture and storage' account for 0.003 % of total EU-28+ISL GHG emissions in 2016. The emission increased between 1993 and 2016 by 15 602%.

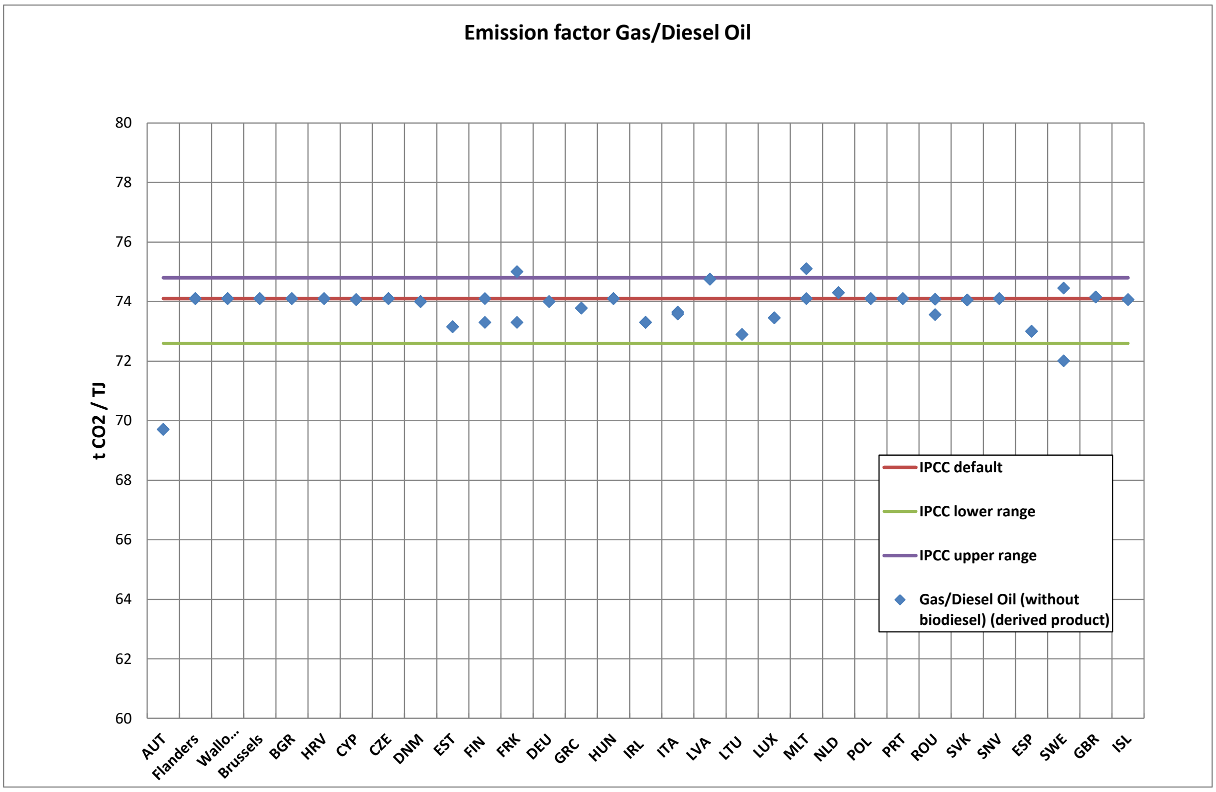
3.3 Methodological issues and uncertainties (EU-28)

The previous section presented for each EU-28 key category in CRF Sector 1 an overview of the Member States' contributions to the key categories in terms of level and trend, and - for each key category - summary information on methodologies and emission factors using the notations T1, T2, D, etc. No detailed explanations of Member States methods used is included for 1A because for most categories the method used in simply multiplying activity data by (country-specific) emissions factors. The most relevant parameter for estimating the GHG emissions from 1A is the emission factor. Therefore, the following figures include overviews of emission factors used by the Member States for the most relevant fuels and also provide the uncertainty range of default emission factors. Where relevant, information from Member States is added that are using emission factors which are significantly outside the range of the default emission factors. The figures show that the large majority of country-specific emission factors used by the EU Member States are within the uncertainty range of the IPCC default emission factors. Note that Annex III of the EU NIR includes an extraction of the emission factors used by MS for each fuel; the following figures summarize this Annex. In addition the Member States' national inventory reports include more detailed information on national methods and circumstances.

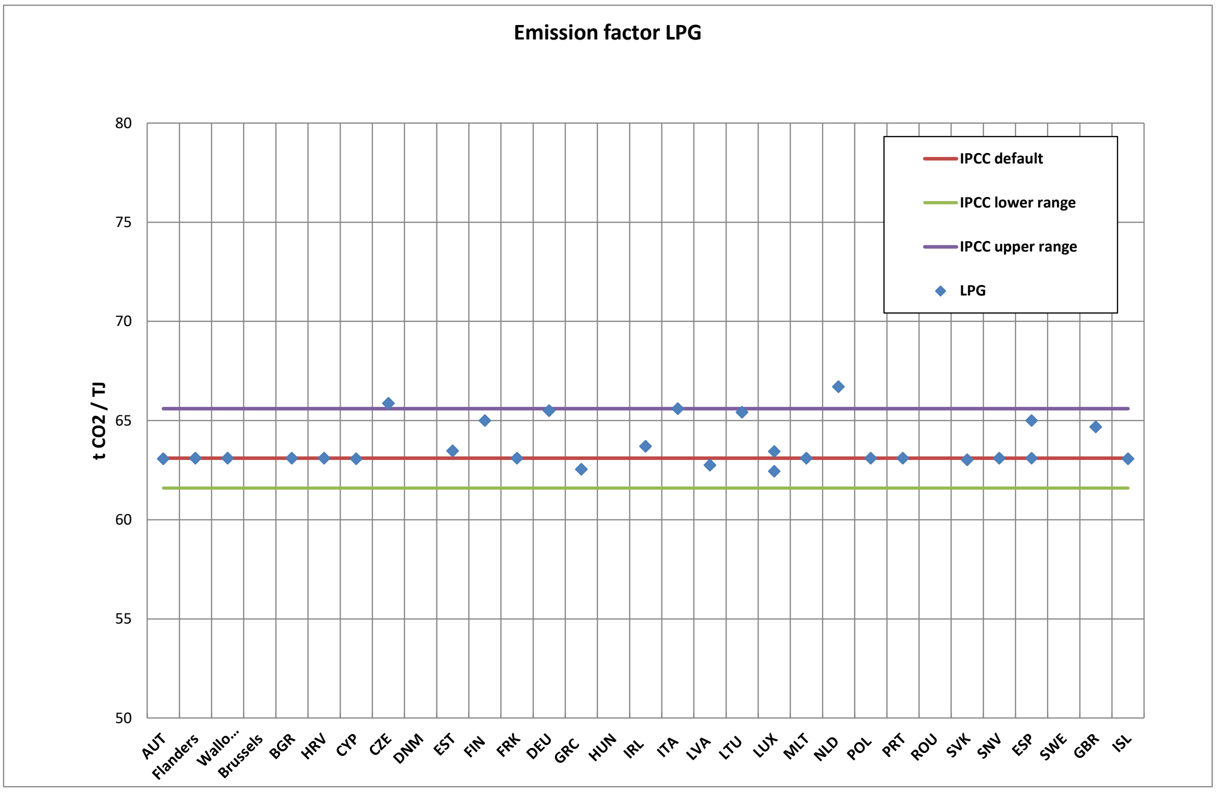


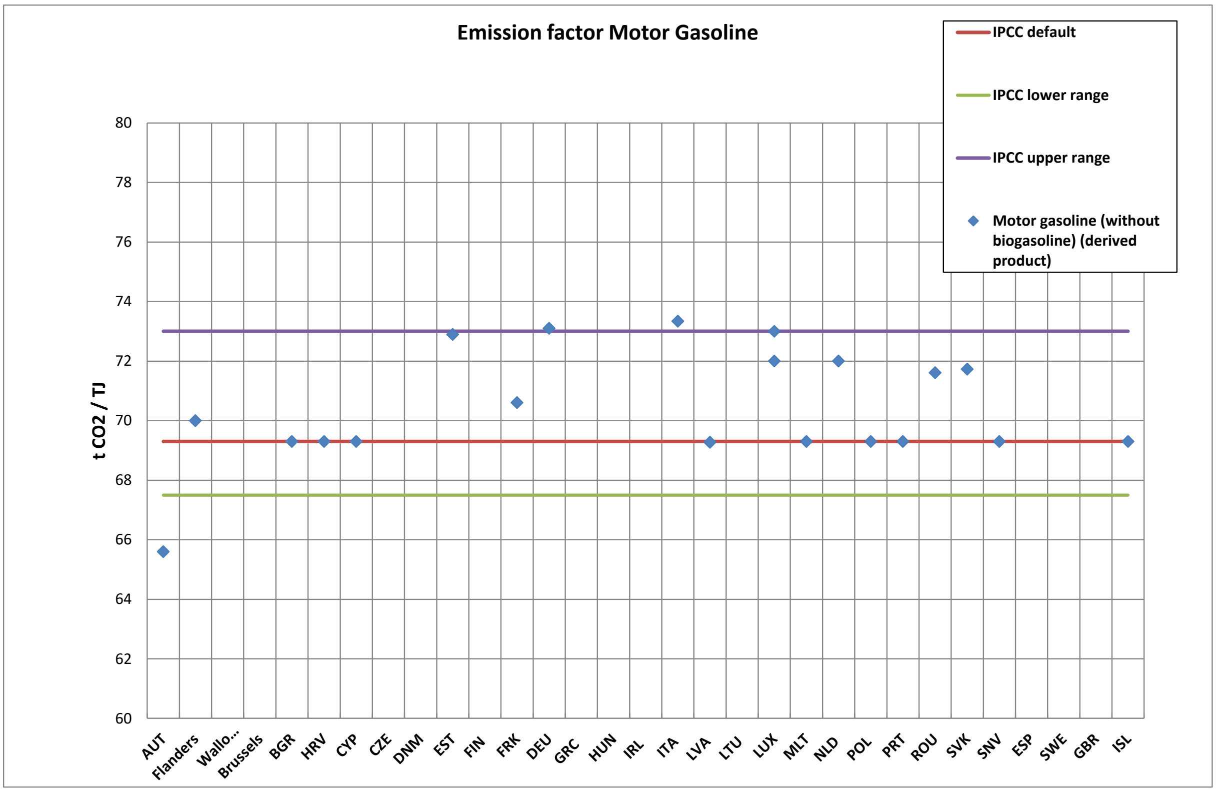
GRC: The higher value is used in 1A1c and is due to the following factors: 1. The consumption of natural gas in 1A1c sector corresponds almost 100% to natural gas produced within the country. 2. The EF is based on ETS reporting, therefore it is a plant specific EF which has been verified according to EU ETS rules. 3. As it was reported in the 2016 NIR, domestic natural gas is produced from two reservoirs, which have high carbon contents (e.g. the "Prinos" reservoir in 2014 had a carbon content of 16.22tC/TJ). 4. The inter-annual changes of the IEFs are caused by the inter-annual changes of the share of each reservoir in the total natural gas production.

GBR: The higher value is used in the 1A1c and it is due to the following fact: In the United Kingdom emissions of gaseous fuels within this sector include colliery methane combustion and natural gas combustion, including offshore own gas use. The carbon emission factor for offshore own gas use is higher than the emission factor for other natural gas combustion, particularly at the start of the time series. This higher emission factor is to be expected, as the unrefined gaseous fuels used in the upstream oil and gas sector will contain heavier hydrocarbons (which are removed in gas treatment prior to injection into natural gas supply infrastructure at onshore terminals).

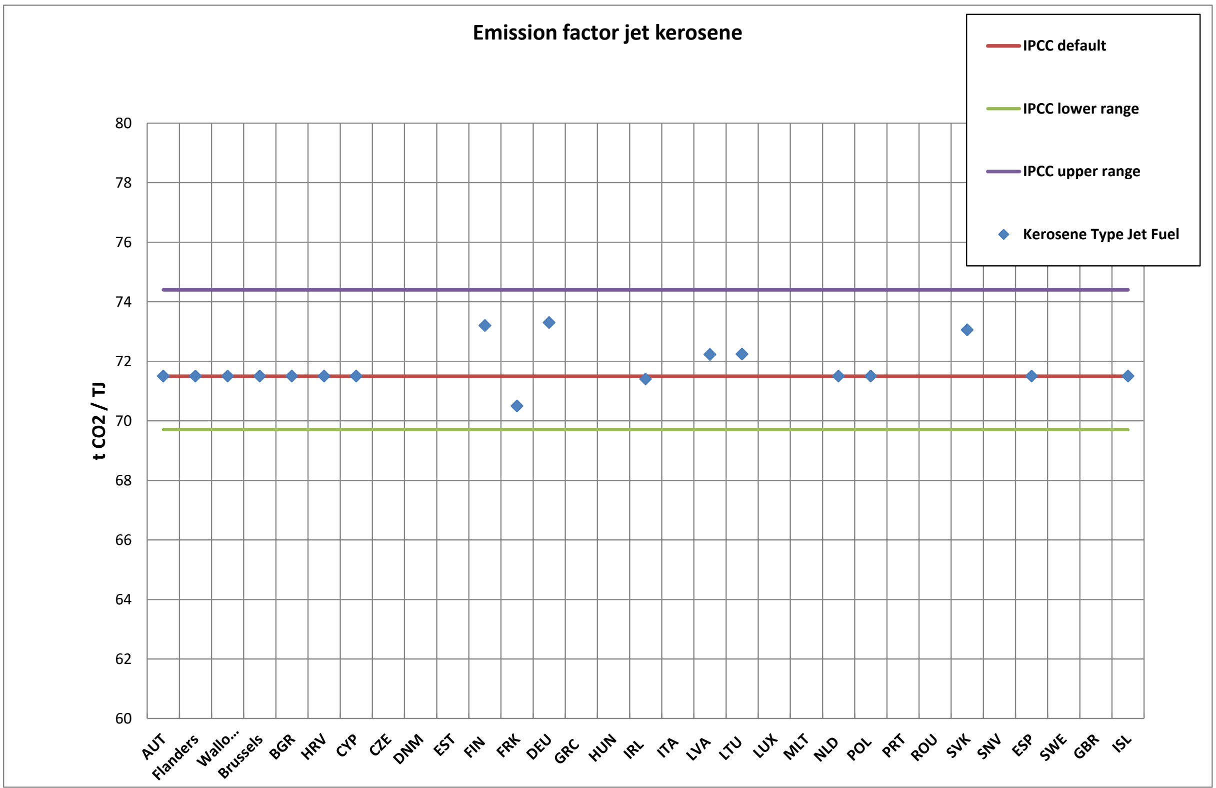


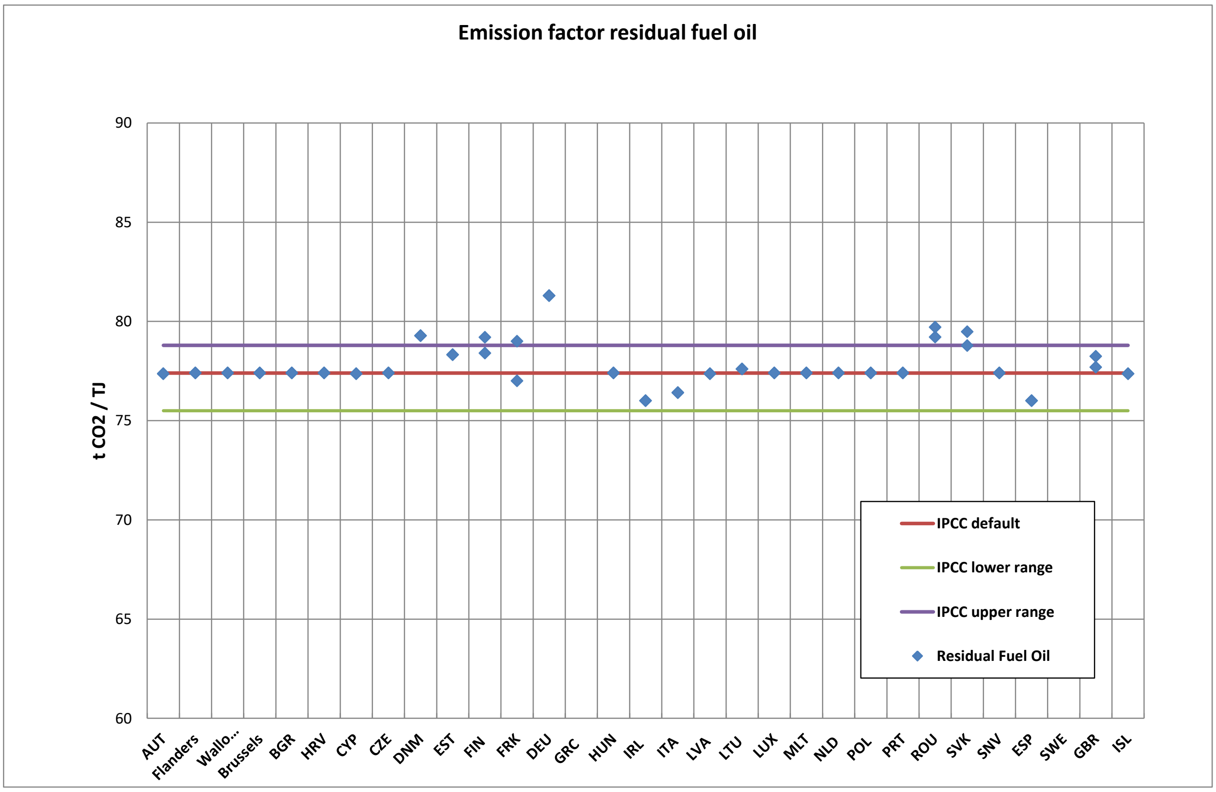
AUT: This factor is used in the reference approach and reflects increasing share of biofuels in blend.





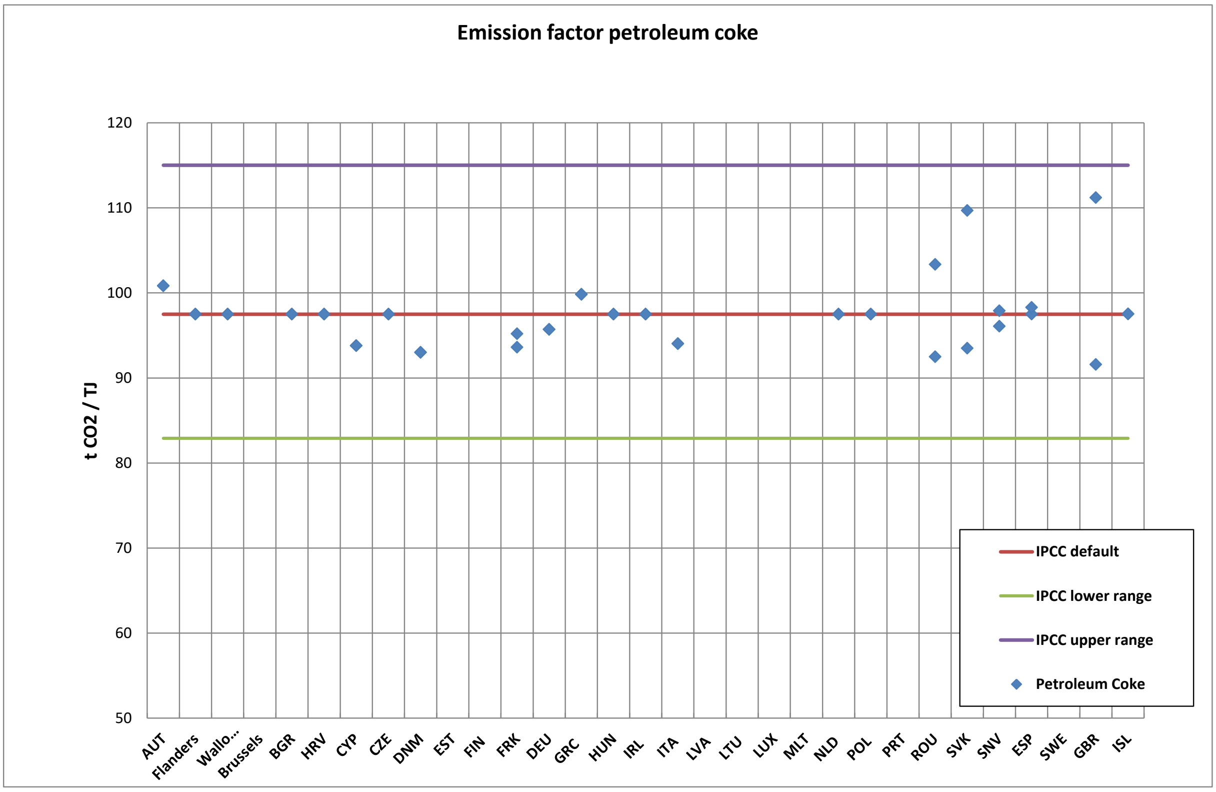
AUT: This factor is used in the reference approach and reflects increasing share of biofuels in blend.

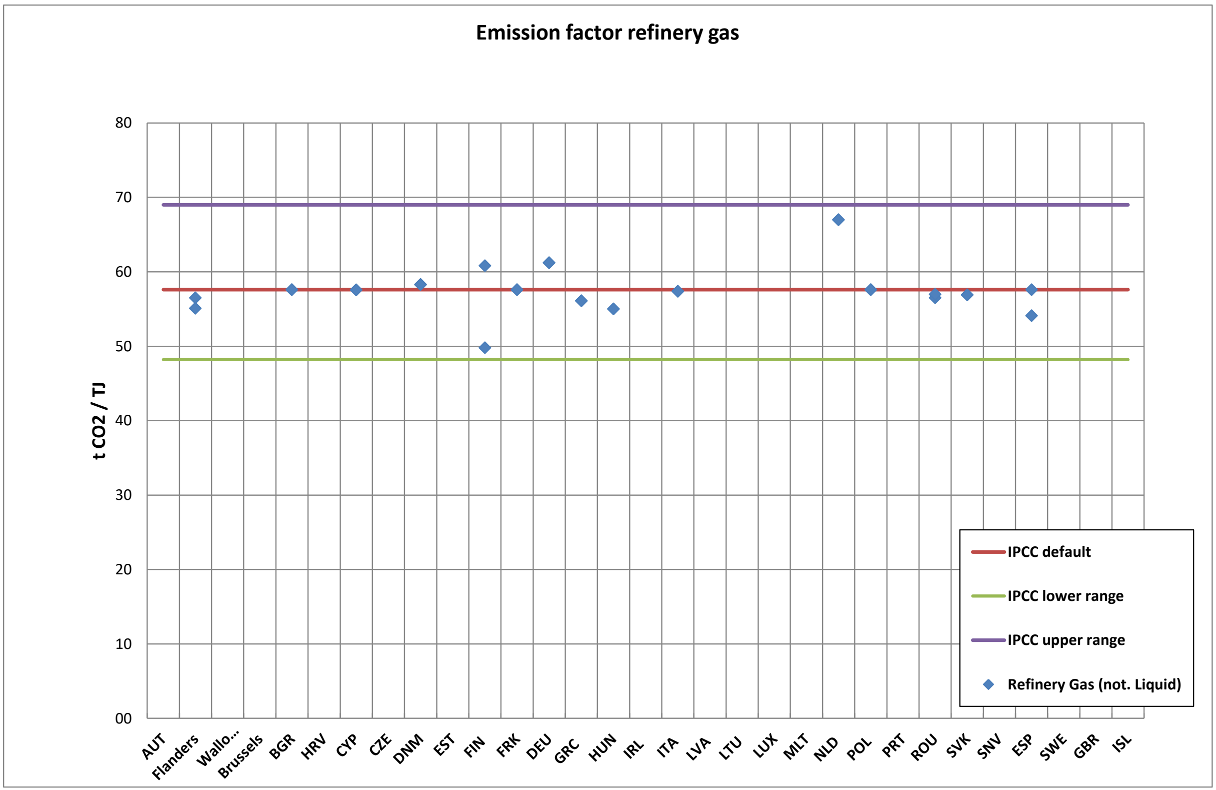


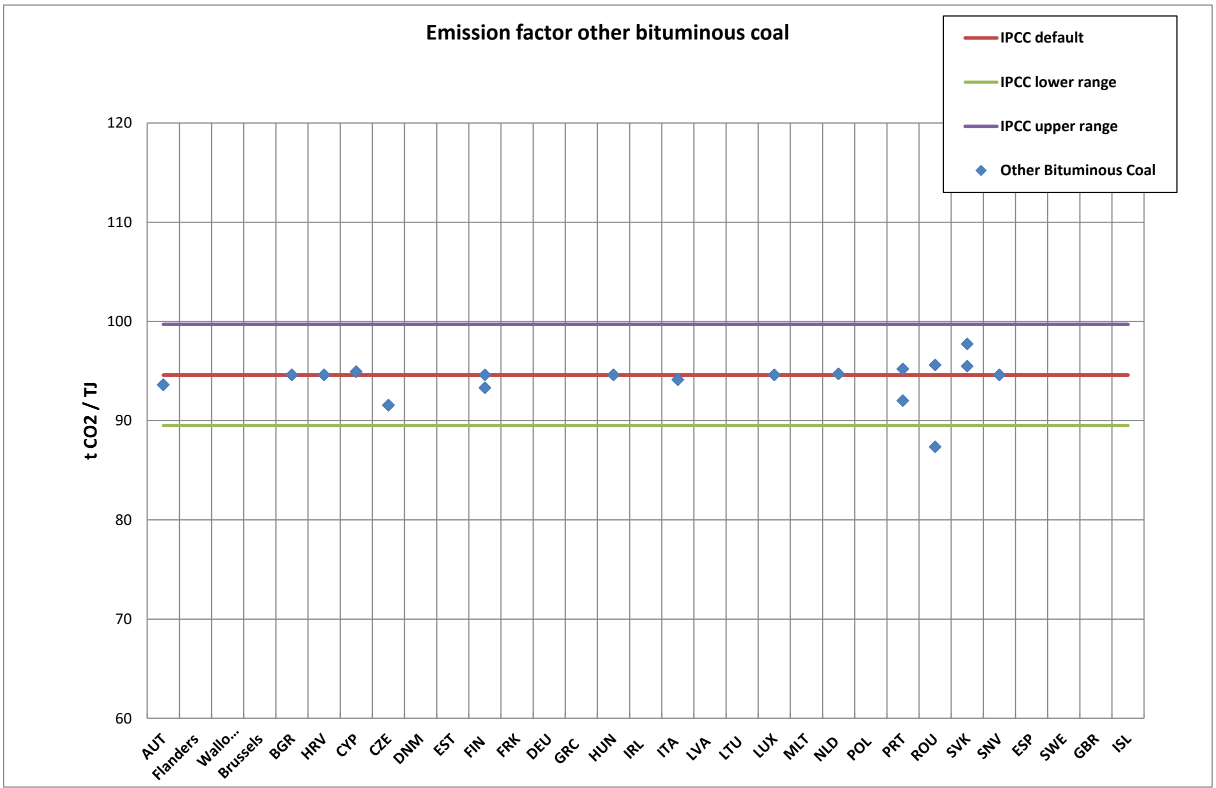


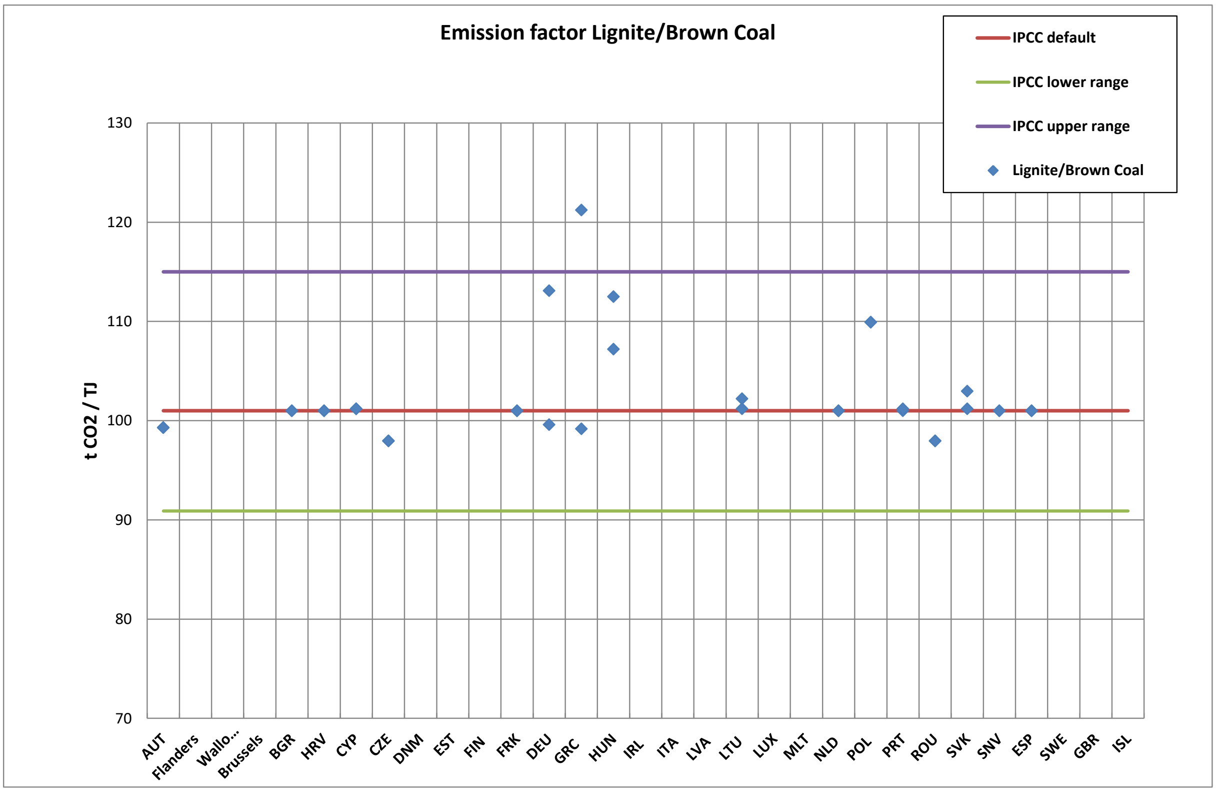
DEU: This is the value for heavy residual fuel oil.

ROU: Romania has developed a specific methodology for the elaboration of national values of specific CO_2 emission factors and the energy sector. Primary data are collected from EU-ETS operators, the data are further processed and national values are developed, based on the previous mentioned in methodology. Primarily, a number of 36 EU-ETS operators were considered.

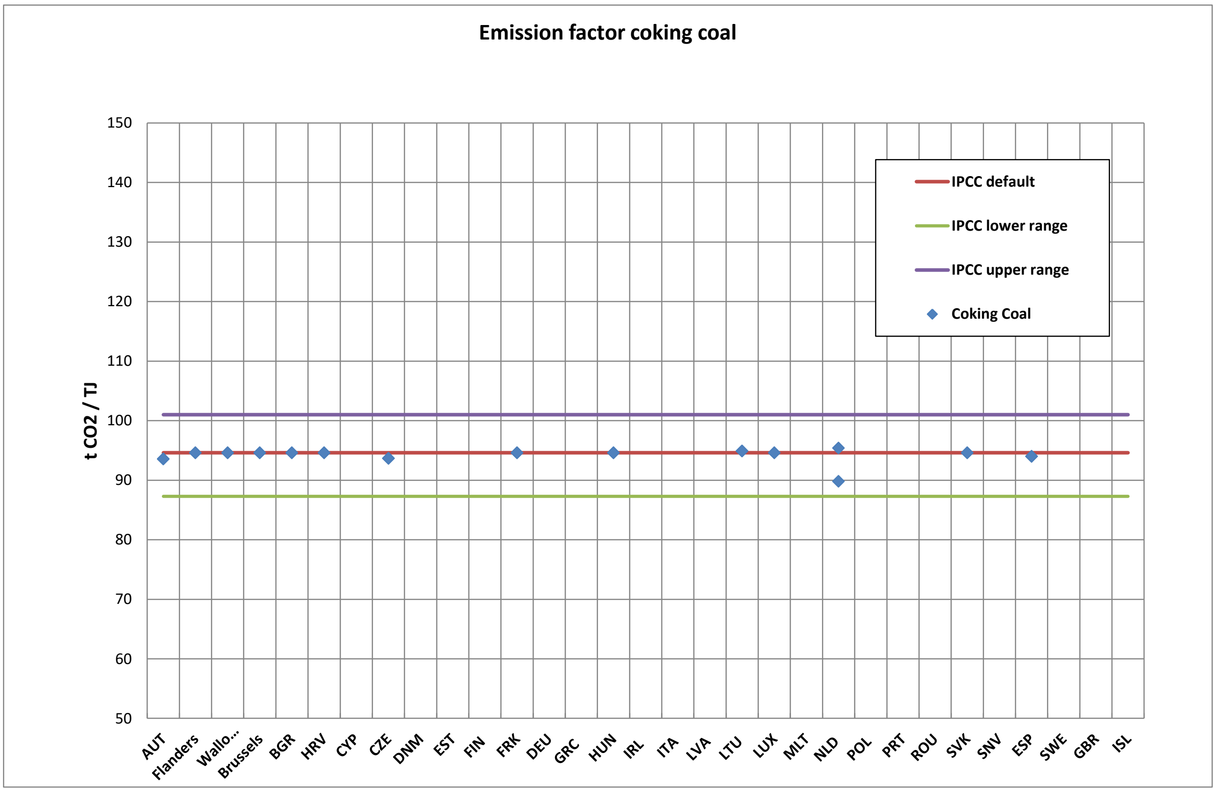



Emission factor refinery gas
t CO2 / TJ
80
70
60
50
40
30
20
10
00
AUT
Flanders
Wallo...
Brussels
BGR
HRV
CYP
CZE
DNM
EST
FIN
FRK
DEU
GRC
HUN
IRL
ITA
LVA
LTU
LUX
MLT
NLD
POL
PRT
ROU
SVK
SNV
ESP
SWE
GBR
ISL
IPCC default
IPCC lower range
IPCC upper range
Refinery Gas (not. Liquid)


Emission factor other bituminous coal
t CO2 / TJ
120
110
100
90
80
70
60
AUT
Flanders
Wallo...
Brussels
BGR
HRV
CYP
CZE
DNM
EST
FIN
FRK
DEU
GRC
HUN
IRL
ITA
LVA
LTU
LUX
MLT
NLD
POL
PRT
ROU
SVK
SNV
ESP
SWE
GBR
ISL
IPCC default
IPCC lower range
IPCC upper range
Other Bituminous Coal



GRC: A country specific carbon content of lignite used for electricity production was used in emission calculations for the period 1990-2005 (33.95 tC/TJ), which is based on studies of the Public Power Corporation (PPC 1993). For the period 2006-2016 plant specific values for CC were used, based on verified EU-ETS reports, ranging from 33.74 to 35.37 tC/TJ. These values lies out of the range suggested by the 2006 IPCC Guidelines. However, given that the net calorific value of the Greek lignite is one of lowest (see Papanicolaou et al., 2004 for an overview of the properties of the Greek lignites) a high value for the carbon content is expected. Moreover, according to international literature (Fott, 1999) the suggested value by IPCC corresponds to a net calorific value of 13 TJ / kt, which is not representative of national circumstances (see Table 3.14 and Figure 3.5). -The oxidation factor 98% is used for the combustion of lignite for electricity production. This is based on a study of the Public Power Corporation (PPC 1993) and verified EU-ETS reports.


Emission factor coking coal
t CO2 / TJ
150
140
130
120
110
100
90
80
70
60
50
IPCC default
IPCC lower range
IPCC upper range
Coking Coal
AUT
Flanders
Wallo...
Brussels
BGR
HRV
CYP
CZE
DNM
EST
FIN
FRK
DEU
GRC
HUN
IRL
ITA
LVA
LTU
LUX
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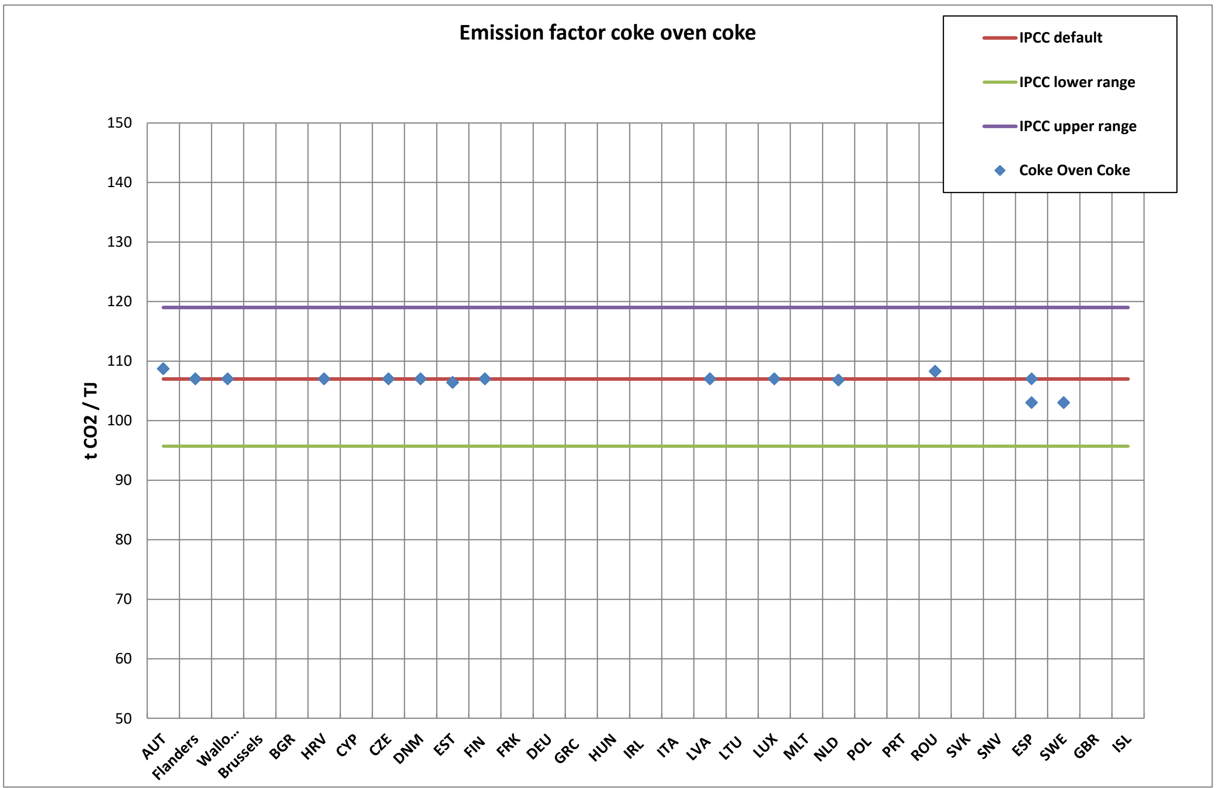
ESP
SWE
GBR
ISL


Emission factor coke oven coke
t CO2 / TJ
150
140
130
120
110
100
90
80
70
60
50
IPCC default
IPCC lower range
IPCC upper range
Coke Oven Coke
AUT
Flanders
Wallo...
Brussels
BGR
HRV
CYP
CZE
DNM
EST
FIN
FRK
DEU
GRC
HUN
IRL
ITA
LVA
LTU
LUX
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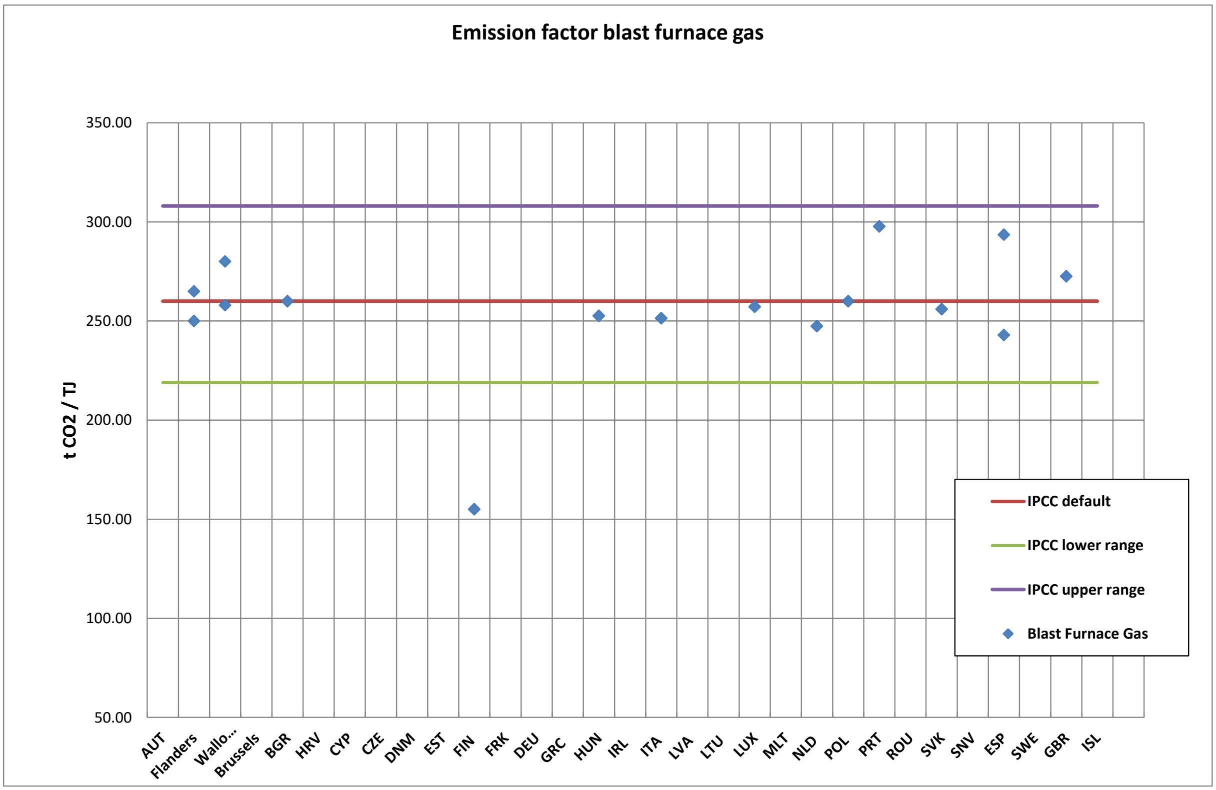
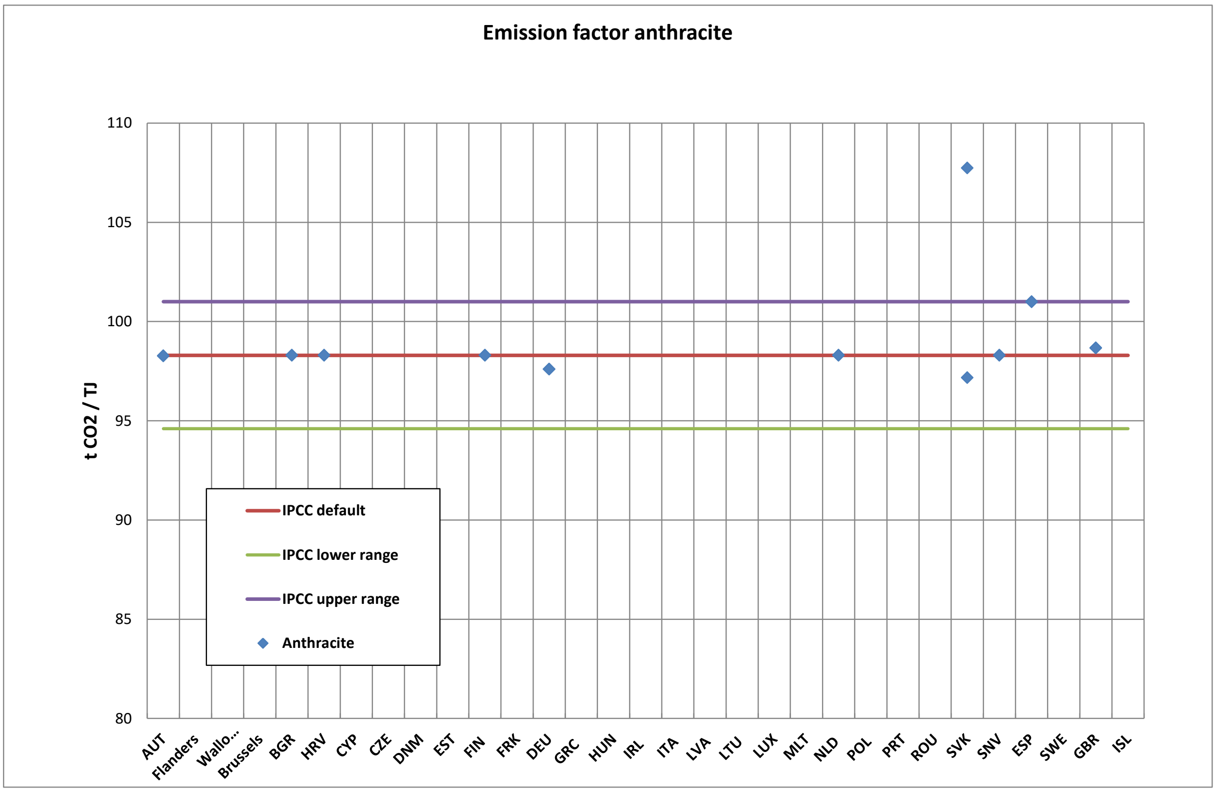
ESP
SWE
GBR
ISL



FIN: Because the number of plants is very small, we have to aggregate certain fuel types to more general categories. In this case, blast furnace gas includes actually two types of gas. One is more like carbon moNO_xide (EF 155), and the other actual blast furnace gas (EF around 265). Both EF values (or range for actual blast furnace gas) are based on plant-level data. In the calculations we use different fuel codes for each fuel type (each plant), but in reporting we aggregate them in the same group, which is named as blast furnace gas (it should probably be 'Blast furnace gas and other derived gases from metal industries').



SVK: The higher value is used for 1A2a, the lower value for 1A1a.

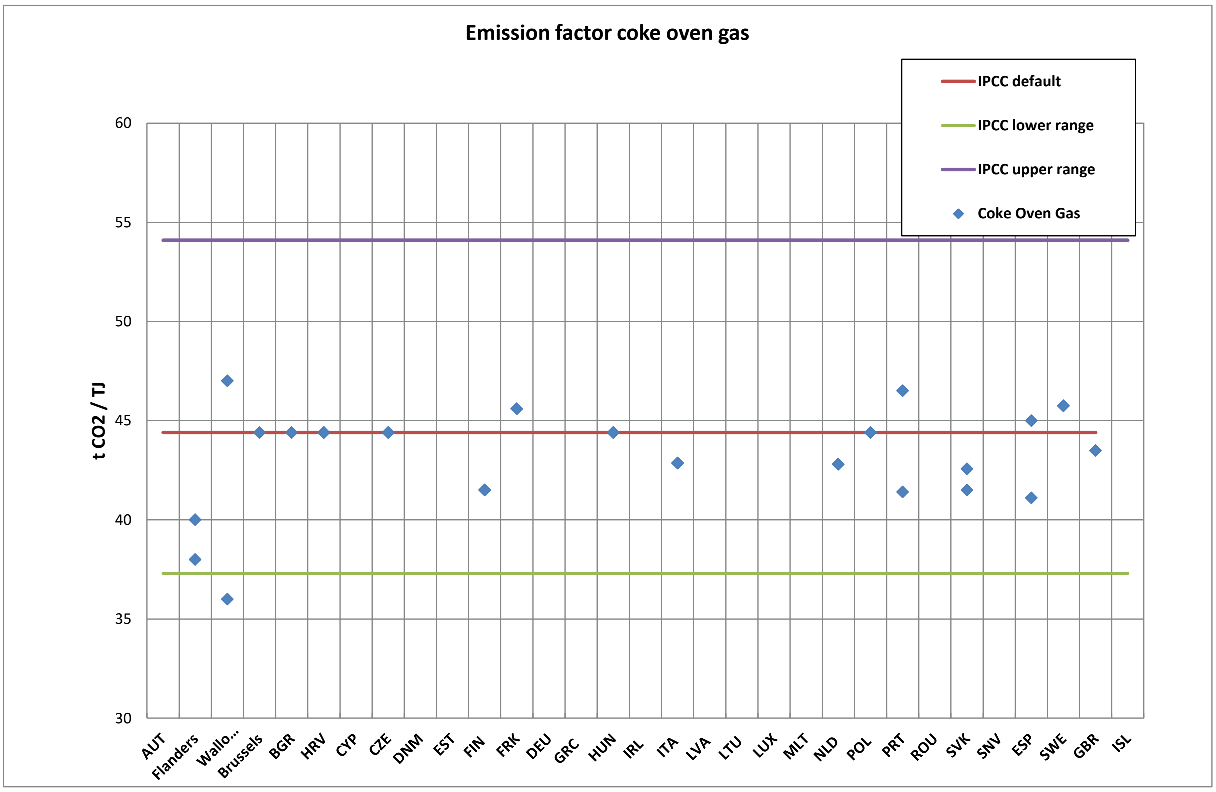


Table 3.125 shows the total EU-28 uncertainty estimates for the sector ‘Energy’ excluding 1A3 ‘Transport’ and the uncertainty estimates for the relevant gases for each source category. For those emissions for which no split by source category was available, uncertainty estimates were made for stationary combustion as a whole. The highest level uncertainty was estimated for N_2O from 1A2c and the lowest for CO_2 from 1A2e. With regard to trend CH_4 from 1A1a shows the highest uncertainty estimates, CO_2 from 1A1a the lowest. The results of this year’s uncertainty analysis are very similar to the results in 2017. For a description of the Tier 1 uncertainty analysis carried out for the EU-28 see Chapter 1.6.

Table 3.125 Sector 1 Energy (excl. 1A3b and 1B): Uncertainty estimates for EU-28

Source category	Gas	Emissions Base Year	Emissions 2016	Emission trends Base Year-2016	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	CO_2	553,542	473,151	-14.5%	2.9%	0.0%
1.A.1.a Public electricity and heat production	CH_4	319	2,988	836.9%	67.1%	5.7%
1.A.1.a Public electricity and heat production	N_2O	2,547	2,844	11.7%	32.2%	0.1%
1.A.1.b Petroleum refining	CO_2	53,136	50,348	-5.2%	4.3%	0.0%
1.A.1.b Petroleum refining	CH_4	19	16	-15.6%	17.6%	0.0%
1.A.1.b Petroleum refining	N_2O	195	130	-33.2%	30.4%	0.1%
1.A.1.c Manufacture of solid fuels and other energy industries	CO_2	49,265	16,388	-66.7%	4.9%	0.0%
1.A.1.c Manufacture of solid fuels and other energy industries	CH_4	146	185	27.0%	137.7%	0.4%
1.A.1.c Manufacture of solid fuels and other energy industries	N_2O	369	151	-59.0%	23.0%	0.1%
1.A.2.a Iron and Steel	CO_2	49,387	40,904	-17.2%	5.4%	0.0%
1.A.2.a Iron and Steel	CH_4	71	61	-15.1%	26.6%	0.0%
1.A.2.a Iron and Steel	N_2O	191	111	-41.9%	34.2%	1.4%
1.A.2.b Non-ferrous Metals	CO_2	3,038	2,142	-29.5%	8.7%	0.0%
1.A.2.b Non-ferrous Metals	CH_4	3	2	-27.4%	64.7%	0.1%
1.A.2.b Non-ferrous Metals	N_2O	17	9	-45.4%	94.5%	0.3%
1.A.2.c Chemicals	CO_2	30,190	6,052	-80.0%	2.3%	0.0%
1.A.2.c Chemicals	CH_4	19	16	-14.8%	69.6%	0.4%
1.A.2.c Chemicals	N_2O	32	27	-12.9%	402.2%	1.8%
1.A.2.d Pulp, Paper and Print	CO_2	3,012	1,542	-48.8%	4.0%	0.0%
1.A.2.d Pulp, Paper and Print	CH_4	15	19	25.4%	37.0%	0.1%
1.A.2.d Pulp, Paper and Print	N_2O	79	99	25.8%	70.0%	0.2%
1.A.2.e Food Processing, Beverages and Tobacco	CO_2	7,986	3,977	-50.2%	1.6%	0.0%
1.A.2.e Food Processing, Beverages and Tobacco	CH_4	9	10	6.0%	66.8%	0.5%
1.A.2.e Food Processing, Beverages and Tobacco	N_2O	34	11	-69.2%	226.0%	0.8%
1.A.2.f Non-metallic minerals	CO2	28,451	21,074	-25.9%	2.7%	0.0%
1.A.2.f Non-metallic minerals	CH4	36	37	3.6%	31.8%	0.2%
1.A.2.f Non-metallic minerals	N2O	206	177	-14.4%	58.2%	0.3%
1.A.2.g Other	CO_2	131,011	82,052	-37.4%	3.4%	0.0%
1.A.2.g Other	CH_4	200	231	16.0%	30.2%	0.1%
1.A.2.g Other	N_2O	818	644	-21.2%	35.4%	0.1%
1.A.4.a Commercial/Institutional	CO_2	68,352	53,517	-21.7%	6.2%	0.0%
1.A.4.a Commercial/Institutional	CH_4	3,149	834	-73.5%	16.8%	0.2%
1.A.4.a Commercial/Institutional	N_2O	560	448	-20.0%	76.6%	0.2%
1.A.4.b Residential	CO_2	180,794	131,244	-27.4%	6.5%	0.0%
1.A.4.b Residential	CH_4	8,529	3,422	-59.9%	58.5%	0.1%
1.A.4.b Residential	N_2O	621	517	-16.7%	139.7%	0.4%
1.A.4.c Agriculture/forestry/fishing	CO_2	31,135	21,139	-32.1%	6.2%	0.0%
1.A.4.c Agriculture/forestry/fishing	CH_4	2,006	2,779	38.5%	21.4%	0.2%
1.A.4.c Agriculture/forestry/fishing	N_2O	1,073	394	-63.2%	100.0%	0.1%
1.A.5 Other	CO_2	15,069	4,239	-71.9%	19.0%	0.2%
1.A.5 Other	CH_4	50	50	-0.4%	186.6%	5.7%
1.A.5 Other	N_2O	139	61	-56.1%	258.6%	1.7%
1.A (where no subsector data were submitted)	*all*	*750,953*	*452,733*	*-39.7%*	*1.3%*	*1.0%*
1.A.1 (where no subsector data were submitted)	*all*	*623,660*	*424,055*	*-32.0%*	*1.5%*	*0.7%*
1.A.2 (where no subsector data were submitted)	*all*	*399,720*	*231,247*	*-42.1%*	*1.9%*	*0.8%*
1.A.3 (where no subsector data were submitted)	*all*	*248,686*	*292,932*	*17.8%*	*2.9%*	*0.7%*
1.A.4 (where no subsector data were submitted)	*all*	*400,281*	*316,633*	*-20.9%*	*3.1%*	*1.5%*
Total - 1.A (where no subsector data were submitted)	**all**	**750,953**	**452,733**	**-39.7%**	**1.3%**	**1.0%**
Total - 1.A.1	**all**	**1,283,197**	**970,256**	**-24.4%**	**1.6%**	**0.4%**
Total - 1.A.2	**all**	**654,524**	**390,445**	**-40.3%**	**1.5%**	**0.5%**
Total - 1.A.3	**all**	**788,848**	**914,701**	**16.0%**	**2.1%**	**0.6%**
Total - 1.A.4	**all**	**696,501**	**530,928**	**-23.8%**	**2.6%**	**1.0%**
Total - 1.A.5	**all**	**15,258**	**4,350**	**-71.5%**	**4.6%**	**3.1%**
Total - 1.A	**all**	**4,189,282**	**3,263,413**	**-22.1%**	**0.9%**	**0.3%**

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.

Table 3.126 shows the total EU-28 uncertainty estimates for the sector 1.B 'Fugitive emissions' and the uncertainty estimates for the relevant gases for each source category. The highest level uncertainties were estimated for N_2O from 1B2 and the lowest for N_2O from 1B1; the highest trend uncertainties were estimated for CH_4 from 1B1, the lowest for CO_2 from 1B1. The results of this year's uncertainty analysis are very similar to the results in 2017.

Table 3.126 1B Fugitive Emissions: Uncertainty estimates for EU-28

Source category	Gas	Emissions Base Year	Emissions 2016	Emission trends Base Year-2016	Level uncertainty estimates based on MS uncertainty estimates	Trend uncertainty estimates based on MS uncertainty estimates
1.B.1 Solid Fuels	CO_2	6,482	3,505	-45.9%	8.2%	0.0%
1.B.1 Solid Fuels	CH_4	93,834	25,683	-72.6%	46.8%	0.2%
1.B.1 Solid Fuels	N_2O	219.2	579.6	164.4%	5.0%	0.1%
1.B.2. Oil and Natural Gas and other emissions from energy production	CO_2	19,825	20,046	1.1%	12.6%	0.1%
1.B.2. Oil and Natural Gas and other emissions from energy production	CH_4	64,652	27,733	-57.1%	32.9%	0.1%
1.B.2. Oil and Natural Gas and other emissions from energy production	N_2O	464	531	14.4%	95.7%	0.1%
1.B (werhe no subsector data were submitted)	*all*	*14,007*	*7,931*	*-43.4%*	*48.2%*	*16.5%*
Total - 1.B	**all**	**199,484**	**86,009**	**-56.9%**	**18.4%**	**8.8%**

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.

Table 3.127 shows the total EU-28 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 1A3e. With regard to trend N_2O from 1A3c show the highest uncertainty estimates, CO_2 from 1A3b the lowest. The results of this year's uncertainty analysis are very similar to the results in 2017.

Table 3.127 1A3 Transport: Uncertainty estimates for EU-28

Source category	Gas	Emissions Base Year	Emissions 2016	Emission trends Base Year-2016	Level uncertainty estimates based on MS uncertainty estimates	Trend uncertainty estimates based on MS uncertainty estimates
1.A.3.a Domestic aviation	CO_2	8,471	8,482	0.1%	12.0%	0.0%
1.A.3.a Domestic aviation	CH_4	9	5	-47.3%	72.2%	0.2%
1.A.3.a Domestic aviation	N_2O	74	65	-12.8%	147.8%	0.2%
1.A.3.b Road transport	CO_2	472,615	571,702	21.0%	3.0%	0.0%
1.A.3.b Road transport	CH_4	6,467	4,103	-36.6%	8.0%	0.1%
1.A.3.b Road transport	N_2O	18,740	17,322	-7.6%	12.2%	0.1%
1.A.3.c Railways	CO_2	7,076	3,079	-56.5%	4.3%	0.0%
1.A.3.c Railways	CH_4	390	293	-24.9%	5.0%	0.0%
1.A.3.c Railways	N_2O	488	200	-59.1%	121.3%	0.5%
1.A.3.d Domestic navigation	CO_2	20,676	12,835	-37.9%	16.0%	0.1%
1.A.3.d Domestic navigation	CH_4	457	239	-47.6%	10.5%	0.1%
1.A.3.d Domestic navigation	N_2O	290	207	-28.7%	218.5%	0.4%
1.A.3.e Other transportation	CO_2	4,256	3,044	-28.5%	1.9%	0.0%
1.A.3.e Other transportation	CH_4	11	13	18.8%	41.8%	0.3%
1.A.3.e Other transportation	N_2O	142	181	27.4%	14.6%	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.

3.4 Sector-specific quality assurance and quality control

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. Table 3.128 summarizes the main checks carried out on Member States' submissions.

Table 3.128 Quality checks carried out on Member States' submissions

Issue	Check
Completeness	Check categories where Member States report the notation key NE for potential underestimations Check categories where Member States report a notation key and 20 or more Member States report emissions and assess if there are potential over- or underestimates Focus on 2016 (ESD)

Issue	Check
	Focus on EU key categories
Time series of emissions	Check time series consistency of Member States' emission estimates for potential over- and underestimates: Focus on 2016 (ESD) Focus on EU key categories
Time series of IEFs	Check time series consistency of Member States' IEFs for potential over- and underestimates: Focus on 2016 (ESD) Focus on EU key categories
Outlier checks of IEFs	Compare IEFs across Member States and assess if there are potential over- and underestimations of emissions Compare Member States' IEFs with (range of) default EF from 2006 IPCC GL Focus on 2016 (ESD) Focus on EU key categories
Recalculations	Check categories where Member States provide recalculations and focus on those of more than 0.05% of national total emissions for each main gas and assess if there are potential over- or underestimates. Also explanations for recalculations were checked either from MS Annexes - MMR IR Art. 8 or NIR. Focus on 2015 Focus on EU key categories
Follow-up from 2017	Check if issues that were classified as "Unresolved" or "Partly resolved" in 2017 have been resolved by Member States in 2018.
Implementation of UNFCCC and ESD review recommendations	Check if recommendations from 2015 and 2016 UNFCCC review reports have been implemented by Member States. Check if recommendations from ESD review 2018 have been implemented by Member States.

In the second half of the year, the EU internal review is carried out for selected source categories. In 2005, the EU internal review was carried out for the first time. In 2012 a comprehensive review was carried out for all sectors and all EU Member States in order to fix the base year 2020 under the EU Effort Sharing Decision. (ESD review 2012). This review also covered the energy sector of the MS GHG inventories (peer review). In 2015, a few Member States volunteered to be reviewed under step 2 of the ESD trial review for the sector energy. In 2016, again a comprehensive review was carried out for all sectors and all EU Member States with a focus on the years 2005, 2008-2010, 2013 and 2014 in order to track progress of the EU Member States under the EU Effort Sharing Decision. (ESD review 2016). In 2017 and 2018, annual reviews were carried out for all significant issues identified the initial checks phase with a focus on the years 2015 and 2016 in order to track progress of the EU Member States under the EU Effort Sharing Decision.

In addition, every year after the ESD review capacity building activities are organized. In 2017 the energy-related webinar had 73 participants from 24 EU Member States. Main issues discussed at the webinar were:

- Inconsistencies between EU-ETS and GHG inventory
- Allocation of emissions from energy and non-energy use of fuels in ammonia production and iron and steel production
- Differences between the reference approach and the sectoral approach
- Use of country-specific emission factors for road transport (follow-up is ongoing)
- Split between national and international bunkers for shipping

EU ETS data

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). During the ESD reviews 2012, 2015, 2016, 2017 and 2018 and during the initial checks

2015, 2016, 2017, and 2018 consistency checks have been carried out between EU ETS data and the inventory estimates.

Eurostat energy data

During the initial checks carried out before the compilation of the EU GHG inventory and during the ESD reviews Eurostat energy data is used for cross checking the sectoral and reference approach of the MS submissions. This cross check between the European energy reporting system and the EU GHG inventory system is an important QA/QC element of the EU GHG inventory compilation.

The quality of the EU GHG inventory is directly affected by the quality of Member States and EU energy statistics systems. EU energy statistics are collected by Eurostat on the basis of the EU energy statistics regulation[18]. The energy statistics regulation was adopted as part of the energy package and establishes a common framework for the production, transmission, evaluation and dissemination of comparable energy statistics in the EU.

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 European energy statistics system and the quality of the EU inventory are directly affected by this regulation that:

- ensures a stable and institutional basis for energy statistics in the EU,
- guarantees long-term availability of energy data for EU policies,
- reinforces available resources for the production of the basic energy statistics at national level.

The energy statistics regulation helps improving the QA/QC of the EU inventory as it:

- makes available more detailed energy statistics by fuel,
- allows the estimation of CO_2 emissions from energy with the reference and sectoral approach,
- assures the quality of the underlying energy statistics,
- improves timeliness of energy statistics,
- provides 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'.

In addition, Article 7(1)(m)(iii) of the MMR in conjunction with Article 12 of the implementing regulation requires Member States to report to the European Commission textual information on the comparison between the reference approach calculated on the basis of the data included in the greenhouse gas inventory and the reference approach calculated on the basis of the data reported pursuant to the Energy Statistics Regulation. Member States with differences of more than +/- 2% in the total national apparent fossil fuel consumption have to provide quantitative information and explanations for the year X-2 in accordance with the tabular format set out in Annex VI of the implementing regulation.

[18] REGULATION (EC) No 1099/2008 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 22 October 2008 on energy statistics as amended by Commission Regulation (EU) No 147/2013 of 13 February 2013.

Eurocontrol data

Since 2010 there are framework contracts in place between the European Commission and EUROCONTROL, the European organization for the safety of air navigation, pertaining to the improvement of GHG and air pollutant emissions inventories submitted by the 28 Member States and the European Union to the UNFCCC and to the UNECE. EU Member States shall be assisted to 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. For this, the European Environment Agency and its ETC/ACM is preparing comparisons between EUROCONTROL results and MS inventory data and is promoting discussions between EUROCONTROL and EEA Member States related to these results. For more information on the process refer to Chapter 1.4.2.

In November 2017 EUROCONTROL provided results on fuel consumption, emissions of CO_2, CH_4 and N_2O and other air pollutants for domestic and international aviation for the years 2005 to 2015 by EU Member States and other EEA member countries (Iceland, Liechtenstein, Switzerland, Norway and Turkey). Recalculations took place to reflect i.a. corrections of aircraft types and their relation to engine Types and the calculation of taxi-in and taxi-out times.

The calculation of EUROCONTROL is a bottom-up modelling, applying the Advanced Emissions Model (AEM). This is a tier 3b approach basing on EUROCONTROL information on flight plan data and flight trajectories (detailed documentation available upon request). Flight plan data is only available for flights under Instrumental Flight Rules. Flights which take place under Visual Flight Rules (VFR) are not included in the dataset of EUROCONTROL.

The comparison of EUROCONTROL results and MS inventory data for the time series 2005 to 2016 has been prepared by the European Environment Agency and its ETC/ACM in February 2018. Results have been shared with Member States during the ‘initial checks’ for aviation gasoline and kerosene consumption, domestic splits for kerosene and implied emission factors for CO_2, N_2O and CH_4. In addition Member States have been contacted in case of considerable differences between inventory and EUROCONTROL results.

Due to the exclusion of flights under VFR in EUROCONTROL’s calculations, the results for the consumption of aviation gasoline (which mainly takes place in smaller aircrafts under VFR) are considerably lower for most Member States in EUROCONTROL calculations than in inventories. In addition most Member States allocate the total consumption of aviation gasoline to domestic aviation, following the recommendation of the IPCC 2006 guidelines, whereas EUROCONTROL displays some small amounts of aviation gasoline consumption for international aviation, too. EU-28 kerosene consumption in 2016 resulting from EUROCONTROL calculations is 1 % lower for both domestic and international aviation compared to the aggregation of Member State results from inventories. The domestic split (as the share of kerosene consumption for domestic aviation on total kerosene consumption) for EU-28 is identical between EU inventory and EUROCONTROL results. For domestic aviation the difference in CO_2 emissions is 0.5 Mt CO_2 in 2016. With this, the actual difference is considerably lower than the one which has been calculated in the very first exercise to compare EUROCONTROL results with MS data in 2007 (see EU NIR 2014). Obviously both the reporting of Member States but also the calculation of EUROCONTROL improved considerably during the years. The development of kerosene consumption along the time series 2005 to 2016 for EU-28 shows the same trends for both domestic and international aviation following EUROCONTROL results and EU inventory numbers. Differences are slightly higher in the years 2005 to 2007 due to different underlying datasets in EUROCONTROL calculations. With the new methodology applied for the calculation of N_2O and CH_4 emissions by EUROCONTROL, implied emission factors for these gases are now much more comparable with Member State results.

Absolute differences in kerosene consumption are partly higher for single Member States. The reasons for these differences are mainly due to the fact, that respective Member States are basing their estimates on fuel sales statistics and on different estimates of domestic splits. In addition there are several general sources of possible differences: First there is the fact, that the consideration of flight trajectories for the calculation of cruise emissions is a method exclusively applied by EUROCONTROL. Furthermore the use of different sources for flight statistics for bottom up modelling, the allocation of aircraft types and engines to flights in statistics and the use of different emission factors for cruise and LTO lead to different results.

During the last years it can be seen that EUROCONTROL information has increasingly been used by Member States, either for checking purposes but also by using the numbers directly in inventory calculations. In the course of the 'initial checks' 2016, 2017 and 2018 an intensive discussion with Member States took place to understand the reasons for differences on MS level. Some of the outcomes could on the one hand lead to eventual further improvement of inventories in next submissions or on the other hand for additional use of national information in EUROCONTOL calculations. In most cases the differences occur due to the need to align inventory numbers with the energy balance which might always lead to differences compared to a bottom-up calculation.

3.5 Sector-specific improvements

The improvements implemented in 2018 were partly due to recommendations derived from an EU internal review and partly motivated by recommendations made by the UNFCCC review team. The major improvements include (i) more transparent and complete overview tables for EU key categories; (ii) more transparent figures related to IEFs of Member States and the EU (iii) more complete and transparent chapter on feedstocks and non-energy use of fuels; (iv) inclusion of summary information related to Member States' use of fuel-specific CO_2 emission factors; (v) follow-up with Member States in order to improve the inventory (e.g. road transport, reference approach); (vi) Provision of more complete explanations for Member States' recalculations.

Table 3.129 provides more detail on the improvements made in the 2018 submission.

Table 3.129 Improvements in the 2018 submission

Improvement	Description	Relevant categories / chapters
More transparent and complete overview tables for EU key categories	The information provided by MS related to their methods used (e.g. T1, T2, M) and emissions factors applied (e.g. D, CS, PS) was checked and consistent information is included for all key categories. In WG1 it was discussed with MS that they should avoid using the notation CS for methods and instead use T1 or T2 in order to make transparent if a MS uses a higher tier method.	1A, 1B
More transparent figures related to IEFs of Member States and the EU	The scale for figures related to IEFs for the EU was adapted in order to improve the transparency of changes in time series	1A
More complete and transparent chapter on feedstocks and non-energy use of fuels	The data basis for CRF table 1A(d) was changed from Eurostat data to MS CRF data (see chapter 3.9. for more information). In addition, more emphasis was laid during the initial checks on the reporting In CRF table 1A(d). Finally, a summary table is included showing the recalculations of the data included in CRF table 1A(d).	Chapter 3.9
Inclusion of summary information related to Member States' use of fuel-specific CO_2 emission factors	Annex III of the EU NIR includes an extraction of the emission factors used by MS for each fuel. In the 2018 EU NIR we included overviews based on Annex III for the most important fuels. The overview includes a comparison of MS emission factors with the IPCC default emission factors and explanations for significant deviations.	Chapter 3.3
Follow-up with Member States in order to improve the inventory	In order to support the MS in developing country-specific CO_2 emission factors for road transport a draft note was prepared addressing this issue and listing the MS that have country-specific CO_2 mission factors. The note includes practical details such as	1A3b, 1B, 1AB

Improvement	Description	Relevant categories / chapters
	number of samples used, origin of samples (petrol stations or refineries). In order to support the MS in improving the reporting in CRF table 1A(b) and 1A(d) a note was circulated including guidance for reporting. The EU is in consultation with Romania to refine the methodology for the estimation of CH_4 emissions in category 1.B.2.b.	
Information on recalculations	The EU NIR contains detailed tables on the recalculations performed by Member States. The main explanations were added to these tables, to the extent possible, either by checking the corresponding tables of the MS Annex on recalculations or from the MS's NIR submissions.	1A3b
Moe transparent information in the NIR	New key categories were added in the report and the major trends were explained. More information was included concerning the methodologies and the use of higher tier methods.	1A3b

3.6 Sector-specific recalculations

Table 3.130 shows that in the energy sector the largest recalculations in absolute terms in 1990 and in 2015 were made for CO_2. In relative terms, the largest recalculations in 1990 were made for CO_2 (0.4 %) and in 2015 for N_2O (+1.2 %).

Table 3.130 Sector 1 Energy: Recalculations of total GHG emissions and recalculations of GHG emissions for the years 1990 and 2015 by gas in kt (CO_2-eq.) and percentage

1990	**CO_2**		**CH_4**		**N_2O**		**HFCs**		**PFCs**		**SF_6**		**Unspecified mix of HFCs and PFCs**		**NF3**	
	Gg	percent	Gg	percent	Gg	percent	Gg	percent	Gg	percent	Gg	percent	Gg	percent	Gg	percent
Total emissions and removals	-14 085	-0.3%	-7 505	-1.0%	-1 819	-0.5%	1	0.0%	0	0.0%	46	0.4%	0	0.0%	0	0.0%
Energy	14 582	0.4%	-154	-0.1%	4	0.0%	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2015																
Total emissions and removals	-682	0.0%	-2 476	-0.5%	-923	-0.4%	2 348	2.2%	12	0.3%	66	1.0%	482	199.2%	-5	-6.6%
Energy	12 842	0.4%	-121	-0.1%	366	1.2%	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO

NO: not occurring

Table 3.131 provides an overview of Member States' contributions to EU-28 and Iceland recalculations. In absolute terms, the UK had the most influence on CO_2 recalculations in the EU-28 + ISL in 2015. Explanations for recalculations by Member State are provided in Chapters 3.2 and 10.1.

Table 3.131 Sector 1 Energy: Contribution of Member States to EU-28 and Iceland recalculations for 1990 and 2015 by gas (difference between latest submission and previous submission kt of CO_2 equivalents)

	1990								2015							
	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF3	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF3
Austria	0	-109	-5	NO	NO	NO	NO	NO	-57	57	2	NO	NO	NO	NO	NO
Belgium	294	-30	-10	NO	NO	NO	NO	NO	-141	10	13	NO	NO	NO	NO	NO
Bulgaria	30	1.0	0.4	NO	NO	NO	NO	NO	-126	0.2	-0.1	NO	NO	NO	NO	NO
Croatia	0.0	0.0	0.0	NO	NO	NO	NO	NO	0.0	0.0	0.0	NO	NO	NO	NO	NO
Cyprus	15	0.2	0.2	NO	NO	NO	NO	NO	38	1	1	NO	NO	NO	NO	NO
Czech Republic	2 538	219	13.1	NO	NO	NO	NO	NO	905	74	5	NO	NO	NO	NO	NO
Denmark	6.7	1.9	0.5	NO	NO	NO	NO	NO	174	-3	1	NO	NO	NO	NO	NO
Estonia	0.0	0.0	0.0	NO	NO	NO	NO	NO	6	0.002	0.002	NO	NO	NO	NO	NO
Finland	-0.01	0.002	0.0	NO	NO	NO	NO	NO	44	0.5	1	NO	NO	NO	NO	NO
France	-1 355	90.0	8.9	NO	NO	NO	NO	NO	2 579	-53	-45	NO	NO	NO	NO	NO
Germany	0	-0.2	-0.1	NO	NO	NO	NO	NO	5 712	97	32	NO	NO	NO	NO	NO
Greece	0	0.2	0.5	NO	NO	NO	NO	NO	0	-1	3	NO	NO	NO	NO	NO
Hungary	5	-5.9	-3.1	NO	NO	NO	NO	NO	53	8	0	NO	NO	NO	NO	NO
Ireland	0.0	0.6	0.6	NO	NO	NO	NO	NO	36	0	7	NO	NO	NO	NO	NO
Italy	4 958	-59	1.7	NO	NO	NO	NO	NO	-1 716	33	-17	NO	NO	NO	NO	NO
Latvia	10	-0.2	0.8	NO	NO	NO	NO	NO	88	-18	-3	NO	NO	NO	NO	NO
Lithuania	1.0	2.7	9.9	NO	NO	NO	NO	NO	-0.2	0.3	-0.1	NO	NO	NO	NO	NO
Luxembourg	0.0	0.0	0.0	NO	NO	NO	NO	NO	-47	1	0.4	NO	NO	NO	NO	NO
Malta	-227	-48	-3.4	NO	NO	NO	NO	NO	1	0.1	-2	NO	NO	NO	NO	NO
Netherlands	2 229	4.8	-21	NO	NO	NO	NO	NO	498	1	-24	NO	NO	NO	NO	NO
Poland	-1.1	-0.0002	-0.01	NO	NO	NO	NO	NO	19	-0.0002	-0.01	NO	NO	NO	NO	NO
Portugal	166	-41.8	11.5	NO	NO	NO	NO	NO	161	-36	12	NO	NO	NO	NO	NO
Romania	-1 230	-7.5	-0.7	NO	NO	NO	NO	NO	-1 114	-5	-2	NO	NO	NO	NO	NO
Slovakia	91	-7.8	-15	NO	NO	NO	NO	NO	227	-9	9	NO	NO	NO	NO	NO
Slovenia	-0.1	-3.2	-2.3	NO	NO	NO	NO	NO	0	-1	4	NO	NO	NO	NO	NO
Spain	604	-166	-1.4	NO	NO	NO	NO	NO	-803	-162	146	NO	NO	NO	NO	NO
Sweden	-0.2	-30.4	-69	NO	NO	NO	NO	NO	72	-51	-18	NO	NO	NO	NO	NO
United Kingdom	6 447	34.7	87	NO	NO	NO	NO	NO	6 234	-66	241	NO	NO	NO	NO	NO
EU28	14 582	-154	4.0	NO	NO	NO	NO	NO	12 842	-121	366	NO	NO	NO	NO	NO
Iceland	86	1.4	1.7	NO	NO	NO	NO	NO	173	1	8	NO	NO	NO	NO	NO
United Kingdom (KP)	5 820	31.7	85	NO	NO	NO	NO	NO	5 632	-67	239	NO	NO	NO	NO	NO
EU28+ISL	14 042	-155	3.6	NO	NO	NO	NO	NO	12 412	-120	372	NO	NO	NO	NO	NO

Abbreviations explained in the Chapter 'Units and abbreviations'.

3.7 Comparison between the sectoral approach and the reference approach (EU-28 + ISL)

The IPCC reference approach for CO_2 from fossil fuels for the EU-28 + ISL is based on Eurostat energy data (Eurostat database, February 2018) for apparent consumption included in CRF table 1A(b) and data from MS CRF submissions for CRF table 1A(d). The reason for using Eurostat data in CRF table 1A(b) is that Eurostat provides a coherent data set for all Member States for apparent consumption in TJ whereas in the CRF submissions some MS use TJ and other MS use kt. Up to 2017 also for CRF table 1A(d) we used apparent consumption from Eurostat. The reason for having used Eurostat data in CRF table 1A(d) for many years was that also for non-energy use of fuels Eurostat provided a coherent data set for all 28 EU Member States. The drawback of Eurostat data was that the definition of non-energy use of fuels in energy statistics is narrower than the definition in the IPCC guidelines because fuels used as reductants are not classified as non-energy use of fuels in energy statistics. In addition, Member States may use other data than the energy balance for compiling the non-energy use data (e.g. EU ETS data, environmental reporting of companies, etc.). Therefore, the EU decided to change the reporting in CRF table 1A(d) and calculate all data as the sum of respective MS data. The drawback of this approach is that Member States may use different allocation of energy use and non-energy use of fuels (e.g. in iron and steel) depending on the allocation in the sectoral approach.

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 provides the annual energy balances which can be used for the estimation of CO_2 emissions from fossil fuels by Member State and for the EU-28 + ISL as a whole.

The Eurostat data for the EU-28 + ISL IPCC reference approach includes activity data and net calorific values as available in the Eurostat database. For the calculation of CO_2 emissions, the IPCC default carbon emission factors are used.

The IPCC reference approach method at EU-28 + ISL level is a three-step process.

- The Energy Statistics Regulation (Regulation EC/1099/2008) is the basis for MS reporting of energy data to Eurostat as well as the basis for the EU's IPCC Reference Approach. For each of the 28 Member States and Iceland, annual data on energy production, imports, exports, international bunkers and stock changes by fuel are available from Eurostat's database http://ec.europa.eu/eurostat/data/database The energy data used for the Reference Approach in the EU + ISL 2016 inventory submission, and reported in table 1.A(b), corresponds to the sum of its 28 MS and Iceland.
- The energy data in Eurostat's database can be exported in mass or volume units or in Terajoules. The latter is based on the calorific values reported by MS in the energy questionnaires, on a net basis. Table 1.A(b) was reported in Terajoules. The data was downloaded in February 2018.
- The carbon emission factors are those from the IPCC 2006 Guidelines http://www.ipcc-nggip.iges.or.jp/public/2006gl/vol2.html
- The carbon excluded from table 1.A(b) is fully consistent with the data included in table 1.A(d).
- Eurostat data is not used for table 1.A(d). Instead we use the sum of the Member States CRF data because the definition of Eurostat non-energy use of fuels is narrower than in the IPCC guidelines and because the reporting in column I is closely linked to the inventories in IPPU sectors.
- The fractions of carbon oxidised reported in table 1.A(b) are the default 2006 IPCC factors of 1, thus assuming complete oxidation of emissions.

CRF table 1A(c) compares EU-28 + ISL CO_2 emissions calculated with the IPCC reference approach and the sectoral approach (Table 3.132). The percentage differences for both energy consumption and CO_2 emissions are very similar to previous submissions despite of the fact that the following revisions were made in 2018:

- We included apparent consumption of Refinery feedstocks and Coke oven/gas coke in CRF table 1.A(b) which was reported as "NO" by mistake in previous submissions.
- We corrected the sign of Stock changes taking into account that the sign of stock changes are opposite in energy statistics and in the 2006 IPCC Guidelines / CRF tables.
- We changed the data source for Fuel quantity for non-energy use in CRF table 1.A(d). Up to the GHG inventory submission 2017 the EU used Eurostat data for non-energy use of fuels. The reason for using Eurostat data was that Eurostat provided a coherent data set for all 28 EU Member States. The drawback of Eurostat data was that the definition of non-energy use of fuels in energy statistics is narrower than the definition in the IPCC guidelines because fuels used as reductants are not classified as non-energy use of fuels in energy statistics. In addition, Member States may use other data than the energy balance for compiling the non-energy use data (e.g. EU ETS data, environmental reporting of companies, etc.). Therefore, the EU decided to change the reporting in CRF table 1A(d) and calculate all data as the sum of respective MS data.

Table 3.132 Comparison of reference approach and sectoral approach for EU-28 and Iceland

[1. Energy][1.AC Comparison of CO2 Emissions from Fuel Combustion]	Unit	1990	1995	2000	2005	2010	2015	2016
Fuel consumption								
Sectoral approach	PJ	51,810	50,324	51,059	53,175	49,536	43,340	43,713
Apparent energy consumption (excluding non-energy use, reductants and feedstocks)	PJ	51,594	50,001	50,364	52,501	49,001	42,613	43,029
Difference	%	-0.4	-0.6	-1.4	-1.3	-1.1	-1.7	-1.6
CO2 emissions								
Reference approach	kt	4,010,493	3,784,388	3,727,089	3,856,274	3,562,525	3,140,083	3,133,677
Sectoral approach	kt	4,100,471	3,867,627	3,835,399	3,955,321	3,647,377	3,232,226	3,211,750
Difference	%	-2.2	-2.2	-2.8	-2.5	-2.3	-2.9	-2.4

Table 3.133 provides an overview for EU-28 Member States and Iceland on differences between the Eurostat and national reference approach for apparent consumption in TJ for 2016. For EU-28 + ISL the differences are very small. However, for some Member States the two data sets show larger differences. The main reasons for diverging energy data are:

- the use of different calorific values (CV);
- 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).

Explanations for the largest differences are as follows:

Estonia – liquid fuels: different treatment of shale oil in the Eurostat energy balances compared to the CRF reference approach.

Iceland – solid fuels: this is due to an error included in CRF table 1A(b) for other solid fuels

Table 3.133 Comparison between Eurostat and national reference approach for apparent consumption for EU-28 for 2016 (CRF 1.A) [19]

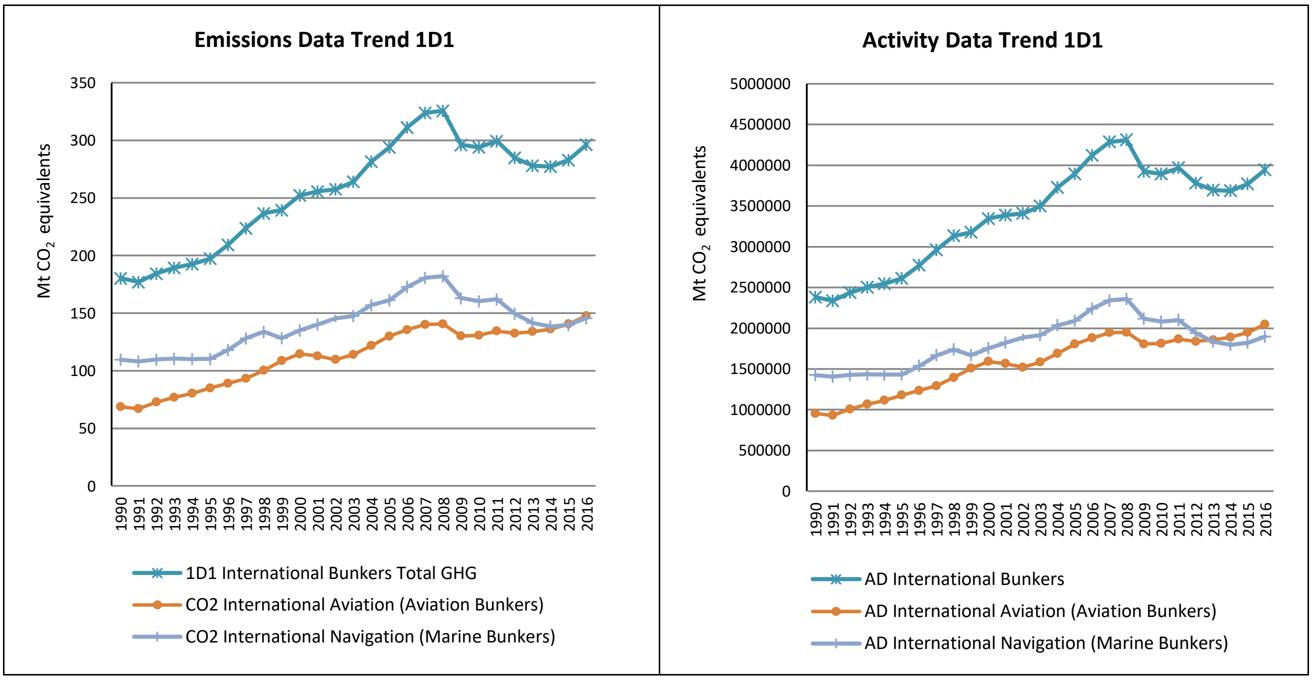
	Total liquid			Total solid			Total gaseous		
	Eurostat TJ	Crf TJ	Difference %	Eurostat TJ	Crf TJ	Difference %	Eurostat TJ	Crf TJ	Difference %
AT	961,388	997,972	4%	247,606	250,498	1%	601,382	601,382	0%
BE	1,876,448	1,869,972	0%	246,802	248,791	1%	1,197,420	1,191,434	0%
BG	318,972	348,910	9%	474,118	474,235	0%	224,958	224,959	0%
CY	166,796	168,516	1%	--	41	0%	--	--	0%
CZ	663,530	661,754	0%	1,385,298	1,367,131	-1%	587,518	588,914	0%
DE	8,346,612	8,333,545	0%	6,466,648	6,350,876	-2%	5,889,178	6,071,122	3%
DK	485,750	495,814	2%	158,640	165,261	4%	241,002	240,999	0%
EE	31,772	36,207	14%	315,202	315,202	0%	35,862	35,861	0%
ES	4,136,654	4,036,974	-2%	853,476	847,829	-1%	2,096,728	2,101,388	0%
FI	723,660	705,334	-3%	266,470	269,430	1%	172,388	170,057	-1%
FR	5,797,896	6,033,886	4%	718,144	762,940	6%	3,206,156	3,206,158	0%
GR	997,154	980,494	-2%	365,882	382,136	4%	292,216	292,216	0%
HR	256,674	277,222	8%	54,466	54,495	0%	181,754	181,753	0%
HU	567,636	572,833	1%	189,206	188,115	-1%	672,208	672,208	0%
IE	543,156	530,912	-2%	112,830	114,996	2%	355,204	355,965	0%
IS	46,784	47,385	1%	8,380	30,510	264%	--	0	0%
IT	4,354,468	4,572,894	5%	919,856	919,201	0%	4,863,352	4,863,929	0%
LT	223,646	230,270	3%	13,318	13,336	0%	154,208	155,084	1%
LU	177,594	177,899	0%	4,380	4,385	0%	59,378	59,378	0%
LV	113,362	105,822	-7%	3,376	3,356	-1%	92,676	93,870	1%
MT	37,360	37,391	0%	--	--	0%	--	438	0%
NL	2,336,906	2,360,906	1%	855,154	854,600	0%	2,503,798	2,503,800	0%
PL	2,111,406	2,135,500	1%	4,091,528	4,096,568	0%	1,225,342	1,225,342	0%
PT	786,070	786,365	0%	238,306	238,251	0%	360,038	363,613	1%
RO	746,842	705,268	-6%	445,522	441,968	-1%	754,314	754,313	0%
SE	937,548	881,489	-6%	159,686	151,847	-5%	68,516	68,868	1%
SI	199,374	199,862	0%	96,004	95,710	0%	59,038	59,039	0%
SK	261,258	276,782	6%	270,020	269,323	0%	326,180	330,129	1%
UK	5,044,330	5,092,598	1%	985,008	995,511	1%	5,811,724	5,808,304	0%
EU-28 + IS	43,251,046	43,660,776	1%	19,945,326	19,906,543	0%	32,032,538	32,220,523	1%

[19] Minus means that Member State-based estimates are lower than the Eurostat-based estimates.

3.8 International bunker fuels (EU-28+ISL)

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[20]. Between 1990 and 2016, greenhouse gas emissions from international bunker fuels increased by 64% in the EU-28+ISL. CO_2 emissions from “Marine bunkers” account for 49 % of total greenhouse gas emissions from international bunkers in 2016, CO_2 from “Aviation bunkers” accounts for 50 % (Figure 3.167).

Figure 3.167 1D1 International bunker fuels: GHG emission trend and activity data



3.8.1 Aviation bunkers (EU-28+ISL)

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 equal 3 % of total GHG emissions in 2016 but are not included in the national total of GHG emissions (Table 3.134).

The Member States France, Germany, Spain and the United Kingdom contributed more than 60 % to the EU-28+ISL emissions from this source. Most Member States (25 in total) increased emissions from Aviation bunkers between 1990 and 2016.

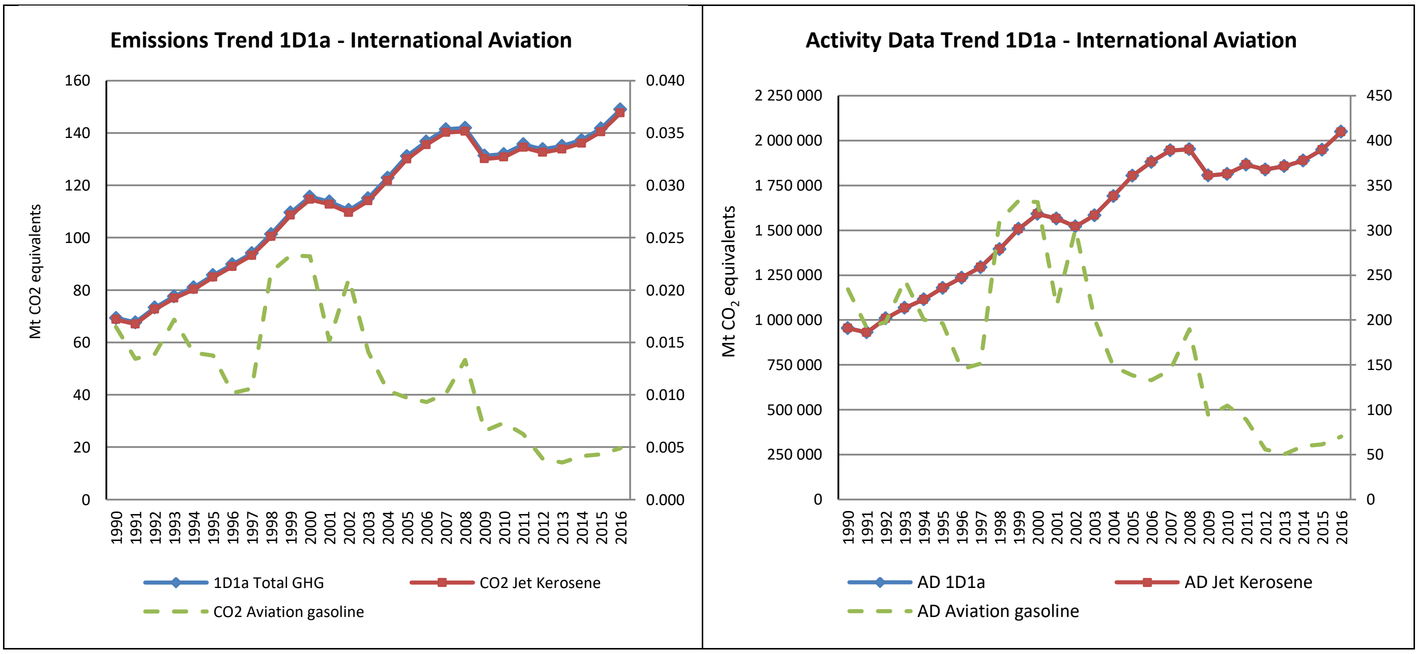
[20] The definitions in Tables 2.8 and 2.9 of the IPCC good practice guidance are based on activities within ‘one country”. This means domestic aviation is defined for individual countries. The decision tree in Figure 2.8 of the IPCC good practice guidance considers ‘national fuel statistics’ for domestic aviation. As the EU is neither a country nor a nation, the EU’s interpretation of the good practice guidance is that the emission estimate at EU 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 3.134 Aviation bunkers: Member States' contributions to CO_2

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016	
	1990	2015	2016		kt CO2	%	kt CO2	%
Austria	886	2 128	2 325	1.6%	1 439	162%	198	9%
Belgium	3 126	4 406	4 373	3.0%	1 247	40%	-33	-1%
Bulgaria	713	529	636	0.4%	-77	-11%	108	20%
Croatia	497	354	376	0.3%	-121	-24%	22	6%
Cyprus	718	751	877	0.6%	159	22%	126	17%
Czech Republic	524	887	956	0.6%	432	83%	68	8%
Denmark	1 731	2 626	2 823	1.9%	1 093	63%	198	8%
Estonia	107	74	65	0.0%	-42	-39%	-9	-12%
Finland	1 008	1 963	1 968	1.3%	960	95%	5	0%
France	8 609	17 316	17 052	11.5%	8 443	98%	-264	-2%
Germany	11 960	24 211	26 170	17.7%	14 210	119%	1 959	8%
Greece	2 475	2 869	3 079	2.1%	604	24%	210	7%
Hungary	497	543	599	0.4%	102	21%	56	10%
Ireland	1 070	2 522	2 589	1.8%	1 519	142%	66	3%
Italy	4 285	9 573	10 301	7.0%	6 017	140%	728	8%
Latvia	221	327	372	0.3%	151	68%	45	14%
Lithuania	399	245	287	0.2%	-112	-28%	42	17%
Luxembourg	386	1 341	1 490	1.0%	1 104	286%	149	11%
Malta	197	350	375	0.3%	178	90%	25	7%
Netherlands	4 604	11 370	11 676	7.9%	7 072	154%	306	3%
Poland	622	1 875	2 002	1.4%	1 380	222%	127	7%
Portugal	1 533	3 141	3 367	2.3%	1 834	120%	225	7%
Romania	790	688	870	0.6%	80	10%	182	26%
Slovakia	67	144	154	0.1%	87	130%	10	7%
Slovenia	49	74	61	0.0%	12	24%	-14	-18%
Spain	4 790	14 100	15 706	10.6%	10 917	228%	1 606	11%
Sweden	1 335	2 164	2 525	1.7%	1 190	89%	361	17%
United Kingdom	15 378	33 172	33 635	22.8%	18 257	119%	463	1%
EU-28	**68 574**	**139 746**	**146 709**	**99%**	**78 136**	**114%**	**6 964**	**5%**
Iceland	219	674	917	0.6%	697	318%	243	36%
United Kingdom (KP)	15 313	33 174	33 652	22.8%	18 339	120%	478	1%
EU-28 + ISL	**68 728**	**140 422**	**147 643**	**100%**	**78 915**	**115%**	**7 222**	**5%**

CO_2 emissions from jet kerosene account for 99 % of total emissions from "Aviation bunkers" in 2016 (Figure 3.168). All Member States but Bulgaria, Croatia, Estonia and Lithuania increased emissions from jet kerosene between 1990 and 2016. Member States with the highest increase between 1990 and 2016 in percent were Iceland, Luxembourg, Spain and Poland.

Figure 3.168 1D1a Aviation bunkers: Trend of CO_2 Emissions and Activity Data



Data displayed as dashed line refers to the secondary axis.

3.8.1.1 Aviation Bunkers – Jet Kerosene (CO_2)

Figure 3. provides an overview of emissions for EU-28+ISL and those Member States contributing most to EU-28+ISL emissions. The United Kingdom, Germany, France and Spain are the Member States that contributed more to the EU-28+ISL emissions. Fuel combustion of EU-28+ISL increased by 115 % between 1990 and 2016.

In Figure 3. the IEF is depicted, showing a mean value of around 72 t/TJ for 2016.

Figure 3.3 Aviation bunkers, Jet kerosene: Emission trend and share for CO_2

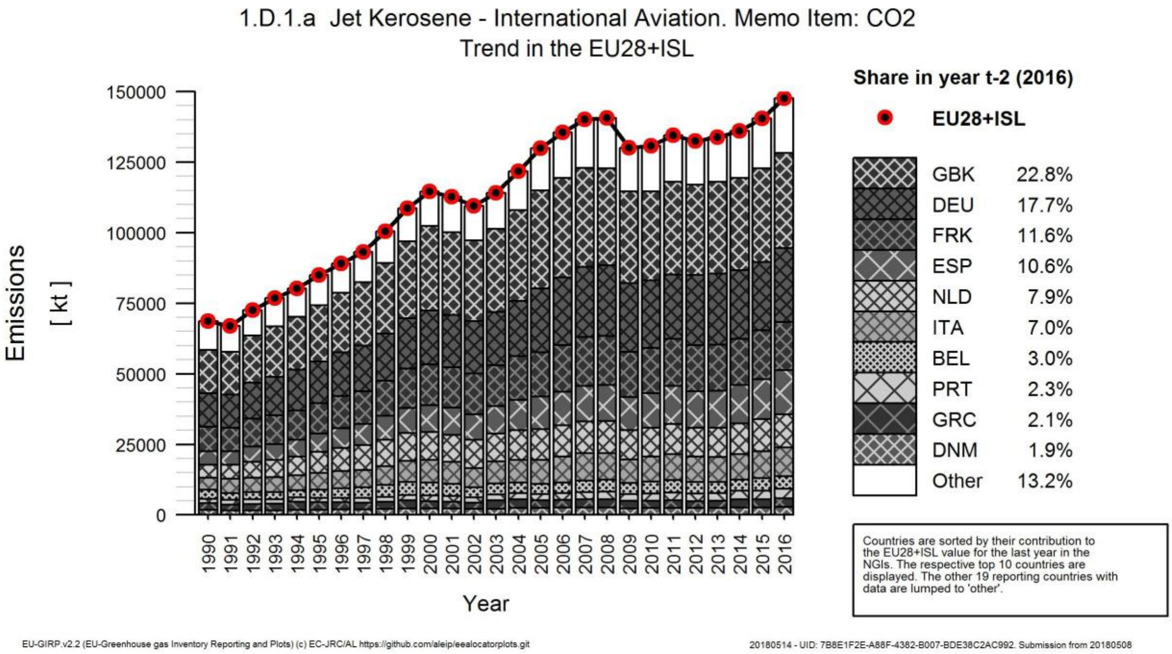
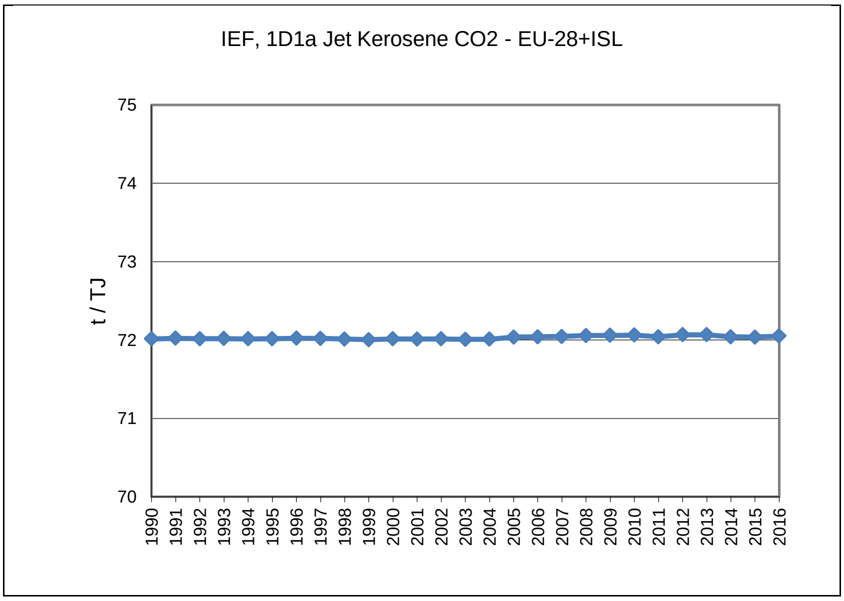
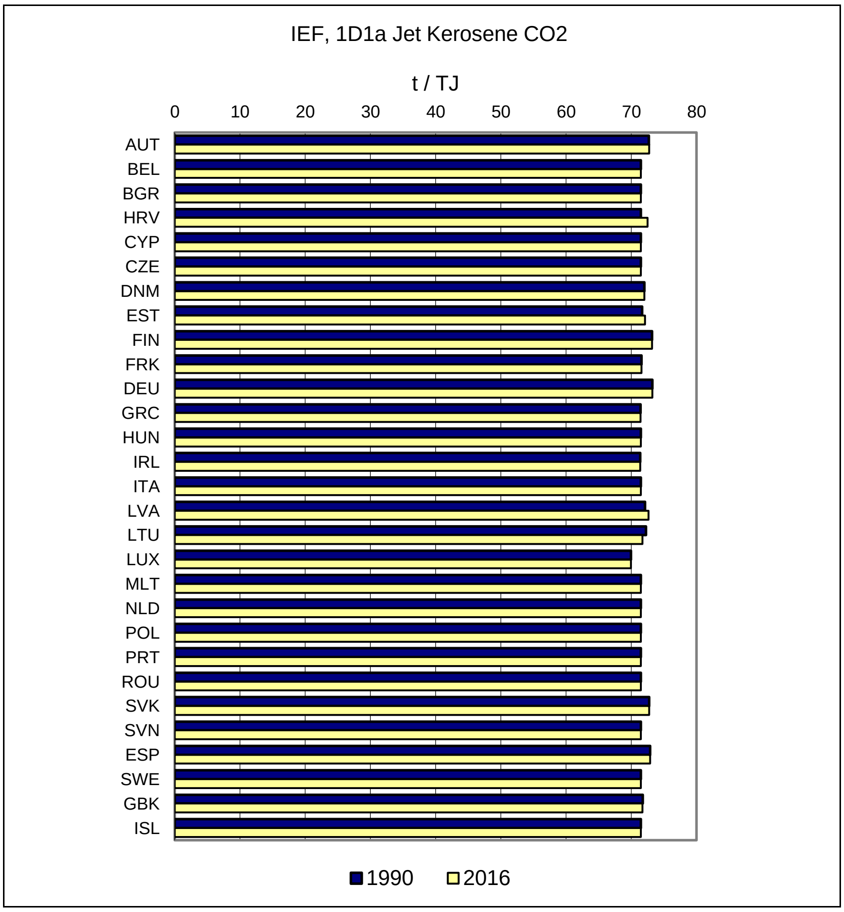


Figure 3.4: 1D1a Aviation bunkers – Jet kerosene: Implied Emission Factors for CO_2 (in t/TJ)





3.8.2 Marine bunkers (EU-28+ISL)

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” equal 3 % of total GHG emissions in 2016 and are also not included in the national total of GHG emissions. Between 1990 and 2016, CO_2 emissions from Marine bunkers increased by 33 % in the EU-28+ISL (Table 3.135).

The Member States the Netherlands, Spain and Belgium contributed most to the emissions from this source (59 %) in 2016. Between 1990 and 2016, most Member States (18 in total) increased emissions from Marine bunkers. The Member States with the highest increase in absolute terms were Belgium, Spain and the Netherlands. Hungary stated that consumption in international navigation was not considered, because separate data on the uses for international navigation are not included in the national statistics.

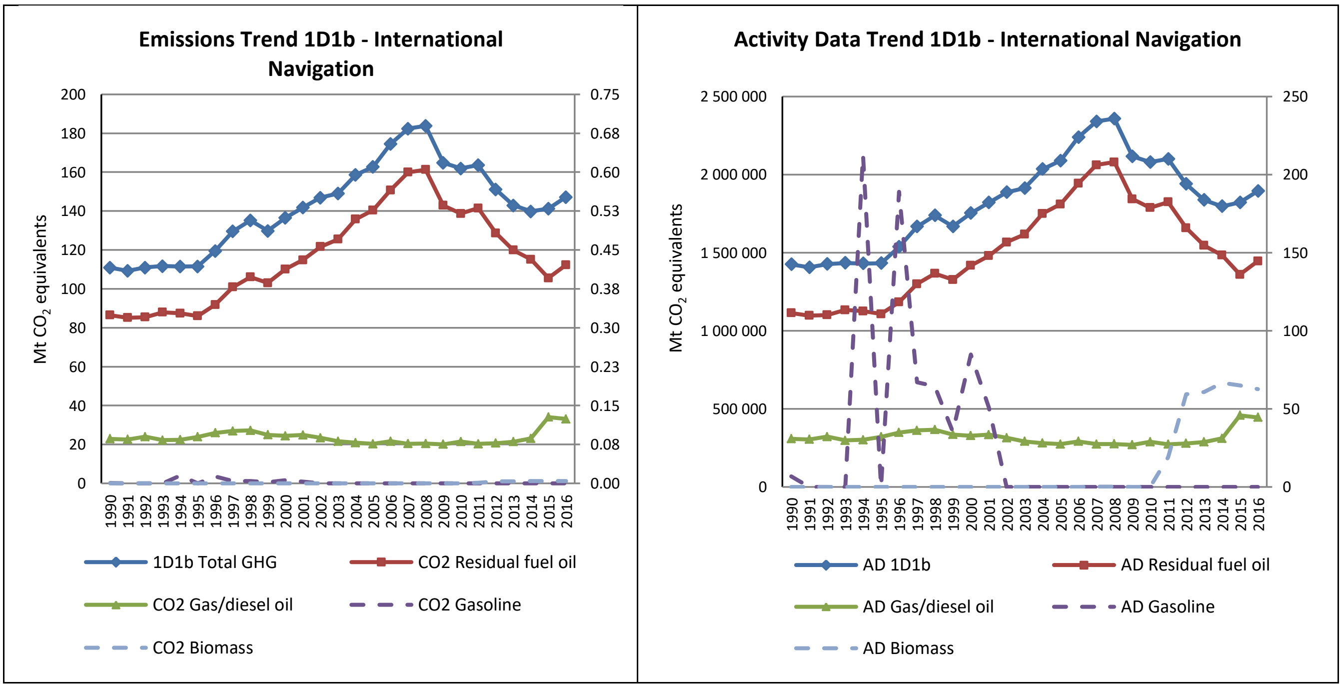
Table 3.135 Marine bunkers: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016	
	1990	2015	2016		kt CO2	%	kt CO2	%
Austria	49	53	58	0.0%	9	17%	5	10%
Belgium	13 313	18 873	21 637	14.9%	8 324	63%	2 764	15%
Bulgaria	183	271	242	0.2%	60	33%	-28	-10%
Croatia	147	5	13	0.01%	-134	-91%	8	146%
Cyprus	183	767	906	0.6%	723	396%	139	18%
Czech Republic	NO	NO	NO	-	-	-	-	-
Denmark	3 012	2 295	1 957	1.3%	-1 055	-35%	-337	-15%
Estonia	552	885	831	0.6%	279	50%	-54	-6%
Finland	1 832	920	887	0.6%	-945	-52%	-33	-4%
France	7 953	5 558	5 015	3.4%	-2 939	-37%	-543	-10%
Germany	6 405	7 165	8 200	5.6%	1 795	28%	1 035	14%
Greece	8 106	5 788	5 586	3.8%	-2 520	-31%	-202	-3%
Hungary	NE,NO	NO,NE	NO,NE	-	-	-	-	-
Ireland	57	491	491	0.3%	435	765%	0	0%
Italy	4 454	5 530	6 752	4.6%	2 299	52%	1 223	22%
Latvia	1 515	812	1 003	0.7%	-512	-34%	192	24%
Lithuania	302	241	512	0.4%	210	70%	272	113%
Luxembourg	0.1	0.1	0.1	0.0001%	0.05	61%	0.01	11%
Malta	895	5 099	5 458	3.7%	4 563	510%	360	7%
Netherlands	34 906	40 406	40 056	27.5%	5 151	15%	-350	-1%
Poland	1 256	604	575	0.4%	-681	-54%	-29	-5%
Portugal	1 400	2 083	2 036	1.4%	636	45%	-47	-2%
Romania	NO	143	100	0.1%	100	∞	-42	-30%
Slovakia	65	22	19	0.0%	-46	-71%	-3	-14%
Slovenia	NO,NA	206	396	0.3%	396	∞	190	92%
Spain	11 659	23 940	24 158	16.6%	12 500	107%	218	1%
Sweden	2 228	6 075	6 725	4.6%	4 498	202%	651	11%
United Kingdom	9 115	11 287	11 762	8.1%	2 647	29%	475	4%
EU-28	**109 587**	**139 518**	**145 379**	**100%**	**35 793**	**33%**	**5 861**	**4%**
Iceland	19	148	185	0.1%	166	859%	37	25%
United Kingdom (KP)	9 156	11 432	11 893	8.2%	2 737	30%	461	4%
EU-28 + ISL	**109 647**	**139 812**	**145 696**	**100%**	**36 048**	**33%**	**5 884**	**4%**

CO_2 emissions from residual fuel oil account for 76 % of total emissions from "Marine bunkers" in 2016 (Figure 3.). Between 1990 and 2016, CO_2 emissions from residual fuel oil increased by 30 % in the EU-28+ISL. Bulgaria, Croatia, Denmark, Finland, France, Greece, Latvia, and Poland decreased their emissions. Czech Republic, Hungary, Luxembourg, Romania and Slovenia reported in 1990 and/or 2016 notation keys. All other Member states reported increased emissions from residual oil between 1990 and 2016. Member States with the highest increase in percent were Iceland, Malta, Cyprus, Sweden and Spain.

CO_2 emissions from gas/diesel oil account for 22 % of total emissions from "Marine bunkers" in 2016. Between 1990 and 2016, CO_2 emissions from gas/diesel oil increased by 45 % in the EU-28+ISL.

Figure 3.5 1D1b Marine bunkers: Trend of CO_2 Emissions and Activity Data



Data displayed as dashed line refers to the secondary axis.

Figure 3. and Figure 3. provide an overview of emissions for residual oil and gas/diesel oil for EU-28 and those Member States contributing most to EU-28 emissions.

3.8.2.1 Marine Bunkers – Residual Oil (CO_2)

Combustion of residual oil in the EU-28+ISL increased by 30 % between 1990 and 2016. In Figure 3. the IEF is depicted, with a mean value of 77.6 t/TJ.

Figure 3.6 Marine bunkers' – Residual Oil: Emission trend and share for CO_2

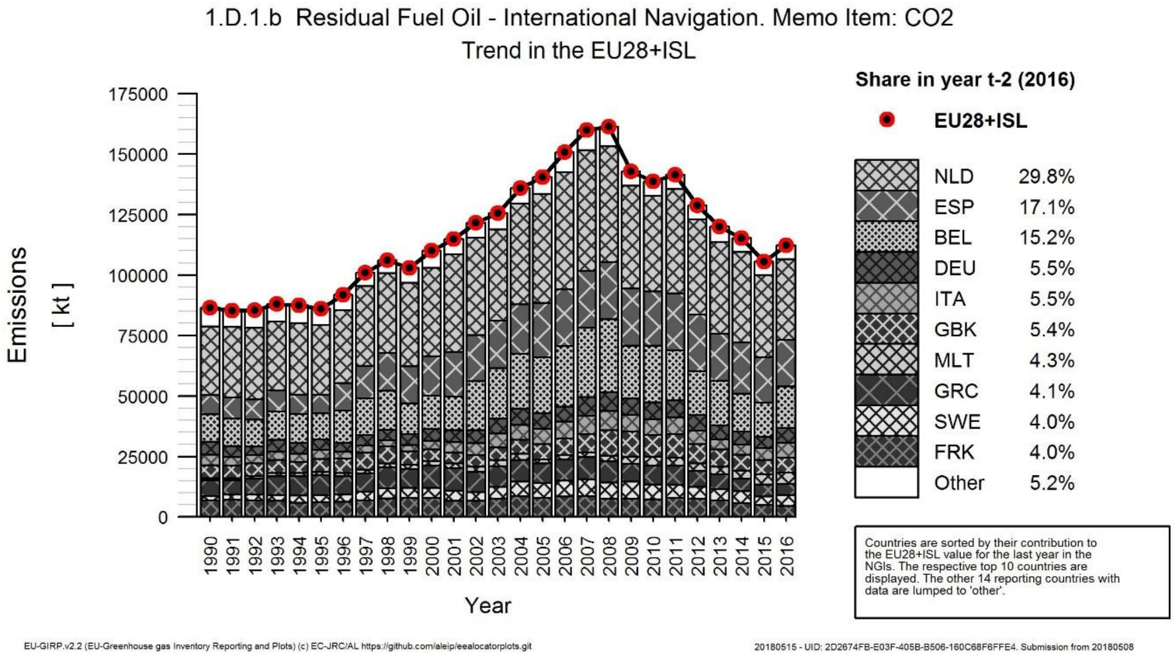
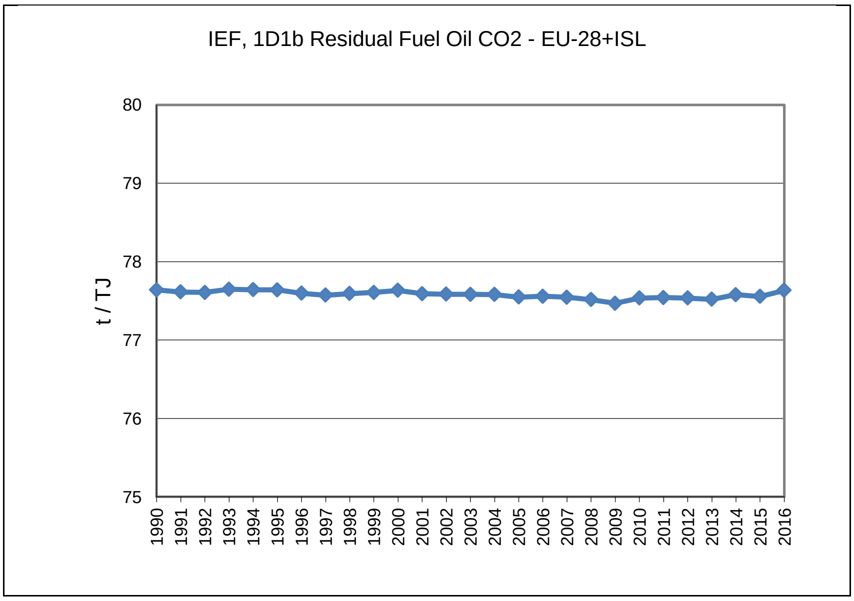
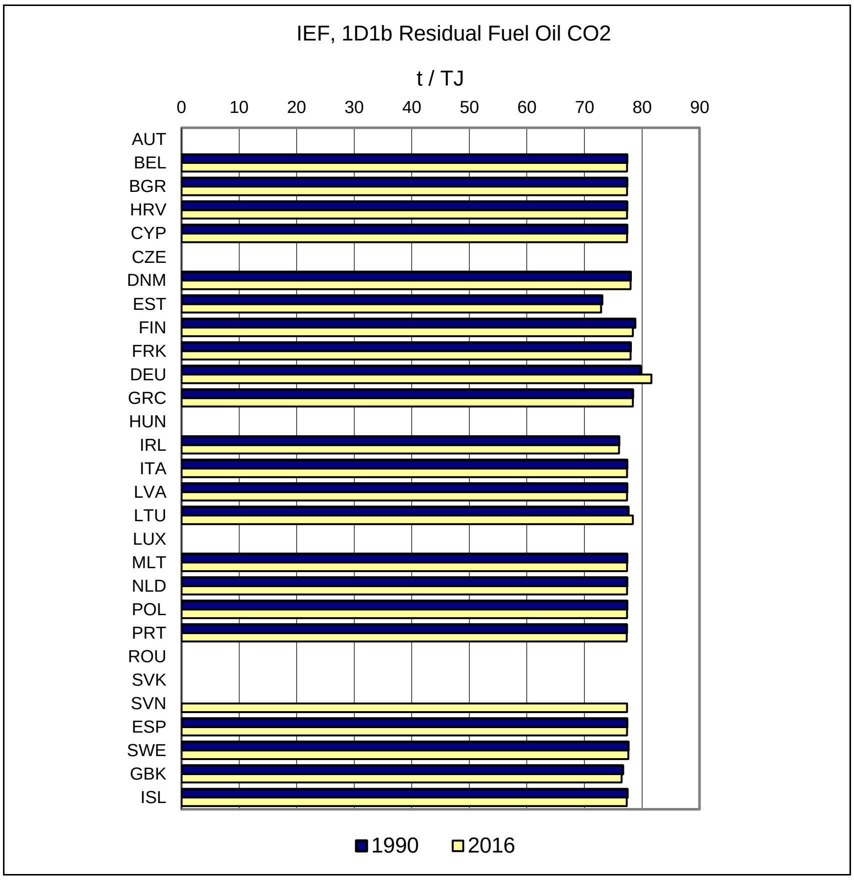


Figure 3.7: 1D1b Marine bunkers – Residual Oil: Implied Emission Factors for CO_2 (in t/TJ)





3.8.2.2 Marine Bunkers – Gas/Diesel Oil (CO_2)

Combustion of gas/diesel oil in the EU-28 increased by 45 % between 1990 and 2016. In Figure 3. the IEF is depicted, with a mean value of 74.4 t/TJ.

Figure 3.8 Marine bunkers, Gas/Diesel Oil: Emission trend and share for CO_2

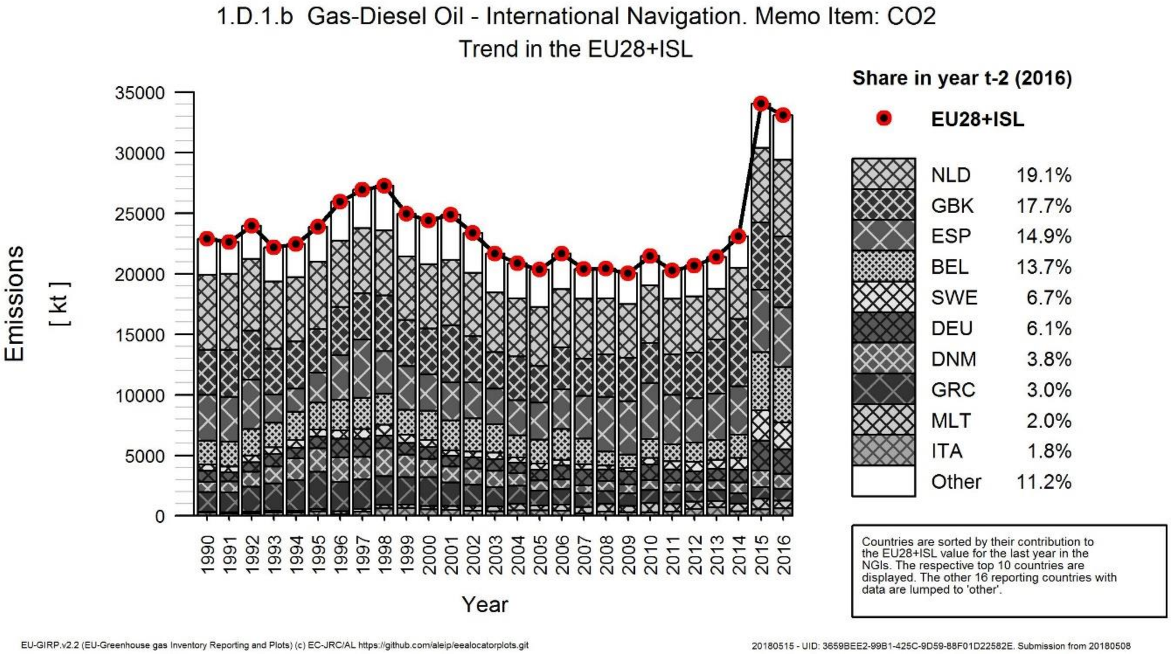
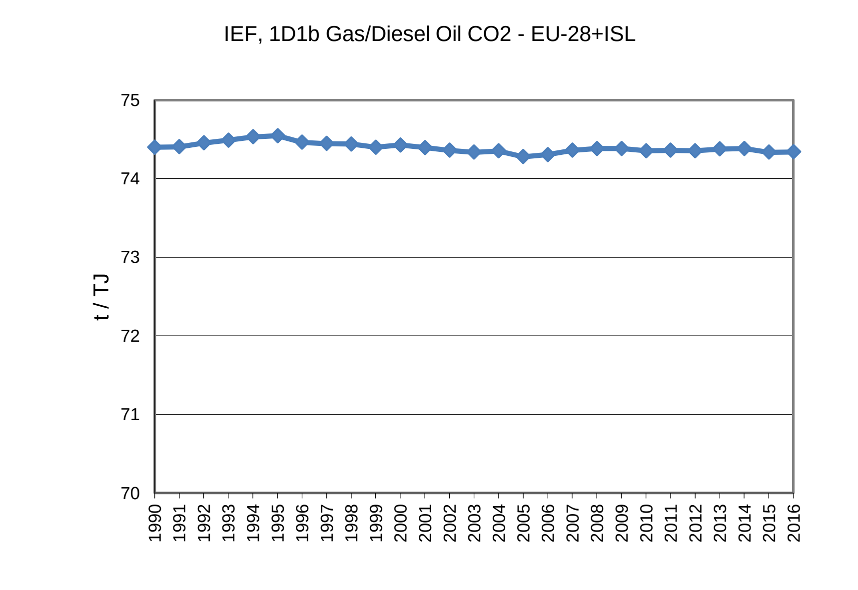


Figure 3.9: 1D1b Marine bunkers – Gas/Diesel Oil: Implied Emission Factors for CO_2 (in t/TJ)



IEF, 1D1b Gas/Diesel Oil CO2 - EU-28+ISL
t / TJ
75
74
73
72
71
70
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
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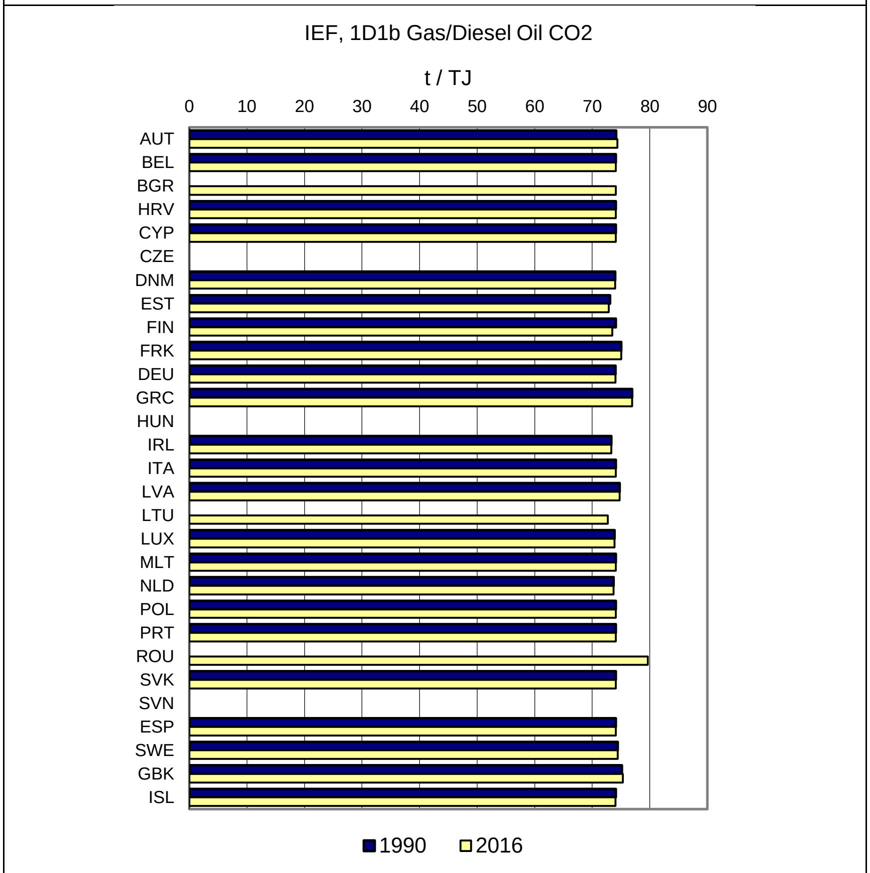
2012
2013
2014
2015
2016



IEF, 1D1b Gas/Diesel Oil CO2
t / TJ
0
10
20
30
40
50
60
70
80
90
AUT
BEL
BGR
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ITA
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NLD
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ROU
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SVN
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SWE
GBK
ISL
1990
2016

3.8.3 QA/QC activities

For more information on QA/QC activities refer to chapter 3.4

3.9 Feedstocks and non-energy use of fuels

According to the 2006 IPCC guidelines non non-energy fuels is divided into three categories:

(1) Raw materials for the chemical industry (Feedstocks). These fossil fuels are used in particular in the production of organic compounds and to a lesser extent in the production of inorganic chemicals (e.g. ammonia) and their derivatives. For organic substances, normally part of the carbon contained in the feedstock remains largely stored in these products. Typical examples of raw materials are feedstocks for the petrochemical industry (naphtha), natural gas, or different types of oils (e.g. the production of hydrogen for the subsequent production of ammonia by partial oxidation).
(2) Reductants. Carbon is used as a reductant in metallurgy and inorganic technologies. Unlike the previous case, here when using fossil fuel as reductant only a very small amount of carbon remains fixed in the products for a longer time and the larger part of the carbon is oxidized during the reduction process. Metallurgical coke is a typical reductant.
(3) Non-energy products. Non-energy products are materials derived from fuels in refineries or coke plants which, unlike the previous two cases, are used directly for their conventional physical properties, specifically as lubricants (lubricating oils and petrolatum), diluents and solvents, bitumen (for covering roads and roofs) and paraffin. Emissions of CO_2 and other GHG occur only to a limited extent in the IPPU category (e.g. during the oxidation of lubricants and paraffin). Substantial emissions occur during their recovery and during disposal by incineration (in the sector Energy and in Waste).

The non-energy use of fuels is reported in CRF table 1.A(d). The purpose of CRF table 1A(d) is twofold:

(1) The table should make transparent the amount of carbon from non-energy use of fuels that is subtracted from the carbon included in all fuels (both energy and non-energy use) in order to make a meaningful comparison between sectoral and reference approach.
(2) The table should make transparent in which categories other than Energy CO_2 emissions from non-energy use of fuels are included in the inventory (mostly IPPU). Therefore the table serves as a basis for consistency checks with the IPPU sector reporting.

Up to the GHG inventory submission 2017 the EU used Eurostat data for non-energy use of fuels. The reason for using Eurostat data was that Eurostat provided a coherent data set for all 28 EU Member States. The drawback of Eurostat data was that the definition of non-energy use of fuels in energy statistics is narrower than the definition in the IPCC guidelines because fuels used as reductants are not classified as non-energy use of fuels in energy statistics. In addition, Member States may use other data than the energy balance for compiling the non-energy use data (e.g. EU ETS data, environmental reporting of companies, etc.). Therefore, the EU decided to change the reporting in CRF table 1A(d) and calculate all data as the sum of respective MS data. The drawback of this approach is that Member States may use different allocation of energy use and non-energy use of fuels (e.g. in iron and steel) depending on the allocation in the sectoral approach.

Table 3.136 shows the fuels that were used for the purpose of non-energy use in the EU in 2016. It shows that 74 % of non-energy use of fuels are liquid fuels with naphta, bitumen and LPG showing the largest contribution to NEU of liquid fuels. Naphta is reported by 17 Member States and is mainly used as feedstock in the petrochemical industry. Bitumen is reported by 28 Member States and is mainly used in the construction industry. LPG is reported by 12 Member States and is mainly used as feedstock in the petrochemical industry. Natural gas accouts for 12 % of non-energy use of fuels and is mainly used for feedstock in ammonia production. Coke oven / gas coke accounts for 8 % of NEU of fuels and is manily used as reductant in the metal industry.

Table 3.136 Fuel quantity for non-energy use in TJ and % for the EU-28 and Iceland

Fuel			TJ	%
Liquid fossil	Primary fuels	Crude oil	5,925	0%
		Natural gas liquids	112,200	2%
		Other kerosene	2,005	0%
		Gas/diesel oil	131,988	3%
		Residual fuel oil	85,767	2%
		Liquefied petroleum gases (LPG)	517,925	10%
		Ethane	58,488	1%
		Naphtha	1,719,060	33%
		Bitumen	596,895	11%
		Lubricants	188,808	4%
		Petroleum coke	62,447	1%
		Refinery feedstocks	11,978	0%
		Other oil	369,095	7%
Other liquid fossil			5,378	0%
Liquid fossil totals			**3,867,960**	**74%**
Solid fossil	Primary fuels	Anthracite	46,426	1%
		Coking coal	139,227	3%
		Other bituminous coal	89,475	2%
		Lignite	350	0%
		Oil shale and tar sand	3,033	0%
		Coke oven/gas coke	400,737	8%
		Coal tar	25,273	0%
Solid fossil totals			**704,520**	**14%**
Gaseous fossil		Natural gas (dry)	642,612	12%
Gaseous fossil totals			**642,612**	**12%**
Waste (non-biomass fraction)			536	0%
Total			**5,215,093**	**100%**

Table 3.137shows the associated CO_2 emissions from the NEU reported in the inventory for the year 2016. It shows that about half of the the CO_2 emissions stem from solid fuels, 25% from liquid fuels and 25 % from natural gas. It has to be noted that the reporting in CRF table 1A(d) is still patchy and work is ongoing between the EU and its Member States in order to improve the reporting in this table.

Table 3.137 CO_2 emissions from the NEU reported in the inventory kt CO_2 and % for the EU-28 and Iceland

Fuel			kt	%
Liquid fossil	Primary fuels	Crude oil	13	0%
		Gas/diesel oil	10	0%
		Residual fuel oil	8	0%
		Liquefied petroleum gases (LPG)	1,801	2%
		Naphtha	9,685	10%
		Bitumen	1,901	2%
		Lubricants	3,232	3%
		Petroleum coke	3,901	4%
		Other oil	1,989	2%
Other liquid fossil			363	0%
Liquid fossil totals			**22,903**	**24%**
Solid fossil	Primary fuels	Anthracite	3,592	4%
		Coking coal	12,821	13%
		Other bituminous coal	7,865	8%
		Lignite	7	0%
		Coke oven/gas coke	24,650	26%
		Coal tar	7	0%
Solid fossil totals			**48,941**	**51%**
Gaseous fossil		Natural gas (dry)	24,568	25%
Gaseous fossil totals			**24,568**	**25%**
Waste (non-biomass fraction)			112	0%
Total			**96,412**	**100%**

Table 3.138 shows the recalculations of non-energy use of fuels for the year 2015. As explained above the main reason for the differences is that the EU changed the data basis from Eurostat in 2017 to the sum of MS data from CRF table 1A(d). The differences are largest for naphta and coking coal. The use of coking coal in iron and steel production is not classified as non-energy use in energy statisitics. Therefore the large difference for coking coal is not surprising. The large difference for naphta has to be further analysed.

Table 3.138 Recalculations of fuel quantity for non-energy use of fuels for the inventory year 2015

FUEL TYPE			ACTIVITY DATA AND RELATED INFORMATION			
			Fuel quantity for NEU (TJ)		Difference in TJ	Difference in %
			2017	2018		
Liquid fossil fossil	Primary fuels	Crude oil	NO	507	507	-
		Orimulsion	IE,NO	IE,NO	0	-
		Natural gas liquids	102,209	102,100	-109	0%
	Secondary fuels	Gasoline	924	IE,NO	-924	-100%
		Jet kerosene	NO	NO	0	-
		Other kerosene	9,122	3,109	-6,013	-66%
		Shale oil	NE,NO	NO	0	-
		Gas/diesel oil	65,702	108,347	42,645	65%
		Residual fuel oil	68,862	160,839	91,977	134%
		Liquefied petroleum gases (LPG)	582,233	570,673	-11,560	-2%
		Ethane	59,486	48,100	-11,386	-19%
		Naphtha	1,427,279	1,709,343	282,064	20%
		Bitumen	577,415	612,529	35,114	6%
		Lubricants	176,183	189,335	13,152	7%
		Petroleum coke	34,148	50,955	16,807	49%
		Refinery feedstocks	NO	12,024	12,024	-
		Other oil	319,937	306,904	-13,033	-4%
Other liquid fossil				4,808	4,808	-
Liquid fossil totals			**3,423,500**	**3,879,573**	**456,073**	**13%**
Solid fossil	Primary fuels	Anthracite	3,952	43,778	39,826	1008%
		Coking coal	2,961	189,235	186,274	6291%
		Other bituminous coal	8,195	79,985	71,790	876%
		Sub-bituminous Coal	NO	IE,NO	0	-
		Lignite	2,903	1,406	-1,497	-52%
		Oil shale and tar sand	1,229	5,214	3,985	324%
	Secondary fuels	BKB and patent fuel	11,760	NO	-11,760	-100%
		Coke oven/gas coke	387,001	384,664	-2,337	-1%
		Coal tar(7)	35,438	24,772	-10,666	-30%
Other solid fossil			793		-793	-100%
		Other	793		-793	-100%
Solid fossil totals			**454,232**	**729,054**	**274,822**	**61%**
Gaseous fossil		Natural gas (dry)	552,331	658,100	105,769	19%
Other gaseous fossil				NO	0	-
Gaseous fossil totals			**552,331**	**658,100**	**105,769**	**19%**
Waste (non-biomass fraction)			NO	561	561	-
Other fossil fuels				NO	0	-
Other fossil fuels totals				NO	0	-
Total fossil fuels			**4,430,063**	**5,266,727**	**836,664**	**19%**

Table 3.139 provides information on feedstocks and non-energy use of fuels from Member States' NIRs.

Table 3.139 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. **Lubricants** manufacture: emissions are assumed to be included in total emissions from category *1.A.1.b* petroleum refinery. use: 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. CO_2 from lubricants which are used in engines are considered in category *2.D.1* 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 fuel or to a minor degree reported under category *5.C* if energy is not recovered. **Bitumen** manufacture: emissions from the production of bitumen are assumed to be included in total emissions of category *1.A.1.b* petroleum refinery. 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*. disposal: CO_2 emissions from the disposal from bitumen are assumed to be negligible. Recycling is not considered. **Naphtha** manufacture: Naphta is produced in the oil refinery and transferred to a petrochemical plant. Residues from the petrochemical plants are transferred back to the oil refinery steam cracker. use: Naphta is used for plastics production (e.g. ethylene). **Petroleum coke** In IEA JQ (2016) non energy use is reported for the manufacture of electrodes. manufacture: No information about emissions from manufacture of electrodes is currently available. Therefore it is not clear if emissions are not estimated or not applicable. use: Emissions from the use of electrodes are considered in category *2.B.4* carbide production and *2.C* metal production. **Residual fuel oil** use: Considerable amounts of residual fuel are used in blast furnaces. Emissions are considered in *2.C.1*. **Coking coal, Bituminous coal, Coke oven coke, Coal Tar** manufacture: emissions from the production of coke are considered in category *1.A.2.a*. use: CO_2 emissions from coal, coke and coal tar used in iron and steel industry are reported under *2.C*. **Natural Gas** use: 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*). **Plastics waste** manufacture: Emissions from manufacture of plastics are considered in category *2.B.* use: plastics waste is used as a reductant in blast furnaces. Emissions are considered in *2.C.1*. Disposal: Any emissions from waste disposal are considered in category 5.A. Waste incineration with energy use is considered in *1.A – other fuels* and - to a minor degree - waste incineration without energy recovery is considered in category *5.C*. **Solvents** manufacture: emissions from the production of solvents are considered in sector *2.D.3* use: CO_2 emissions from solvent use are considered in sector *2.D.3*. disposal: emissions from the disposal of solvents are considered in 5.A. **Paraffin wax** use: CO_2 emissions from paraffin wax use are considered in sector *2.D.2*.	National Inventory Report, Chapter 3.2.3

Belgium	The emissions of non-energy use of fuels and related emissions (emissions from recovered fuels from processes) are reported under categories 2B1, 2B8 and 2B10. During the 2015 submission a re-allocation of the offgas-emissions/recovered fuels from cracking units (biggest part) plus some other processes (non-energy use) emissions (reported in the category 1A2c / other fuels before), were moved to the category 2B8b Industrial Processes and Product Use / Chemical Industry / Petrochemical and Carbon Black Production / Ethylene during this submission as prescribed in the new IPCC 2006 guidelines. 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. 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. 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 why this sector 2B8b is a key source for the trend assessment). Since the petrochemical industry is important in Flanders and Belgium and the emissions from the feedstocks are a key source in the Belgian inventory, the study mentioned above was conducted to get more detailed, country-specific information. A distinction is made between: 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 2B8. This is the largest source of CO_2 emissions. This includes the recovered fuels in the steam cracking units in the 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] and from emission estimates from 2013 on, these emissions are taken over from the reported emissions via the ETS-Directive. 2. CO_2 emissions occurring during chemical processes, for example, the production of ammonia based on natural gas or the production ethylene oxide (and production of acrylic acid from propene, production of cyclohexanone from cyclohexane, production of paraxylene/metaxylene, etc) where CO_2 is formed in a side reaction (reported respectively under 2B1 and 2B10). These CO_2 emissions result from the same surveys in the chemical sector in Flanders as those reported under 2B8 and are taken over from the reported emissions via the ETS-Directive from emission estimates from 2013 on. Emissions of flaring activities in the chemical industry are allocated to the category 5C1.2.b (Waste Incineration / Non-biogenic / Other / Flaring in the chemical industry) since last submission. 3. Waste treatment of final products was 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 5C) or under the sector of energy (category 1A1a), depending whether or not energy recuperation takes place during the process.	National Inventory Report, Chapter 3.2.3
Bulgaria	Non-energy use of fuels is reported for the following fuels: • Anthracite • Coke Oven Coke • Other bituminous coal • Lubricants • Bitumen • Naphtha • Paraffin waxes • White spirit • Residual Fuel Oil • Other Oil Products • Petroleum Coke • Natural Gas as Feedstock There are some fluctuations of the reported consumption for some of the fuels during the time series due to changes in the industrial production – differences in production volume, decommissioning of installations or shift from one fuel type to another. Some discrepancies with the quantities of fuels reported as non-energy use exist in the Energy balance – for some fuels only for the latest years is reported non-energy use, in addition some industrial plants do not properly report their non-energy use of fuels. In order to improve the consistency, additional data was collected from several chemical plants regarding the annual production of ammonia, soda ash and calcium carbide. The amounts of energy and non-energy use of natural gas, anthracite, other bituminous coal and coke oven coke we reallocated according to the quantities of fuels considered as emission sources in the Industrial Processes sector. The non-energy use of fuels is on average 8.1% of the total apparent energy consumption during the period 1988-2016 and 6.3% for 2016. The apparent consumption is calculated according to Equation 6.2 in Vol. 2, Ch. 6 of the 2006 IPCC Guidelines. The most significant fuels used as feedstock are bitumen, anthracite and natural gas. The use of naphtha has been discontinued since 2010. In general, most of the non-energy use of fuels is attributed to the industrial sector (lubricants, paraffin wax), chemical and petrochemical industry (anthracite, natural gas, naphtha, white spirit and other petroleum products) and construction (bitumen). All sources of emissions due to non-energy use of fuels (natural gas) are reported under category 2B Chemical Industry. The quantities of waste oils, which are used with energy recovery in the non-metallic minerals and other industrial plants, are reported as other fuels under category 1.A.2.g Other industries.	National Inventory Report, Chapter 3.3.3

Cyprus	In Cyprus fuels that are used for non-energy uses are Lubricants and Bitumen. Bitumen/asphalt is used for road paving and roof covering where the carbon it contains remains stored for long periods of time. Consequently, there are no fuel combustion emissions arising from the deliveries of bitumen within the year of the inventory. Lubricating oil statistics usually cover not only use of lubricants in engines but also oils and greases for industrial purposes and heat transfer and cutting oils. All deliveries of lubricating oil should be excluded from the Reference Approach. Non-energy use of fuels in Cyprus refers to the consumption of lubricants in transport and bitumen in construction. Data on the non-energy consumption of fuels was obtained from the national energy balance (Gross inland deliveries (Calculated)).	National Inventory Report, Chapter 3.2.10
Croatia	Non-energy fuel consumptions (fuels used as feedstock) and appropriate emissions, where onepart or even the whole carbon is stored in product for a longer time and the other part oxidizes and goes to atmosphere, are described here. The feedstock use of energy carriers occurs in chemical industry (natural gas consumption for ammonia production, production of naphtha, ethane, paraffin and wax), construction industry (bitumen production), and other products such as motor oil, industrial oil, grease etc. As a result of non-energy use of bitumen in construction industry there is no CO_2 emission because all carbon is bound to the product.	National Inventory Report, Chapter 3.2.3
Denmark	The consumption for non-energy purposes is subtracted in the reference approach, because non-energy use of fuels is included in other sectors (Industrial processes and Solvent use) in the Danish national approach. Three fuels are used for non-energy purposes: lubricants, bitumen and white spirit. The total consumption for non-energy purposes is relatively low – 10.5 PJ in 2016. The CO_2 emission from oxidation of lube oil during use was 31.7 Gg in 2016 and this emission is reported in the sector industrial processes and product use (sector 2.D). The reported emission corresponds to 20 % of the CO_2 emission from lube oil consumption assuming full oxidation. This is in agreement with the methodology for lube oil emissions in the 2006 IPCC Guide-lines (IPCC, 2006). Methodology and emission data for lube oil are shown in NIR Chapter 4.5.2. For white spirit the CO_2 emission is indirect as the emissions occur as NMVOC emissions from the use of white spirit as a solvent. The indirect CO_2 emission from solvent use was 57.8 Gg in 2016. The methodology and emission data for white spirit are included in NIR Chapter 4.5.4. The CO_2 emission from bitumen is included in sector 2.D.3, Road paving with asphalt and Asphalt roofing. The total CO_2 emissions for these sectors are 0.84 Gg in 2016. Methodology and emission data for non-energy use of bitumen are shown in NIR Chapter 4.5.6.	National Inventory Report, Chapter 3.4.1
Estonia	The following fuels are reported under CRF category 1.AD Feedstocks and non–energy use of fuels: Lubricants; Bitumen; Natural gas; Other/Oil shale. Activity data on lubricants and bitumen consumption is received from Statistics Estonia (Joint Questionnaire that Statistics Estonia sends to IEA annually). Data on natural gas that is used for the category non-energy use, is taken from the national energy balance sheet. Activity data on oil shale reported in the CRF 1.AD is calculated on the basis of plant-specific data. This reported amount consists of oil shale semi coke – the by-product of shale oil production which contains a small amount of organic matter (carbon). Oil shale semi-coke is stored in the oil shale waste dumps (carbon stored). Natural gas for non-energy purposes was used for ammonia production and is reported in the CRF category 2.B.1. Natural gas was only used in the company Nitrofert AS. In 2010 and 2011 the factory was temporarily closed down due to low ammonia price in the World market. In 2012 the ammonia production factory was reopened and during 2013 it was closed again and has remained closed ever since.Lubricants are used in the Energy sector for lubricating (mainly in transport and manufacturing sub-sectors). Some used lubricants (waste oils) are incinerated and corresponding emissions are taken into account in the CRF 1.A.2.f/Other fuels.	National Inventory Report, Chapter 3.2.3
Finland	The emissions from the non-specified burning of feedstocks are calculated by a separate module in ILMARI. The ILMARI system includes point source (bottom-up) data on feedstock combustion in the petrochemical industry and these emissions are reported in corresponding subcategories of 1.A.2. These specified energy uses of feedstock are subtracted from the corresponding total amounts of feedstock. For the rest of the feedstock, 100% of carbon is estimated to be stored in products (mainly plastics). Residual fuel oil and coke are used as feedstocks in the metal industry and corresponding amounts are subtracted from the reference approach. All (100%) of this carbon is estimated to be released as CO_2 during the process and emissions are reported in category 2.C.1 (see section 4.4.2). Natural gas, heavy fuel oil, LPG, naphtha and other oil products are used as feedstock in the chemical industry. Carbon included in these feedstocks is subtracted from the reference approach. Most of carbon is stored in the products, but certain process emissions are reported in sector 2.B.10 (see section 4.3.5). From other feedstocks, only carbon from paraffin waxes is estimated to oxidise and these emissions are reported in sector 2.D.2 (section 4.5.3). The ILMARI system includes point source (bottom-up) data also on waste oil combustion in different branches of industry, and these emissions are reported in corresponding subcategories of 1.A.2. For the rest of lubricants we use top-down calculation methodology, presuming that 33% of carbon is stored in products (recycled lubricants) and 67% of carbon is released as CO_2 either in burning of lubricants in motors (two-stroke oil and part of motor oil in four-stroke engines) or illegal combustion of waste oil in small boilers. These non-specified emissions from burning of lubricants (excluding above mentioned emissions reported in 1.A.2) are included in category 2.D.1 (Section 4.5.2). According to IPCC 2006 Revised Guidelines emissions from 2-stroke oil should be reported in the Energy Sector. We do not have data on sales of 2-stroke oil separately, thus we have not separated these emissions from the use of 4-stroke oil and other lubricants. However, we have made a rough estimate for 2013, showing that CO_2 emissions from 2-stroke oil might be around (less than) 7 kt. To be able to reallocate these emissions to Energy Sector, we would have to split the figure to four subsectors (road transport, residential non-road machinery, commercial non-road machinery and leisure boats). As we do not have full time series of activity data to allocate these emissions to Energy subsectors, we are not able to do the split and have included them in 2.D.1, correspondingly to the top-down calculation methodology described above. This misallocation should not result in over- or underestimation of emissions.	National Inventory Report, Chapter 3.2.3

France	The fossil fuels are consumed for different purposes, for energy use and non-energy use (raw material, intermediate material as well as reducing agent). Emissions can occur in the sector of fuel combustion and industrial process. However, it is not always possible, partly for practical reasons, to separately report these two types of emissions. In the IPCC Guidelines, 2006, the following rule is formulated: Combustion emissions from fuels obtained directly or indirectly from the feedstock for an IPPU process will normally be allocated to the part of the source category in which the process occurs. These source categories are normally 2B and 2C. However, if the derived fuels are transferred for combustion in another source category, the emissions should be reported in the appropriate part of Energy Sector source categories (normally 1A1 or 1A2). In the French inventory, in order to preserve the coherence of the inventory of greenhouse gas emissions (under the UNFCCC) and the inventory of atmospheric pollutants (under the UNECE) on the one hand, and between the sectoral approach and the reference approach, on the other hand, it was decided to maintain the distinction between energy uses (reported in CRF 1A) and non-energy (in CRF 2). Finally, to ensure the completeness of the inventory, a feedback on total final consumption (energy + non-energy) energy balance is assured. With regard to the consumption of solid fuels (coal and coke coal) the energy balance accounts all types of use of these fuels as energy consumption and they are well distinguished after energy use and non-energy use in the inventory as well. The solid fuels which are used as reducing agents as well as intermediate material are considered in the CRF category 2C in steel and ferro-alloys production and 2B7 soda ash production. The petroleum products for non-energy use are principally consumed on site of petrochemical installations. This usage is well investigated by an exhaustive survey conducted by the national statistics authority. According to the survey approximately 14% of the consumption of petroleum products is used for non-energy use, mainly as primary material. This survey defines the quantities of different oil products that are consumed in steam crackers reported under CRF 2B (in particular naphta). Emissions from non-energy use of petroleum coke are reported in under 2C3 (aluminium production) and 2B6 (titanium dioxide production). Emissions which are related to the combustion of motor oil for 2-stroke engines are considered in CRF category 1A3 whereas emissions from 4-stroke engines are covered under 2D1. The emissions of recovered oil which is combusted during cement production are reported under category CRF 1A2. Those which are burned in waste incinerators are reported under CRF 6. The non-energy use of natural gas is mainly occurring in the ammonia and hydrogen production and is reported under CRF 2B. The emissions from energy use of natural gas in these industries is included in 1A2.	National Inventory Report, Chapter 3.2.3
Germany	The great majority of the coal, oil and gas that Germany uses is used for energy-related purposes. The remainder of the coal, oil and gas is used as feedstock for production processes. This consumption enters into the balance as "non-energy use" (NEU). In the German Energy Balance, this consumption is listed separately, in line 43. The chemical industry is the leading user of fossil fuels for non-energy-related purposes. It uses fossil fuels in steam crackers, in reforming, in synthetic-gas production and in the produciton of graphite electrodes. In crackers and reforming, the most important products resulting from such processes are ethylene, propylene, 1,3-butadiene, benzene, toluene and xylene; in production of synthetic gases, the most important such products are ammonia and methanol. Bitumen, lubricants and paraffin waxes are produced in refineries. Bitumen is used in a range of applications, including road surfaces and bitumen sheeting for roofs. Lubricants are used in road vehicles and machines (inter alia). Without suitable adjustments, the consumption figures listed in Energy Balance line 43 cannot be compared with the CO_2 and NMVOC emissions from use of fossil fuels, in non-energy-related uses, that are reported in the inventory under industrial processes. The reason is that for the industrial processes, only emissions from production or use of products are taken into account, while line 43 takes account of entire feedstocks, thereby including both product-specific emissions and the carbon quantities stored in products. The latter account for far and away the largest share of the feedstocks. Yet a more important difference is that import and export quantities are taken into account in calculation of emissions from use of products. In the interest of obtaining a complete balance, Table 477 (see below) also takes account of the fossil-fuel carbon quantities stored in products. The correlation between material-related applications and products and the various relevant fuels is oriented to Table 1.3 from Volume 3 of the 2006 IPCC GL, and is based on information provided by relevant associations, producers and experts. In some cases, we had to make our own estimates of the applicable correlation with individual fuels. The produced quantities of the products listed in the table have been obtained from data reported by the Federal Statistical Office and by the Federal Office of Economics and Export Control (BAFA) and have been converted into CO_2 equivalents. For methanol, ethylene, propylene, 1,3-butadiene, benzene, toluene and xylene, the conversions were carried out via the molar masses of the relevant products and the molar mass of CO_2. The pertinent CO_2 equivalent emissions were split among the three feedstocks used in Germany (naphta, LP gas and other petroleum products), in keeping with (internal) data provided by associations. In the case of carbon black, the product is assumed to consist of pure carbon. That carbon was also converted into CO_2 equivalents. The production quantities for bitumen, lubricants and paraffin waxes were obtained from the Official Mineral Oil Statistics, and they are based on gross refinery production. The production quantities have been converted into CO_2 equivalents with the help of the following IPCC standard values (Table 1.2 and Table 1.4 from Vol. 2 of the 2006 IPCC GL). For the year 2014, the sum of the carbon from the pertinent emissions and of the carbon stored in products amounts to 106 % of the non-energy-related consumption given in line 43 of the Energy Balance. Consequently, the relevant material-related use can clearly be shown to include the quantities listed in the Energy Balance as non-energy-related consumption. No gaps in determination of non-energy-related CO_2 emissions are apparent in the inventory.	National Inventory Report, Chapter 18.8

Greece	Non-energy fuel use concerns the consumption of fuels as raw materials (e.g. in chemical industry, metal production) for the production of other products, or the use of fuels for non-energy purposes (e.g. bitumen). Part of the carbon content of fuels is stored in final products and is not oxidized into carbon dioxide for a certain time period. The fraction of the carbon contained in final products and the time period for which carbon is stored in them, depend on the type of fuel used and of the products produced. The oxidation of the carbon stored in final products occurs either during the use of the product (e.g. solvents) or during their decomposition (e.g. through combustion). It should be noted that emissions during production processes (e.g. ammonia and hydrogen production) should be reported under the sector of IPPU, while emissions from burning of products should be reported under the waste sector or energy sector (as long as energy exploitation takes place).Non-energy use of fuels in Greece refers to the consumption of: • naphtha, natural gas, and lignite (for the period 1990 – 1991) in chemical industry, • petroleum coke in the production of non-ferrous metals, • lubricants in transport (including off-road transportation), • bitumen in construction and • other petroleum products in the industrial and residential sectors The calculation of carbon dioxide emissions from non-energy use of fuels is based on the relevant consumption by fuel type (Table 3.9) and the fraction of the carbon stored by fuel type (Table 3.10). 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 to industrial processes sector since the 2012 submission, by using data from ETS reports and plant specific information. Non-energy use of lignite is accounted in the industrial processes 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 itdid not produce ammonia for the period 1992 – 1998. • The non-energy use of natural gas for hydrogen production is included in the industrial processes sector, by using data from ETS reports and information from Public Gas Corporation. The associated CO_2 emissions from hydrogen production from liquid fuels are reported under the subcategory 1.A.1.b, because while disaggregated data on the amount of liquid fuels used for hydrogen production are available from the EU ETS reports for the period 2005–2016, for the period 1990–2004 the amount of liquid fuel used for hydrogen production is reported together with the amount of fuel combusted in the refineries as provided in the national energy balance. It is therefore not possible to report these emissions separately for the period 1990–2004. • CO_2 emissions from the use of fuels as reduction agents in the iron and steel industry, are only reported under the industrial processes sector. • 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. • 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. Since this submission, following 2006 IPCC GLs, all fuels with non-energy use were reallocated to the IPPU sector (e.g. other petroleum products, lubricants, etc). On the basis of the abovementioned clarifications, the possibility to double-count or underestimate CO_2 emissions from the non-energy use of fuels is minor.	National Inventory Report, Chapter 3.2.3
Hungary	All the fuels regarded as NEU in IEA Energy Statistics are allocated into IPPU sectors and also some amount from the quantities regarded as energy use in order to follow the suggestion of IPCC 2006. This is the case by Natural Gas use in sector 2B1 – Ammonia, Naphtha use in 2.B.8 Petrochemical and the Coke used in 2C1 – Iron and steel. Therefore, the Fuel quantities for NEU reported in CRF Table 1.A.(d) and QA/QC check Table for NEU included in Annex of the NIR are higher than the actual quantity reported in IEA Energy Statistics. However, the differences are well-known and documented. Carbon content of all fuels which are allocated under the Industrial Processes sector is taken as stored carbon in the 1.AD sector (and in the reference approach), however the calculation of emission in the IPPU sector is not based on a default carbon-stored approach, but usually plant-specific (EU ETS) data, except for Lubricant and Paraffin wax use source categories.	National Inventory Report, Chapter 3.2.3
Ireland	This category includes fossil fuels used for non-energy purposes; without the combustion and oxidation process. There are a number of fuel types applicable in Ireland: • Lubricants – IPCC default oxidation value of 0.2 is used, see category 2.D.1; • Bitumen – IPCC default value of 1.0 is used for the proportion of carbon stored; • Paraffin wax – IPCC oxidation value of 0.9 is used for candles and 0.2 for all other paraffin wax, see category 2.D.2; • White spirit – IPCC default value of 1.0 is used for the proportion of carbon stored; • Natural Gas – a significant amount of natural gas feedstock was used in ammonia production from 1990-2003. Emissions from the non-energy use of fossil fuels have been included in the Industrial Processes and Product Use sector, CRF Category 2.D (Chapter 4 of this report).	National Inventory Report, Chapter 3.2.3

Italy	The quantities of fuels stored in products in the petrochemical plants are calculated on the basis of information contained in a detailed yearly report, the petrochemical bulletin, by Ministry of Economic development (MSE, several years [b]). The report elaborates results from a detailed questionnaire that all operators in Italy fill out monthly. The data are more detailed than those normally available by international statistics and refer to: • input to plants; • quantities of fuels returned to the market; • fuels used internally for combustion; • quantities stored in products. National petrochemical balance includes information on petrochemical input entering the process and used for the production of petrochemical products, and petrochemical plants output, returns to the market, losses and internal consumption. Due to chemical reactions in the petrochemical transformation process, the output quantity of some fuels could be greater than the input quantity; in particular it occurs for light products as LPG, gasoline and refinery gas, and for fuel oil. Therefore for these fuels it is possible to have negative values of the balance. For this matter, with the aim to allow the reporting on CRF tables, these fuels have been added to naphta. The amount of fuels recovered from the petrochemical processes and returning on the market are considered as an output, because consumed for transportation or in the industrial sectors, and no carbon is stored. In Table 3.36 and Table 3.37 the overall results and details by product are reported respectively. In Table 3.36 the breakdown of total petrochemical process is reported; the percentages referring to the “net” input are calculated on the basis of the total input subtracting the quantity of fuels as gasoil, LPG, fuel oil and gasoline which return on the market because produced from the petrochemical processes. In Table 3.37 the input to the petrochemical processes in petrochemical plants and the relevant losses, internal consumption and return to the market are reported, at fuel level, allowing the calculation of the quantity stored in products, subtracting the output (returns to the market, losses and internal consumption) from the input (petrochemical input). Carbon stored, for all the fuels, is therefore calculated from the amounts of fuels stored (in tonnes) multiplied by the relevant emission factors (tC/t) reported in Table 3.37. Non-energy products amount stored from refineries, and other manufacturers, are reported in the National Energy Balance (MSE, several years [a]) and the carbon stored is estimated with emission factors reported in Table 3.38. For lubricants the net carbon stored results from the difference between the amount of lubricants and the amount of recovered lubricant oils. The energy content has been calculated on the basis of the IPCC default values. Minor differences in the overall energy content of these products occur if the calculation is based on national parameters instead of IPCC default values. In the CRF tables the fuel input amount is reported so that the fractions of carbon stored could be derived. As these fractions are derived from actual measurements they do not correspond to any default values and may vary over time. 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 our 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 (Patel and Tosato, 1997).	National Inventory Report, Chapter 3.8
Latvia	Under this category consumption of different types of fuels used as feedstock is reported. Emissions from these fuels are reported as “CO_2 not emitted” because it is assumed that in CO_2 emissions is captured and not emitted to the air. Consumption of Bitumen, Lubricants, Coke, White spirits and Paraffin wax is reported in 1.D tables for all years in time series 1990–2016. Carbon emission factors used in 2006 IPCC Guidelines were taken for all fuel types – Bitumen (22 t/TJ), Lubricants (20 t/TJ), Coke (29.2 t/TJ), White spirits (20 t/TJ) and Paraffin waxes (20t/TJ). Activity data prepared by CSB and available on CSB on-line database were used (Table 3.14). Constant increase of bitumen use since 2004 until 2008 is explained with development of construction sector and availability of financial resources from European Union (Latvia is a member of European Union since 2004) for building and improvement of transportation infrastructure. However, during the economic crisis the funding reduced and the amounts of bitumen used decreased in 2008-2010. After 2010 increase of bitumen use can be seen, it can be explained with increased financial resource to road paving. Lubricants are mainly used in transport sector and IPPU. Coke is used as ingredient in metallurgy to produce higher quality steel. Evident decrease in coke use can be explained with changes in metallurgy. Financial crisis in 2010 and bankruptcy of “Liepājas metalurgs” is the reason of reduced metal production and use of coke. Therefore in last three years there has been no usage of coke. Paraffin waxes and white spirits mainly are used as feedstocks in chemical industry and wood processing..	National Inventory Report, Chapter 3.2.3

Lithuania	Feedstocks and non-energy use of fuel are included in national Energy balances (see Annex III). Use of fuels for feedstocks and non-energy use is dominated by natural gas (Figure 3-14). In 2016, natural gas amounted about 80.4% in the structure of feedstocks and non-energy use of fuels. The natural gas is used for ammonia, calcium ammonium nitrate, organic products and nitric acid production in the JSC Achema. JSC Achema is a leading manufacturer of nitrogen fertilizers and chemical products in Lithuania and the Baltic states. The previous ERT recommended to cross-check the data reported as non-energy use in the energy sector and the data reported under the industrial processes as the calculated CO_2 non-emitted from the use of natural gas for non-energy purpose differs from CO_2 emissions from ammonia production. A cross-check between the natural gas data used in industrial processes and the data reported as non-energy use in the energy sector showed that difference occur due to the use of different calorific values for the natural gas. In the industrial processes sector a specific calorific value is based on average annual lower calorific value of natural gas which is calculated on the basis of reports from the natural gas supplier AB Lietuvos dujos, which measure the calorific value twice a month. In the energy sector calculations are based on the data provided by the Lithuanian Statistics where fuel consumption is calculated in terms of tonnes of oil equivalent and terajoules using the net calorific value. The data reported as non-energy use in the energy sector and the data reported under the industrial processes also differs because the data reported as non-energy use in the energy sector accounts not only feedstocks for ammonia production, but also feedstocks for calcium ammonium nitrate, organic products and nitric acid production. It is necessary to mentioned that JSC Achema revised data for non-energy use for 2005-2014 in 2016, therefore in this submission revised data are reported in CRF 1.AD Feedstocks, reductants and other non-energy use of fuels. The amounts of excluded carbon were calculated in accordance with the methodology provided in 2006 IPCC Guidelines Volume 2 (page 6.7). The amounts of excluded carbon are reported in CRF 1.AD Feedstocks, reductants and other non-energy use of fuels and linked to the CRF 1.AB Fuel Combustion - Reference Approach as excluded carbon.	National Inventory Report, Chapter 3.2.3
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 the fraction of carbon stored, the IPCC default values are applied. Lubricants Manufacturing: manufacturing of lubricants does not occur in Luxembourg. Use: Lubricants are either used in road transportation (motor oil and greases) or in the manufacturing and construction industry (mainly greases). Emissions from lubricants use are reported under category 2D1 – Lubricant Use. Please refer to section 4.5.1 for more details on the estimation of emissions from lubricant use. Disposal: incineration of lubricants (waste oil) does not occur in Luxembourg. Waste oil is either recycled or exported. Bitumen Manufacturing: manufacturing of bitumen does not occur in Luxembourg. Use: by default the carbon contained in bitumen is considered to be entirely stored in the product, i.e. asphalt for road paving. Disposal: CO_2 emissions from the disposal of bitumen are assumed to be negligible. Recycling is not considered. Coke oven coke Manufacturing: not occurring. All coke used in the iron and steel industry is imported. Use: CO_2 emissions from coke used in iron and steel industry are reported under 2.C.1 – Iron and Steel Production. Disposal: not applicable. Other bituminous coal Manufacturing: Manufacturing of electrodes from anthracite used in the electric arc furnaces does not occur in Luxembourg. Use: Emissions from the use of electrodes in the iron and steel production are considered in category 2.C.1 – Iron and steel production. Disposal: not applicable. Other oil products Manufacturing: not occurring. All products such as white spirits, etc. are imported. Use: CO_2 emissions from solvent and other products use are considered in category 2.D.3. - Nonenergy products from fuels and solvent use – Other – Solvent use. Disposal: emissions from the disposal of plastics in landfills are considered in 6.A and emissions from incineration, with energy recovery, of waste plastics are considered in 1 A 1 a.	National Inventory Report, Chapter 3.2.3
Malta	Activity data on feedstocks and non-energy use of fuels has been obtained from the National Statistics Office. The non-energy fuels used locally are bitumen and lubricant, which are used for asphalting and to minimise friction between moving surfaces, respectively. Emissions from Lube oil used in 2-stroke engines are estimated using the COPERT 5 model and are included under sub-category 1A3b Road Transportation.	National Inventory Report, Chapter 3.2.3

Netherlands	Table 3.2 shows that a large share of the gross national consumption of petroleum products was used in non-energy applications. These fuels were mainly used as feedstock in the petro-chemical industry (naphtha) and in products in many applications (bitumen, lubricants, etc.). Also, a fraction of the gross national consumption of natural gas (mainly in ammonia production) and coal (mainly in iron and steel production) was used in non-energy applications and hence not directly oxidized. In many cases, these products are finally oxidized in waste incinerators or during use (e.g. lubricants in two-stroke engines). In the RA, these product flows are excluded from the calculation of CO_2 emissions.	National Inventory Report, Chapter 3.2.3
Poland	As the use of energy products for non-energy purposes can lead to emissions, Poland has calculated emissions from lubricant and paraffin waxes use and report them under category 2D Non-energy products from fuels and solvent use.For more description see chapter 4.5.	National Inventory Report, Chapter 3.2.3
Portugal	Emissions of greenhouse gas emissions from feedstock use are only clearly accounted in the inventory in the following situations: - 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; - emission of CO_2 liberated as sub-product in production processes such as ammonia production; - 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; 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: - emissions from mineral oil use as lubricants; - emissions from wear of bitumen in roads.	National Inventory Report, Chapter 3.6.5
Romania	Non-energy use of fuels is reported in the Energy balance for the following fuels on the entire time-series: Lubricants; Bitumen; Naphtha; LPG; Refinery gas; Motor Gasoline; Kerosene Type Jet Fuel; Other Kerosene; Gas-Diesel Oil; Petroleum Coke; Residual Fuel Oil; Natural Gas as Feedstock; Other Products; Paraffin waxes; White spirit; Lignite; Brown Coal; Coal Oil and Tars (from coking coal); Other Bituminous Coal. For the liquid fuels reported on the EU-ETS, the national parameter of the NCVs were determined and used to calculate the non-energy use of the fuels: annualy for the EU-ETS period (2007-2012 years) and average of the EU-ETS period for the rest of the back time series; it is the case of the following fuels: Transport Diesel, Refinery Gas, Petroleum Coke, Residual Fuel Oil, Heating and Other Gasoil. Country specific values NCVs and CO_2 EFs have determined and used for 2015 and 2016 years. The following type of fuels have been added to the Table1.A(d), “Feedstocks, reductants and other non-energy use of fuels - Other fuels” category: Refinery gas, Paraffin waxes, White spirit. According to the IPCC 2006GL provisions, Volume 3, Chapter 5: Non-Energy Products from Fuels and Solvent Use, the following methodology to report in the CRF Table 1.A(d), Feedstocks, reductants and other non-energy use of fuels, was used: • Bitumen: the carbon is reported as being full stored in the final product; • Lubricants, Naphta, Refinery gas, Other kerosene, Gas Diesel-Oil, Petroleum Coke, Residual Fuel Oil, Other products, White spirit: the carbon was presumed that is fully emitted and not stored, having the full oxidation during use; • Paraffin Waxes: the fraction of carbon stored is 0.8, the rest of 0.2 being emitted. The non-energy use of fuels is an average of 11% from the total apparent energy consumption during the period 1999-2008, and arround 15% for the rest of the years. This could be in tight relation with the developing of the industry after 2000 until the economic crisis to have effects on the industry branches. In 2015 the share of the non-energy use of the fuels in total consumption is about 6%. In 2016 the share of the non-energy use of the fuels in total consumption is about 7%. The most significant fuels used as feedstock are natural gas, bitumen, naphtha and lubricants. Also, the Coke_Oven_Coke used as reduction agent in Blast Furnace, the associated emissions being accounted in Industrial Processes sector, represents an important non-energy use quantity. For coal oil and tars the assumption suggested in the methodology (5.91 % from the coking coal consumption is assumed to be stored in products) was applied.	National Inventory Report, Chapter 3.2.3

Slovakia	Using the IPCC 2006 Guidelines, the quantity of carbon excluded from reference approach (carbon used for ammonia production, petrochemicals production, carbide production, hydrogen production, iron and steel production, ferroalloys production, aluminium production as well as non-energy using of lubricants) was estimated. Total carbon excluded from reference approach was 1 974.5 Gg in 2016, which represents 7 239.9 Gg of CO_2. The emissions from the carbon excluded are reported in respective categories in the IPPU sector. The major share of carbon excluded represents the carbon from coking coal, both in fuel consumption and in amount of carbon (52.1% and 51.8%, respectively) The other significant source of carbon excluded is using of natural gas (21.8% in fuel consumption and 17.8% in quantity of carbon). Details on the share in fuel units and carbon units are presented on the Figures 3.33 and 3.34. The CO_2 emissions excluded from the RA are presented in Figure 3.35 for the whole time series 1990 – 2016. Liquid fuels (natural gas liquids, naphtha, and refinery feedstocks), solid fuels (coking coal, other bituminous coal) and gaseous fuels (natural gas) are used as feedstock in Slovakia. Lubricants and bitumen (liquid fuels) are used for non-energy purposes. The respective amounts of mentioned fuels are allocated in the IPPU sector and emissions are included there. The allocation of the fuels excluded from the reference approach and included in the IPPU sector is presented in the Table 3.66 and 3.67. The plant-specific (where available) and country-specific NCVs and EFs are used for estimation the volume of carbon excluded and respective CO_2 emissions excluded from the reference approach balance. The following fuels were balanced as feedstocks and non-energy use: natural gas, natural gas liquids, naphtha, lubricants, refinery feedstocks, coking coal, other bituminous coal. The quantities of the fuels and carbon used for non-energy purposes were provided directly by the plant operators or by the Statistical Office of the Slovak Republic.	National Inventory Report, Chapter 3.4
Slovenia	The biggest fraction of non-energy usage of fuels was the consumption of natural gas for the production of methanol, amounting to 89,475 Sm3 of natural gas in 2010, when this production stopped, and there has been no methanol production in Slovenia since 2011. Natural gas was entirely used as the row material for transformation into methanol. In every cycle only a fifth of it is transformed to the product, while the remaining natural gas is returned into the process. Stored CO_2 has been calculated on the basis of the formula from IPCC guidelines. We have assumed that all methane used for methanol production is stored in the product or in CO in emitted gas. This fact was confirmed also by expert from the company Nafta-Petrochem. The remaining amount of non-energy use of natural gas is used in the chemical industry also as a row material for production of organic and inorganic chemicals and plastics. According to the Statistical data all lubricants in Slovenia have been used for non-energy purpose only. Data about different types of use are not available. Likely, the largest applications for lubricants are in the form of motor oil. After the end of use, the lubricants which have been used in the engines are collected and mostly used as a fuel. In the line with the IPCC methodology emissions from lubricants used in the 2-stroke engines are reported in energy sector under road transport, while other emissions from lubricants are reported in the IPPU sector. The remaining amount of lubricants which is not combusted or oxidised during use is collected as waste oil. Slovenia has been adhering to the basic system of collection, recovery and disposal of waste oil since 1998. Recovery is the preferred choice, if technically feasible and if its cost is not unreasonably higher than the cost of disposal One of the forms of recovery is the utilisation of waste oils for energy – co-incineration in accordance with recovery procedure R1. Records by the SEA show that most waste oils have been used for this purpose. The only evidence of such a use is in the cement production. Emissions are already included in the inventory and are reported in the CRF tables in "1.A.2.g.viii Manufacturing industry and construction/Other industries under other fossil fuels". A small portion of collected waste oils has also been incinerated (procedure R9) or reformed and then reused (procedure D10). We reported these emissions in waste sector under waste incineration in submission 2010 for the first time. No other use of lubricants as a fuel has been recorded in Slovenia until now. The data on import and export as well as data from waste oil combusted in the industry have been obtained from SORS while the data on incineration of waste oils are from SEA. Stored CO_2 has been calculated on the basis of the formula 6.4 from 2006, IPCC guidelines, Vol. 2, Ch.6 Reference Approach. **Other fuels** Coke and petroleum coke, used in industry as reduction agent or feedstock, have been subtracted from energy sector and emissions from these fuels are presented in industrial processes sector. Before 1997, amount of coke, used for production of iron and steel, ferroalloys and carbide was reported as fuel consumption in relevant sectors. After 1997, this fuel started to be collected separately, but it took a while that all non-energy used fuel was reported correctly. Energy and non-energy use of fuel in industry have been presented separately in statistical data since 2000. To avoid double counting we have subtracted all coke used in iron and steel, ferroalloys and carbide production from energy sector except coke in iron production in the base year 1986. In that time, pig iron was still produced and disaggregated into the consumption of fuel as an additive. Thus the consumption of fuel as an energy product was impossible. For consumption of coke, the decision was taken to attribute all coke, which is consumed in the production of iron and steel in this year, to the energy sector as fuel consumption and no emissions from coke used in iron and steel production are presented in industrial processes. There are also other uses of fuel in chemical processes not emitting any GHGs, therefore no explanation is included in the CRF tables. In 2016, a small amount of fuel oil, LPG and white spirit was used, mostly for production of lacquers, paintings and other coatings. The same is valid also for bitumen which is used for road paving and for production of roofing material and during this use no GHG emissions occur.	National Inventory Report, Chapter 3.2.3

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. Main sources are information directly from the plant or industry association about the use of fossil fuels, such as non-energy inputs following the sector/process to determine types of fuels, determined types of fuels from the quantity consumed for this purpose as retention carbon products, such as CO_2 emissions versus its complementing and replacing the figures reported in the above mentioned sources . Following sectors / processes - in most cases on individual plant level - are investigated: i) sodium carbonate; ii) calcium carbide and silicon ; iii) silicon ; iv) ferroalloys (ferrosilicon, ferromanganese and silicon manganese); v) ammonia ; vi) glass; vii) electrical steel mills ; viii) aluminum (anode manufacture); ix) hydrogen in the refining industry emplaced x) refinery plants. The exploitation of this information has led to a revision in the inventory figures for natural gas, petroleum coke, coal coke and coal (anthracite) and other fuels whose registered consumption for non-energy use is minor , such as coking coal , diesel , LPG, fuel oil, gas and refinery steel or wood.	National Inventory Report, Chapter 3.1.4 translation
Sweden	Activity data on feedstocks and non-energy use of fuels is collected from the environmental reports and the EU ETS statistics. Sweden uses the same data for CRF table 1.A.d, non-energy use (NEU) of fuels as for feedstocks and non-energy uses in the IPPPU sector (CRF 2) and Fugitive sector (CRF 1.B). Net calorific values and carbon emission factors are the same as in CRF 1.A.b. The parameter “fraction of carbon stored” has been set to 1.00 for all fuels, which is in line with the 2006 IPCC Guidelines. Emissions from use of fuels reported in CRF 1.B or CRF 2 is reported as “CO_2 emissions from the NEU reported in the inventory” in the CRF-tables.	National Inventory Report, Chapter 3.2.3
United Kingdom	The methodology for estimating emissions from fuels used for non-energy purposes is set out in the relevant sections of this NIR. A summary of the method, including all non-energy uses is included in **Annex 3**. The UK energy statistics (DUKES, 2016) contain an allocation for non-energy use for each fuel in the commodity balance tables. The UK inventory estimates emissions from fuels, including emissions arising from non-energy uses. In some cases, the inventory estimate for non-energy use does not agree with the DUKES allocation, and reallocations are made between energy and non-energy use for inventory reporting. In 2013, the Inventory Agency carried out research into non-energy uses of fuels; this was followed up by the DECC (now BEIS as of 2016) energy statistics team during 2014, and a series of revised allocations were introduced in the Digest of UK Energy Statistics 2014 (DECC, 2014), improving consistency between the inventory and the UK energy statistics. The activity data used for the national inventory and any deviations from the UK energy balance are presented and explained in **Annex 4**. The evidence that the Inventory Agency uses to make estimates for NEU includes: • annual reporting by plant operators (e.g. EU ETS returns include data on the use of process off-gases in the chemical and petrochemical production sector); • periodic surveys or research by trade associations / research organisations / environmental regulators, such as to assess the fate of coal tars and benzoles, petroleum coke or waste oils, or the impact of regulations on solvents, waste, product design and use; and, • information on the estimated split of stored: emitted carbon from feedstock chemicals in literature sources, including other country NIRs, where UK-specific information is not available. In many cases the energy statistics allocate fuels to non-energy use that are used in chemical and petrochemical production processes where either: • fossil carbon-containing off-gases are used for combustion in facility boilers; or • products containing the “stored” carbon are subsequently used / partly combusted / disposed and degraded with some proportion of the “stored carbon” in products ultimately emitted to atmosphere. In other instances, the allocation of fuels to “non-energy use” in the UK energy balance is contrary to other statistical evidence from industry or surveys that the Inventory Agency has access to in the compilation of the national inventory. For example, in the UK the allocation of petroleum coke to domestic and industrial combustion sources in the energy balance are missing for many years in the time series, whereas evidence from environmental reporting and research indicates that several industries use petroleum coke directly as a fuel or process input (e.g. cement kilns, chemical manufacturing processes, domestic fuel manufacturers), and that petroleum coke is supplied as a fuel for the residential market..	National Inventory Report, Chapter 3.2.3

4 INDUSTRIAL PROCESSES AND PRODUCT USE (CRF SECTOR 2)

This chapter starts with an overview on emission trends in CRF Sector 2 Industrial processes and Product Use. This chapter comprises the categories formerly reported under CRF Sector 2 (Industrial Processes) and Sector 3 (Solvents), which are now split as follows:

- Mineral Industry (CRF Source Category 2.A)
- Chemical Industry (CRF Source Category 2.B)
- Metal Industry (CRF Source Category 2.C)
- Non-Energy Products from Fuels and Solvent Use (CRF Source Category 2.D)
- Electronics Industry (CRF Source Category 2.E)
- Product Uses As Substitutes for Ozone Depleting Substances (CRF Source Category 2.F)
- Other Product Manufacture and Use (CRF Source Category 2.G)
- Other (CRF Source Category 2.H)

For each EU-28 key category, overview tables are presented including the Member States' contributions to the key categories in terms of level and trend, and information on methodologies and emission factors.

4.1 Overview of sector

CRF Sector 2 Industrial Processes and Product Use is the third largest sector contributing 9 % to total EU-28 GHG (without LULUCF) emissions in 2016. The most important GHGs from this sector are CO_2 (6 % of total GHG emissions), HFCs (3 %) and N_2O (0.2 %). According to the IPCC 2006 guidelines, which have been applicable since the inventory compilation for 2014 (data for 2013), this sector now also entails the use of solvents and other product use. The use of solvents manufactured using fossil fuels as feedstocks can lead to evaporative emissions of various non-methane volatile organic compounds (NMVOC) which are subsequently further oxidised in the atmosphere.

The emissions from the sector Industrial Processes and Product Use decreased by 23 % from 518 Mt in 1990 to 377 Mt in 2016 (Figure 4.1) In 2016, the emissions decreased by 0.6 % compared to 2015. Factors for declining emissions in the early 1990s were lower economic activity in several sectors. The decrease in 2009 was driven by reductions in cement production and a significant drop in the iron and steel production as a consequence of the economic crisis. In 2010 emissions increased again, *inter alia* due to the recovery of steel production.

The key categories in this sector are:

- 2.A.1 Cement Production (CO_2)
- 2.A.2 Lime Production (CO_2)
- 2.A.4 Other Process Uses of Carbonates (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.8 Petrochemical and Carbon Black Production (CO_2)
- 2.B.9 Fluorochemical Production (HFCs)
- 2.B.9 Fluorochemical Production (Unspecified mix of HFCs and PFCs)
- 2.B.10 Other chemical industry (CO_2)
- 2.C.1 Iron and Steel Production (CO_2)
- 2.C.3 Aluminium production (PFCs)

- 2.D.3 Other non energy products (CO_2)
- 2.F.1 Refrigeration and Air Conditioning Equipment (HFCs)
- 2.F.2 Foam Blowing Agents (HFCs)
- 2.F.3 Fire Protection (HFCs)
- 2.F.4 Aerosols/ Metered Dose Inhalers (HFC)

Figure 4.1: CRF Sector 2 Industrial Processes and Product Use: EU-28 and Iceland GHG emissions for 1990–2016 in CO_2 equivalents (Mt)

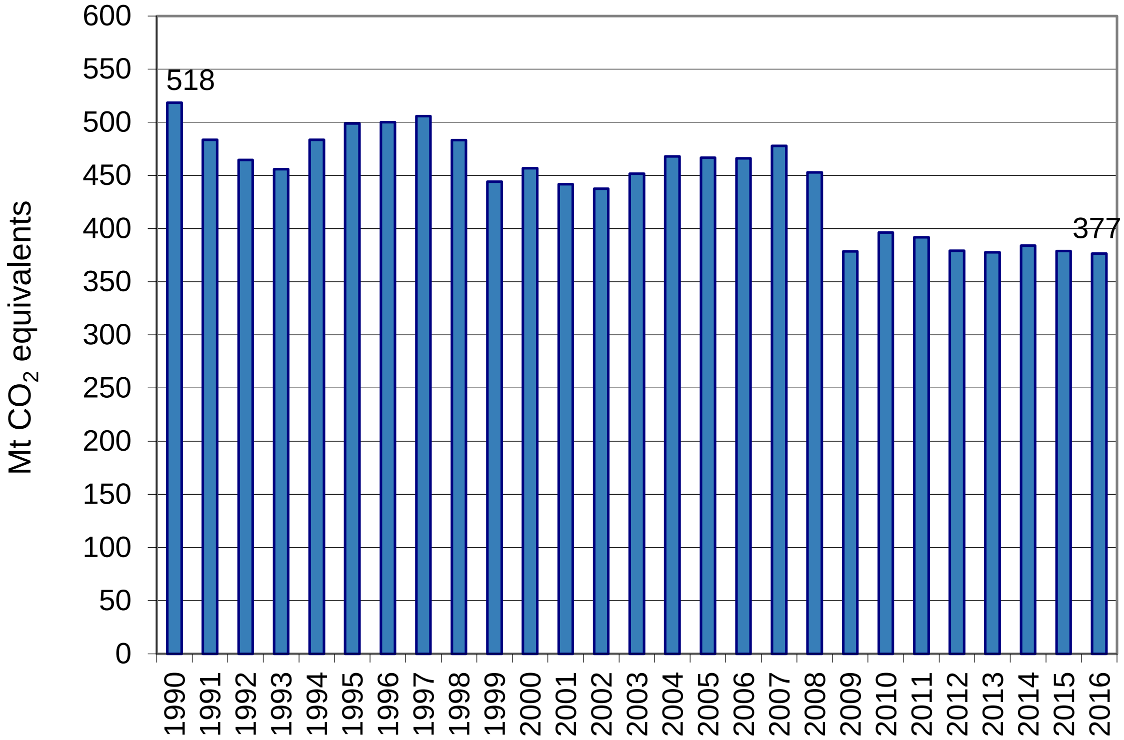
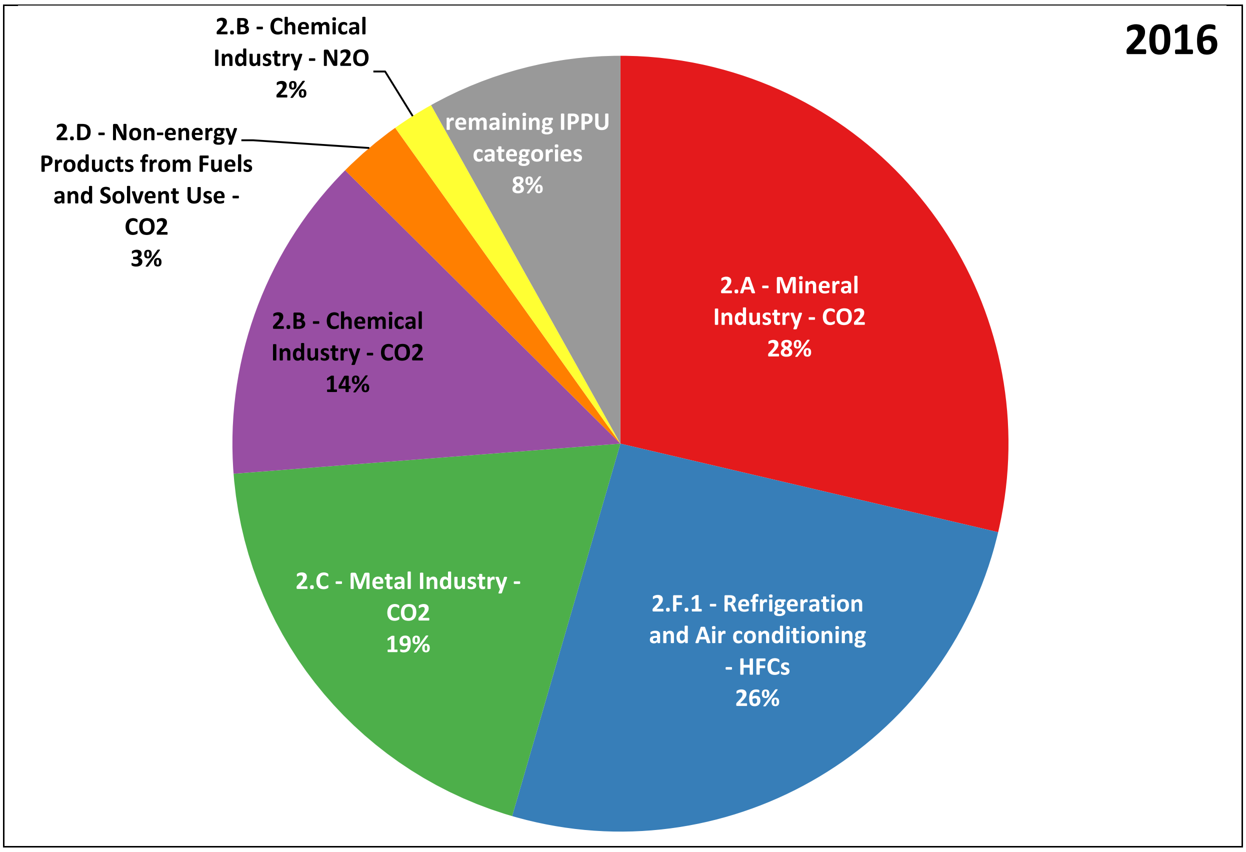
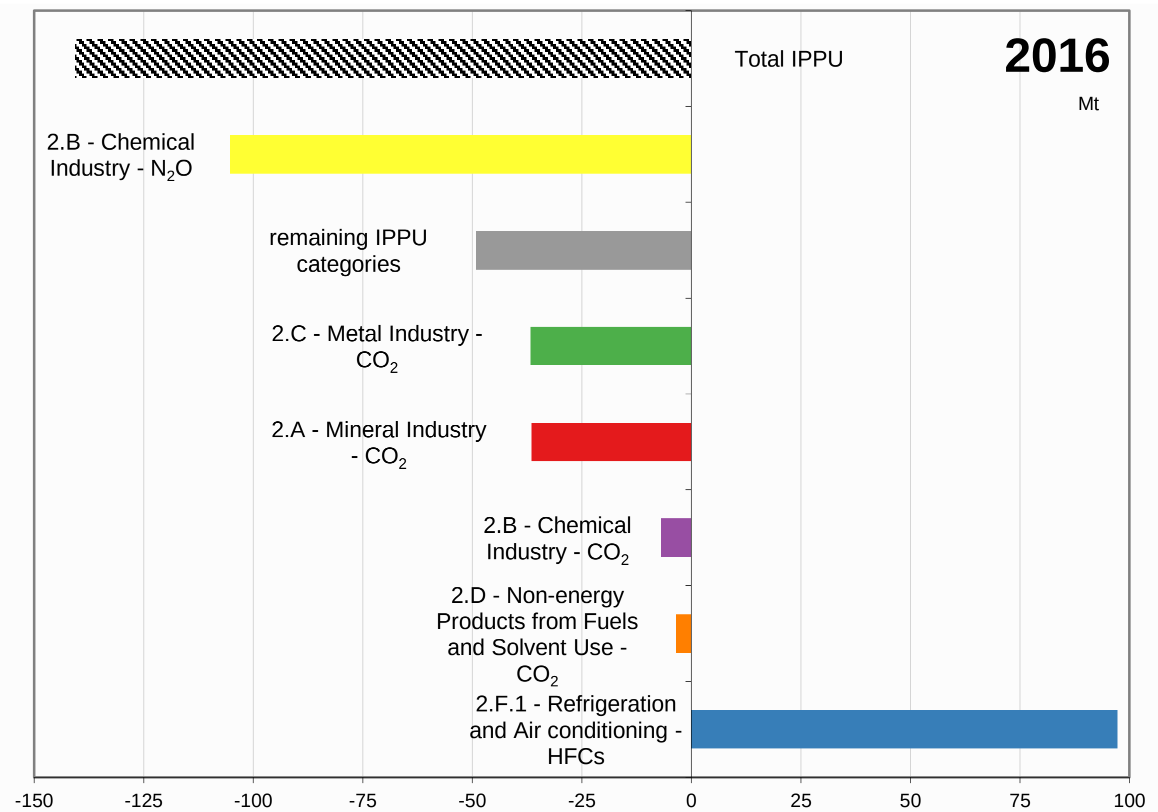


Figure 4.2: CRF Sector 2 Industrial processes and Product Use: Share of largest key categories in 2016



Note: Other is calculated by subtracting the presented categories from the sector total

Figure 4.3: CRF Sector 2 Industrial processes and Product Use: absolute change of GHG emissions by large key categories 1990–2016 in CO_2 equivalents (Mt)



4.2 Source categories and methodological issues

4.2.1 Mineral industry (CRF Source Category 2A)

The source category 2A Mineral industry includes three key categories:

Table 4.1: Key source categories for level and trend analyses and share of MS emissions using higher tier methods for sector 2A (Table excerpt).

Source category gas	kt CO_2		Trend	Level		share of higher Tier
	1990	2016		1990	2016	
2.A.1 Cement Production (CO_2)	102679	74699	0	L	L	100%
2.A.2 Lime Production (CO_2)	25925	18695	0	L	L	99.9%
2.A.4 Other Process Uses of Carbonates (CO_2)	11721	10332	0	L	L	NA

This sector is dominated by cement production which contributes nearly 70% of emissions. Cement production emissions occur during the production of clinker, an intermediate component in the cement manufacturing process. The source category 2A2 Lime production accounts for 17% of the sector where CO_2 emitted during the calcination of the calcium in limestone or dolomite for lime production. The source category 2A4 Other process uses of carbonates accounts for 10% of the sector and is composed of several sources with independent estimation methods. The remaining 4% of emissions is from 2.A.3 Glass production.

The share of higher tiers used is complete or very high for each of the three key categories. It is difficult to aggregate the Tiers for 2A4 Other process uses of carbonates, as MS estimates are across a number of source categories with estimation methods using a combination of higher tiers and default methods.

While Mineral industry emissions have fallen by 25 % since 1990, they decreased by less than 1% between 2015 and 2016. Mineral sector emissions appear to have plateaued since the 2009 economic crisis. (Figure **4.4**). Only six countries have higher Mineral industry CO_2 emissions in 2016 compared to 1990 (Table 4.2).

Figure 4.4 2A Mineral industry CO_2 emissions

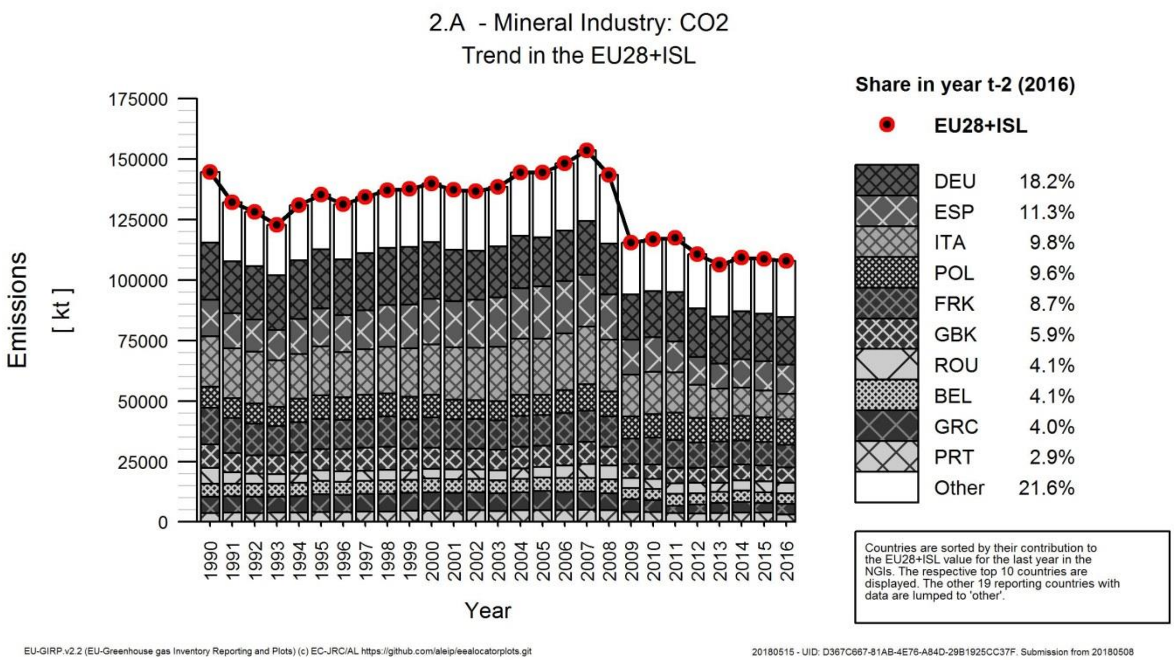


Table 4.2 2A Mineral industry: Member States total GHG and CO_2 emissions

Member State	GHG emissions in 1990 (kt CO2 equivalents)	GHG emissions in 2016 (kt CO2 equivalents)	CO2 emissions in 1990 (kt)	CO2 emissions in 2016 (kt)
Austria	3 092	2 788	3 092	2 788
Belgium	5 323	4 377	5 323	4 377
Bulgaria	3 236	2 451	3 236	2 451
Croatia	1 281	1 238	1 281	1 238
Cyprus	717	896	717	896
Czech Republic	4 082	2 816	4 082	2 816
Denmark	1 082	1 231	1 082	1 231
Estonia	614	237	614	237
Finland	1 214	1 081	1 214	1 081
France	14 973	9 399	14 973	9 399
Germany	23 522	19 609	23 522	19 609
Greece	6 775	4 272	6 775	4 272
Hungary	2 895	1 163	2 895	1 163
Ireland	1 117	1 968	1 117	1 968
Italy	20 720	10 607	20 720	10 607
Latvia	595	356	595	356
Lithuania	2 142	514	2 142	514
Luxembourg	623	420	623	420
Malta	1	0	1	0
Netherlands	1 411	1 501	1 411	1 501
Poland	8 855	10 394	8 855	10 394
Portugal	3 690	3 132	3 690	3 132
Romania	6 531	4 398	6 531	4 398
Slovakia	2 714	2 183	2 714	2 183
Slovenia	695	432	695	432
Spain	15 157	12 152	15 157	12 152
Sweden	1 673	1 996	1 673	1 996
United Kingdom	9 804	6 327	9 804	6 327
EU-28	**144 535**	**107 939**	**144 535**	**107 939**
Iceland	52	1	52	1
United Kingdom (KP)	9 804	6 327	9 804	6 327
EU-28 + ISL	**144 588**	**107 940**	**144 588**	**107 940**

Abbreviations explained in the Chapter 'Units and abbreviations'.
For consistency with other sub-sectors this table shows both CO_2e and CO_2, however as there are no N_2O or CH_4 emissions for this category, the two sets of columns in this table show the same numbers.

Table 4.3 provides information on the Member States' contribution to EU-28+ISL recalculations in CO_2 from 2A Mineral industry for 1990 and 2015 as well as some explanations for the larger recalculations in absolute terms provided by Member States.

Table 4.3 2A Mineral industry: Contribution of MS to EU-28+ISL recalculations in CO_2 for 1990 and 2015 (difference between latest submission and previous submission in kt of CO_2 equivalents and percent)

	1990		2015		Main explanations
	kt CO_2	%	kt CO_2	%	
Austria	-	-	-2	-0.3	
Belgium	-	-	99	1.4	In the Flemish region there is a re-allocation of emissions of CO_2 (99.33 kton) from combustion (category 1A2c) to process emissions (category 2B10). The total emissions remain the same in these 2 categories.
Bulgaria	-	-	-	-	
Croatia	7	0.9	35	6.6	Technical correction
Cyprus	-	-	-	-	Lime - recalculations have been performed in order to introduce the correction factor for hydrated lime as indicated in 2006 IPCC Guidelines. The new values are similar compared with the 2017 submission.
Czech Republic	-	-	0	0.0	Updated activity data, new methodology in subcategory 2.A.3 Glass Production
Denmark	-0	-33.2	-0	-3.6	A calculation error was corrected for production of container glass; this recalculation leads to a decrease in emissions for 1990-1993 of 0.9 - 3.8 Gg CO_2. For production of expanded clay products, the implied emission factor (IEF) for expanded clay products displayed a significant increase from 2012 to 2013.The company has explained that the estimates made by the company prior to 2013 did not take into account the carbonate content of the clays used but only the pure carbonates. To ensure time series consistency, the entire time series prior to 2013 was recalculated to include an estimate of the contribution of carbonate content in the clay. The result is an increase of 1.1 - 6.8 Gg CO_2 for 1990-2012. A change in data from Statistics Denmark caused an increase in emissions from other uses of soda ash of 0.1 - 1.9 Gg CO_2.
Estonia	-	-	-	-	
Finland	-0	-0.0	-4	-0.5	The whole time series of emissions from lime production were recalculated, correction factors were revised for other limestone and dolomite use.
France	116	1.6	80	1.2	2A4d: Emissions and consumption of some activities that were included in the previous edition have been transferred to other CRF codes: the use of carbonates in the chemical sector towards CRF 2B10; the use of carbonates in the district heating and electricity sector towards CRF 2G4; the use of carbonates in the magnesium sector towards CRF 2C7.
Germany	-	-	-0	-0.0	Revised AD 2.A.3, 2.A.4.a) and EF (2.A.4.a); adjustment of sodium carbonate use in 2.A.4.b
Greece	-	-	-	-	
Hungary	-	-	-	-	Inclusion of non-ETS plants in Ceramics subsector
Ireland	-	-	-	-	
Italy	-	-	-0	-0.0	Update of activity data
Latvia	-	-	-	-	Recalculations are done in 2.A.1 Cement production and 2.A.2 Lime production sectors. Within 2.A.1 recalculation was done due to recalculation of CKD correction factor for 1995-2015, but in 2.A.2 CO_2 emissions were recalculated due to adding of CO_2 emissions from non-marketed lime production in iron & steel industry for 1990-2010 and due to introduction of default correction factor 1.02 for lime kiln dust (LKD).
Lithuania	-	-	25	1.2	2.A.4.d Mineral Wool Production CO_2 emissions from mineral wool production were recalculated due to correction of dolomite consumption and emission factor for dolomite.
Luxembourg	-	-	-	-	
Malta	-	-	-	-	
Netherlands	-	-	-3	-0.1	Inclusion of emissions from lime production
Poland	-	-	-	-	EF for ceramic production was slightly corrected
Portugal	10	0.8	14	2.2	2.A.3 (Glass Production): It was made a correction in glass production activity data that is also reflected in combustion related emissions; 2.A.4.d (Other Uses of Carbonates): Emissions related to carbonates consumptions in fertilizers industry (2A4d) for the period 1990-1991 have been revised. In order to obtain a consistent timeserie, these

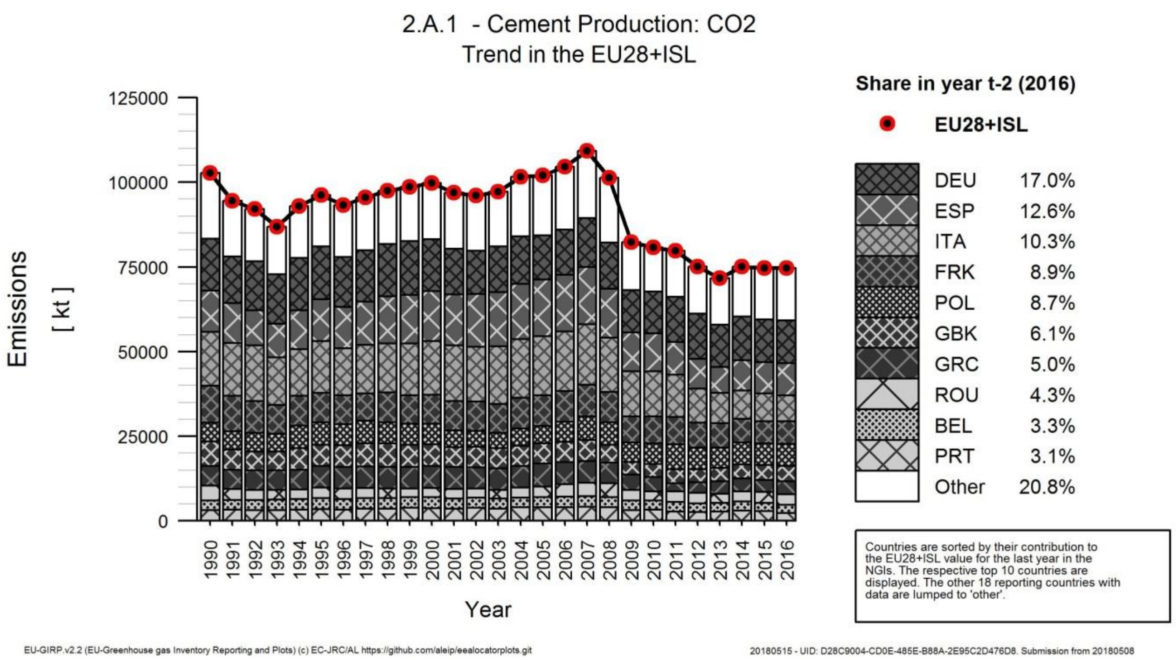
	1990		2015		Main explanations
	kt CO_2	%	kt CO_2	%	
					values are now estimated based on gross domestic product trend for this period.
Romania	1 355	32.2	247	31.9	Recalculations have been made for the 2007-2015 period. Recalculations were made as a result of the changes in activity data for those years. (CRF Category 2.A.4 d)
Slovakia	-	-	-	-	2.A.2 category. In the pulp and paper plants, the CO_2 from biomass is used for the production of CaCO3 from the lime with subsequent limestone decomposition into CaO; no fossil limestone is used.
Slovenia	-	-	-	-	
Spain	-	-	827	25.9	2A3 Upgrade to EMEP/EEA 2016. New estimates of pollutants were previously considered to be included in sector 1A2f (combustion). For CO_2 there are small recalculations in 2015 due to correction of errors in the activity data. 2A4 Fixed some typing errors occurred in the 2017 submission
Sweden	-15	-11.6	-3	-1.6	Minor correction of data/change of data source.
United Kingdom	3	0.0	11	0.2	minor revision to the extrapolation method used to derive an estimate for UK clinker production due to data being unavailable for 2015.
EU28	1 475	2.6	1 328	2.6	
Iceland	-	-	-	-	Updated NCV, C content from ETS reports
United Kingdom (KP)	3	0.0	11	0.2	Minor revision to the extrapolation method used to derive an estimate for UK clinker production due to data being unavailable for 2015.
EU28+ISL	1 475	2.6	1 328	2.6	

(*) contribution of the recalculation as percentage of the total emissions of category 2A for the respective year and MS

4.2.1.1 2A1 Cement production

CO_2 emissions from Cement production contributed 1.7% of total EU 28+ISL (without LULUCF) emissions in 2016. In 2016, CO_2 emissions from Cement production were 27% below 1990 levels. This source is a key category of CO_2 emissions in terms of emissions level and trend.

Figure 4.5 2A1 Cement production: EU-28+ISL CO_2 emissions



Germany, Spain and Italy were the largest emitters accounting for 17%, 13% and 10% respectively of cement related emissions. (Figure 4.5 and Table 4.4**Error! Reference source not found.**). Cement production saw only a small 0.1% increase in overall emissions in 2016 compared to 2015, with increases balancing decreases. The three countries with the largest absolute growth (2015-2016) were Greece, Spain, and Poland. The three countries with the largest absolute reductions were Portugal, Italy and Romania.

Table 4.4 2A1 Cement production: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016		Method	Emission factor Informa-tion
	1990	2015	2016		kt CO2	%	kt CO2	%		
Austria	2 033	1 701	1 729	2.3%	-304	-15%	28	2%	T3	PS
Belgium	2 824	2 348	2 436	3.3%	-388	-14%	88	4%	T3	PS
Bulgaria	2 100	1 105	1 200	1.6%	-900	-43%	95	9%	T2	PS
Croatia	1 086	1 169	1 077	1.4%	-9	-1%	-93	-8%	T2	CS
Cyprus	668	877	883	1.2%	216	32%	6	1%	CS	CS
Czech Republic	2 489	1 558	1 698	2.3%	-792	-32%	139	9%	T3	PS
Denmark	882	932	1 095	1.5%	213	24%	164	18%	T3	PS
Estonia	483	206	185	0.2%	-298	-62%	-20	-10%	T2	PS
Finland	729	462	553	0.7%	-176	-24%	91	20%	T3	PS
France	10 937	6 606	6 639	8.9%	-4 298	-39%	33	0%	T2,T3	CS,PS
Germany	15 297	12 626	12 663	17.0%	-2 635	-17%	37	0%	T2	CS
Greece	5 762	3 467	3 772	5.0%	-1 989	-35%	305	9%	CS	PS
Hungary	1 751	676	705	0.9%	-1 045	-60%	30	4%	T3	PS
Ireland	884	1 652	1 794	2.4%	910	103%	142	9%	T3	PS
Italy	15 846	8 196	7 680	10.3%	-8 165	-52%	-516	-6%	T2	CS,PS
Latvia	346	470	346	0.5%	1	0%	-124	-26%	T2	PS
Lithuania	1 668	518	452	0.6%	-1 216	-73%	-66	-13%	T2	PS
Luxembourg	570	329	355	0.5%	-215	-38%	25	8%	T2	CS,PS
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	416	249	239	0.3%	-177	-43%	-10	-4%	CS	PS
Poland	5 453	6 342	6 530	8.7%	1 076	20%	188	3%	T2	CS
Portugal	3 176	2 921	2 297	3.1%	-879	-28%	-624	-21%	T3	OTH
Romania	4 445	3 337	3 181	4.3%	-1 264	-28%	-156	-5%	CS,T2	PS
Slovakia	1 464	1 309	1 341	1.8%	-124	-8%	32	2%	T2	PS
Slovenia	470	367	344	0.5%	-127	-27%	-23	-6%	T2	CS
Spain	12 279	9 216	9 414	12.6%	-2 865	-23%	198	2%	T2	CS
Sweden	1 272	1 529	1 538	2.1%	266	21%	9	1%	T3	PS
United Kingdom	7 295	4 461	4 553	6.1%	-2 742	-38%	93	2%	T3	CS
EU-28	**102 628**	**74 631**	**74 699**	**100%**	**-27 928**	**-27%**	**68**	**0%**	**-**	**-**
Iceland	52	NO	NO	-	-52	-100%	-	-	NA	NA
United Kingdom (KP)	7 295	4 461	4 553	6.1%	-2 742	-38%	93	2%	T3	CS
EU-28 + ISL	**102 679**	**74 631**	**74 699**	**100%**	**-27 980**	**-27%**	**68**	**0%**	**-**	**-**

Presented methods and emission factor information refer to the last inventory year.
Abbreviations explained in the Chapter 'Units and abbreviations'.

Table 4.5 shows information on methods, activity data, and emission factors for CO_2 emissions from 2A1 Cement production for 1990 and 2016. All cement production emissions are estimated with higher Tier methods and most Member States use plant-specific emission factors.

The implied emission factors per tonne of clinker produced in 2016 range from 0.47 t CO_2/t of clinker produced for Luxembourg to 0.58 t CO_2/t of clinker produced for Estonia. Countries use country-specific and plant-specific emission factors (typically based on raw meal carbon content characterization), they also provide data on clinker production which allows for the calculation of comparative IEFs. In 2016 the EU-28+ISL IEF remained at 0.53 t CO_2/t of clinker.

Table 4.5 2A1 Cement production: Information on methods applied and emission factors for CO_2 emissions

Member State	1990				2016				Method	Emission Factor Informa-tion
	Activity Data		Implied Emission Factorn (t/t)	CO2 Emission (kt)	Activity Data		Implied Emission Factor (t/t)	CO2 Emission (kt)		
	Description	(kt)			Description	(kt)				
Austria	Cement Clinker	3 694	0.55	2 033	Cement Clinker	3 300	0.52	1 729	T3	PS
Belgium	Clinker production	5 292	0.53	2 824	Clinker production	4 458	0.55	2 436	T3	PS
Bulgaria	-	3 987	0.53	2 100	-	2 257	0.53	1 200	T2	PS
Croatia	Clinker production	2 062	0.53	1 086	Clinker production	2 059	0.52	1 077	T2	CS
Cyprus	Clinker production	1 249	0.53	668	Clinker production	1 648	0.54	883	CS	CS
Czech Republic	Clinker production	4 726	0.53	2 489	Clinker production	3 188	0.53	1 698	T3	PS
Denmark	Clinker production	1 406	0.63	882	Clinker production	1 973	0.56	1 095	T3	PS
Estonia	Clinker production	790	0.61	483	Clinker production	319	0.58	185	T2	PS
Finland	Clinker production	1 470	0.50	729	Clinker production	1 117	0.50	553	T3	PS
France	Clinker production	20 854	0.52	10 937	Clinker production	12 528	0.53	6 639	T2,T3	CS,PS
Germany	Clinker production	28 863	0.53	15 297	Clinker production	23 892	0.53	12 663	T2	CS
Greece	Clinker production	10 645	0.54	5 762	Clinker production	7 086	0.53	3 772	CS	PS
Hungary	Clinker production	3 210	0.55	1 751	Clinker production	1 371	0.51	705	T3	PS
Ireland	Clinker production	1 610	0.55	884	Clinker production	3 275	0.55	1 794	T3	PS
Italy	Clinker production	29 786	0.53	15 846	Clinker production	14 762	0.52	7 680	T2	CS,PS
Latvia	Clinker production	669	0.52	346	Clinker production	678	0.51	346	T2	PS
Lithuania	Clinker production	3 058	0.55	1 668	Clinker production	852	0.53	452	T2	PS
Luxembourg	Clinker production	1 048	0.54	570	Clinker production	750	0.47	355	T2	CS,PS
Malta	-	NO	NO	NO	-	NO	NO	NO	NA	NA
Netherlands	-	770	0.54	416	-	498	0.48	239	CS	PS
Poland	Clinker production	10 309	0.53	5 453	Clinker production	12 075	0.54	6 530	T2	CS
Portugal	-	6 128	0.52	3 176	-	4 413	0.52	2 297	T3	OTH
Romania	Clinker production	8 379	0.53	4 445	Clinker production	5 933	0.54	3 181	CS,T2	PS
Slovakia	Cement Clinker	2 836	0.52	1 464	Cement Clinker	2 599	0.52	1 341	T2	PS
Slovenia	Clinker production	891	0.53	470	Clinker production	667	0.52	344	T2	CS
Spain	Clinker production	23 212	0.53	12 279	Clinker production	18 009	0.52	9 414	T2	CS
Sweden	Clinker production	2 348	0.54	1 272	Clinker production	2 847	0.54	1 538	T3	PS
United Kingdom	Clinker production	13 199	0.55	7 295	Clinker production	8 056	0.57	4 553	T3	CS
EU-28	**-**	**192 489**	**0.53**	**102 628**	**-**	**140 611**	**0.53**	**74 699**	**-**	**-**
Iceland	Clinker production	97	0.53	52	Clinker production	NO	NO	NO	NA	NA
United Kingdom (KP)	Clinker production	13 199	0.55	7 295	Clinker production	8 056	0.57	4 553	T3	CS
EU-28+ISL	**-**	**192 586**	**0.53**	**102 679**	**-**	**140 611**	**0.53**	**74699**	**-**	**-**

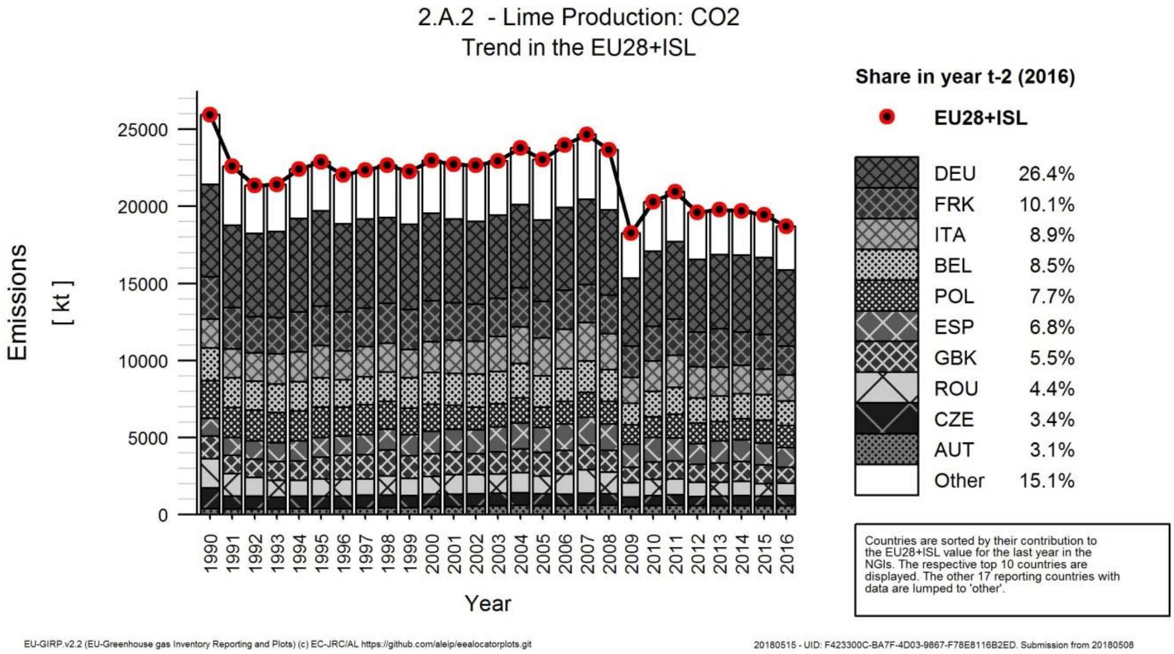
Abbreviations are explained in the Chapter 'Units and abbreviations'.
Presented methods and emission factor information refer to the last inventory year.

4.2.1.2 2A2 Lime production

CO_2 emissions from 2A2 Lime production account for only 0.4% of total EU 28+ISL (without LULUCF) emissions. Between 1990 and 2016, CO_2 emissions from this source decreased by 28%.

Lime production CO_2 emissions saw a 3.9% decrease in overall emissions in 2016 with decreases outweighing increases. The largest increase was only 37kt in Netherlands, large decreases occurred in France, Spain and the United Kingdom (Figure 4.6).

Figure 4.6   2A2 Lime production: EU-28+ISL CO_2 emissions



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 economic factors and development of competing and substitute products. Romania also contributed considerably to the drop in the early nineties. Germany, France and Italy are the largest emitters contributing 26 %, 10 % and 9 % of the sector respectively (Table 4.6).

Table 4.6 2A2 Lime production: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016		Method	Emission factor Informa-tion
	1990	2015	2016		kt CO2	%	kt CO2	%		
Austria	396	579	582	3.1%	185	47%	3	1%	T3	PS
Belgium	2 097	1 665	1 589	8.5%	-508	-24%	-76	-5%	T3	PS
Bulgaria	390	204	217	1.2%	-174	-45%	13	6%	T2	D
Croatia	153	101	93	0.5%	-60	-39%	-7	-7%	T2	CS
Cyprus	5	2	2	0.0%	-3	-55%	0	1%	T1	D
Czech Republic	1 337	612	640	3.4%	-697	-52%	28	5%	T3	PS
Denmark	105	51	55	0.3%	-50	-47%	5	10%	T3	CS
Estonia	130	39	39	0.2%	-90	-70%	1	1%	T2	PS
Finland	401	359	386	2.1%	-14	-4%	27	7%	T2	CS
France	2 751	2 257	1 893	10.1%	-857	-31%	-364	-16%	T2,T3	CS,PS
Germany	5 987	4 976	4 935	26.4%	-1 052	-18%	-41	-1%	T2	D
Greece	404	163	174	0.9%	-230	-57%	11	7%	CS	PS
Hungary	614	151	126	0.7%	-488	-79%	-24	-16%	T3	PS
Ireland	214	177	174	0.9%	-40	-19%	-3	-2%	T3	PS
Italy	1 877	1 652	1 661	8.9%	-217	-12%	8	1%	T2	CS,PS
Latvia	180	1	NO	-	-180	-100%	-1	-100%	NA	NA
Lithuania	223	39	37	0.2%	-186	-83%	-2	-5%	T2	D
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	1	NO	NO	-	-1	-100%	-	-	NA	NA
Netherlands	163	129	166	0.9%	3	2%	37	29%	CS	D
Poland	2 461	1 495	1 448	7.7%	-1 013	-41%	-47	-3%	T2	CS
Portugal	203	351	339	1.8%	136	67%	-12	-3%	T3	OTH
Romania	1 898	831	832	4.4%	-1 066	-56%	0	0%	T2	CS,D
Slovakia	795	534	522	2.8%	-273	-34%	-13	-2%	T2	PS
Slovenia	201	60	61	0.3%	-140	-70%	1	1%	T3	CS
Spain	1 146	1 380	1 275	6.8%	129	11%	-105	-8%	T2,T3	D,PS
Sweden	331	420	428	2.3%	96	29%	8	2%	T3	D
United Kingdom	1 462	1 220	1 021	5.5%	-441	-30%	-199	-16%	T3	CS
EU-28	**25 925**	**19 448**	**18 695**	**100%**	**-7 230**	**-28%**	**-754**	**-4%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	1 462	1 220	1 021	5.5%	-441	-30%	-199	-16%	T3	CS
EU-28 + ISL	**25 925**	**19 448**	**18 695**	**100%**	**-7 230**	**-28%**	**-754**	**-4%**	**-**	**-**

Presented methods and emission factor information refer to the last inventory year.
Abbreviations are explained in the Chapter 'Units and abbreviations'. With reference to the notation key "IE" to report CO_2 emissions from lime production in the Netherlands, these are included in 2D2 Food industries.

Table 4.7 shows information on the methods and emission factors for CO_2 emissions from 2A2 Lime production for 1990 and 2016. While production data is not necessarily explicitly used for emissions calculations (plant-specific emission factors are typically derived from raw meal carbon content characterization), countries that report emissions from lime production provide activity data for calculating comparative IEFs. Lime production data is the combined figure for the three types of lime: quicklime (high-calcium lime), dolomitic lime and hydraulic lime production The weighted average IEF in 2016 is 0.74 t CO_2/t of lime produced. The lime production activity data for each country reflect a mix of lime types, and so the implied emission factors per tonne of lime produced range from 0.45 for UK to 0.81 for Finland. Of the twenty-five countries which report lime production emissions, all but one use higher tier methodologies (country or plant specific emission factors or Tier 2 or Tier 3) which accounts for more than 99.9 % of emissions from this category.

Table 4.7 2A2 Lime production: Information on methods applied, activity data, emission factors for CO_2 emissions

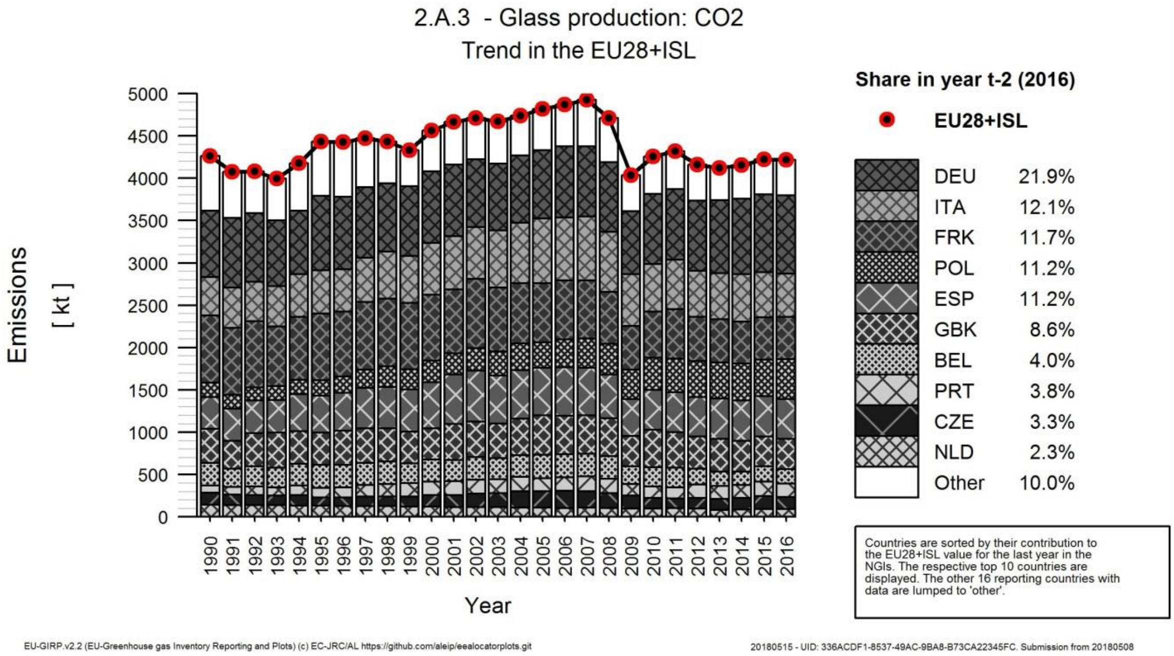
Member State	1990				2016				Method	Emission Factor Informa-tion
	Activity Data		Implied Emission Factorn (t/t)	CO2 Emission (kt)	Activity Data		Implied Emission Factor (t/t)	CO2 Emission (kt)		
	Description	(kt)			Description	(kt)				
Austria	Lime Production	513	0.77	396	Lime Production	773	0.75	582	T3	PS
Belgium	Lime Production	2660	0.79	2097	Lime Production	2009	0.79	1589	T3	PS
Bulgaria	-	490	0.80	390	-	278	0.78	217	T2	D
Croatia	Lime Production	232	0.66	153	Lime Production	125	0.75	93	T2	CS
Cyprus	Lime Production	7	0.73	5	Lime Production	3	0.73	2	T1	D
Czech Repub	Lime Production	1823	0.73	1337	Lime Production	836	0.77	640	T3	PS
Denmark	Lime Production	134	0.79	105	Lime Production	70	0.79	55	T3	CS
Estonia	Lime Production	185	0.70	130	Lime Production	55	0.71	39	T2	PS
Finland	Lime Production	488	0.82	401	Lime Production	480	0.81	386	T2	CS
France	Lime Production	3589	0.77	2751	Lime Production	2922	0.65	1893	T2,T3	CS,PS
Germany	Lime Production	7927	0.76	5987	Lime Production	6577	0.75	4935	T2	D
Greece	Lime Production	491	0.82	404	Lime Production	229	0.76	174	CS	PS
Hungary	Lime Production	831	0.74	614	Lime Production	172	0.74	126	T3	PS
Ireland	Lime Production	255	0.84	214	Lime Production	229	0.76	174	T3	PS
Italy	Lime Production	2583	0.73	1877	Lime Production	2320	0.72	1661	T2	CS,PS
Latvia	Lime Production	225	0.80	180	Lime Production	NO	NO,NA	NO	NA	NA
Lithuania	Lime Production	288	0.77	223	Lime Production	48	0.77	37	T2	D
Luxembourg	Lime Production	NO	NO	NO	Lime Production	NO	NO	NO	NA	NA
Malta	Lime Production	2	0.75	1	Lime Production	NO	NO	NO	NA	NA
Netherlands	Limestone used	372	0.44	163	Limestone used	380	0.44	166	CS	D
Poland	Lime Production	3464	0.71	2461	Lime Production	1975	0.73	1448	T2	CS
Portugal	Carbonate used	519	0.39	203	Carbonate used	829	0.41	339	T3	OTH
Romania	Lime Production	2414	0.79	1898	Lime Production	1062	0.78	832	T2	CS,D
Slovakia	Lime Production	1076	0.74	795	Lime Production	663	0.79	522	T2	PS
Slovenia	Lime Production	275	0.73	201	Lime Production	80	0.76	61	T3	CS
Spain	Lime Production	1601	0.72	1146	Lime Production	1818	0.70	1275	T2,T3	D,PS
Sweden	Lime Production	439	0.75	331	Lime Production	574	0.75	428	T3	D
United Kingd	Carbonate used	3282	0.45	1462	Carbonate used	2292	0.45	1021	T3	CS
EU-28	-	**NE**	**NE**	**25925**	-	**25369**	**0.74**	**18695**	-	-
Iceland	-	NO	NO	NO	-	NO	NO	NO	NA	NA
United Kingdom (KP)	Carbonate used	NE	NE	1462	Carbonate used	2292	0.45	1021	T3	CS
EU-28+ISL	-	**NE**	**NE**	**25925**	-	**25369**	**0.74**	**18695**	-	-

Presented methods and emission factor information refer to the last inventory year. Abbreviations explained in the Chapter 'Units and abbreviations'. Not all countries show production as the activity data for this emissions category. Gap-filled values are shown against Lime production for EU activity and the EU IEF.

4.2.1.3 2A3 Glass production

CO_2 emissions from 2A3 Glass production contributed to only 0.1% of total EU 28+ISL (without LULUCF) emissions in 2016. As can be seen in Figure 4.7, emissions in 2016 were similar to 1990 levels (just 1.1% lower). CO_2 emissions from glass production in 2016 decreased by -0.2% on 2015 levels.

Figure 4.7 2A3 Glass production: EU-28+ISL CO_2 emissions



In 2016, Germany was responsible for 22%, Italy for 12 % and France for 12 % of the emissions from this source. The largest absolute reduction in annual emissions compared to 1990 has been seen in France (-303kt or 38%).

Table 4.8 2A3 Glass production: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016		Method	Emission factor Informa-tion
	1990	2015	2016		kt CO2	%	kt CO2	%		
Austria	39	40	38	0.9%	0	-1%	-2	-4%	T3	PS
Belgium	266	186	170	4.0%	-96	-36%	-16	-9%	T3	CS,PS
Bulgaria	138	80	84	2.0%	-54	-39%	4	4%	T3	CS
Croatia	36	31	33	0.8%	-3	-9%	2	6%	T3	CS
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czech Republic	143	152	138	3.3%	-5	-3%	-14	-9%	T3	PS
Denmark	16	9	9	0.2%	-7	-45%	0	1%	T3	PS
Estonia	1	10	9	0.2%	8	662%	-1	-6%	T3	PS
Finland	21	2	2	0.1%	-19	-90%	0	2%	T3	CS
France	797	499	494	11.7%	-303	-38%	-5	-1%	T2,T3	CS,PS
Germany	780	916	923	21.9%	143	18%	7	1%	T2	CS
Greece	20	16	17	0.4%	-4	-17%	0	2%	CS	CS
Hungary	82	55	56	1.3%	-26	-32%	1	1%	T3	CS,PS
Ireland	13	NO	NO	-	-13	-100%	-	-	NA	NA
Italy	453	534	512	12.1%	59	13%	-22	-4%	T2	CS,PS
Latvia	0	0	0	0.0%	0	4%	0	-23%	T3	D,PS
Lithuania	12	6	7	0.2%	-5	-41%	1	9%	T2	D
Luxembourg	54	65	65	1.5%	12	22%	0	0%	CS	PS
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	142	95	96	2.3%	-47	-33%	0	0%	CS	CS
Poland	169	434	471	11.2%	302	178%	37	8%	T1	D
Portugal	84	167	159	3.8%	75	90%	-8	-5%	T3	OTH
Romania	150	59	58	1.4%	-92	-61%	-1	-1%	T2	CS,D
Slovakia	8	12	15	0.4%	7	88%	3	24%	T3	PS
Slovenia	3	10	11	0.3%	8	232%	1	7%	T3	D
Spain	374	473	471	11.2%	96	26%	-2	0%	T3	CS,D,PS
Sweden	54	18	16	0.4%	-38	-71%	-2	-11%	T3	CS,D
United Kingdom	406	351	361	8.6%	-45	-11%	10	3%	T3	CS
EU-28	**4 262**	**4 222**	**4 215**	**100%**	**-48**	**-1%**	**-7**	**0%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	406	351	361	8.6%	-45	-11%	10	3%	T3	CS
EU-28 + ISL	**4 262**	**4 222**	**4 215**	**100%**	**-48**	**-1%**	**-7**	**0%**	**-**	**-**

Presented methods and emission factor information refer to the last inventory year. Abbreviations explained in the Chapter 'Units and abbreviations'.

Table 4.9 shows information on the methods applied, activity data, and the emissions factors for CO_2 emissions from 2A3 Glass production for 1990 to 2016. The use of plant-specific data reported and verified under the EU ETS by Member States can be largely considered as equivalent to a Tier 2 or Tier 3 method. It is problematic to calculate a specific share of EU emissions calculated with higher tier methods notwithstanding that each country's estimates may be composed of several sources with independent estimation methods, using partly higher tiers, partly default methods. Even so at least 89% of emissions from this category are calculated using higher Tier methods.

The table below shows activity data as production (glass) or inputs (carbonate use). Gap-filled values were calculated for EU glass production and the EU IEF.

Table 4.9 2A3 Glass production: Information on methods applied, activity data, emission factors for CO_2 emissions

Member State	1990				2016				Method	Emission Factor Informa-tion
	Activity Data		Implied Emission Factor (t/t)	CO2 Emission (kt)	Activity Data		Implied Emission Factor (t/t)	CO2 Emission (kt)		
	Description	(kt)			Description	(kt)				
Austria	Glass Production	399	0.10	39	Glass Production	481	0.08	38	T3	PS
Belgium	Glass Production	1 993	0.13	266	Glass Production	1 595	0.11	170	T3	CS,PS
Bulgaria	-	818	0.17	138	-	632	0.13	84	T3	CS
Croatia	Glass Production	275	0.13	36	Glass Production	259	0.13	33	T3	CS
Cyprus	-	NO	NO	NO	-	NO	NO	NO	NA	NA
Czech Republic	Glass Production	1 237	0.12	143	Glass Production	1 295	0.11	138	T3	PS
Denmark	Glass Production	200	0.08	16	Glass Production	203	0.04	9	T3	PS
Estonia	Glass Production	12	0.10	1	Glass Production	82	0.11	9	T3	PS
Finland	Used Carbonates	48	0.44	21	Used Carbonates	5	0.40	2	T3	CS
France	Glass Production	4 307	0.19	797	Glass Production	2 792	0.18	494	T2,T3	CS,PS
Germany	Glass Production	6 562	0.12	780	Glass Production	7 471	0.12	923	T2	CS
Greece	Glass Production	135	0.15	20	Glass Production	104	0.16	17	CS	CS
Hungary	Glass Production	418	0.20	82	Glass Production	401	0.14	56	T3	CS,PS
Ireland	Carbonate Use	64	0.21	13	Carbonate Use	NO	NO	NO	NA	NA
Italy	Glass Production	3 779	0.12	453	Glass Production	5 347	0.10	512	T2	CS,PS
Latvia	Glass Production	44	0.01	0	Glass Production	C	C	0	T3	D,PS
Lithuania	Glass Production	66	0.18	12	Glass Production	45	0.15	7	T2	D
Luxembourg	Glass Production	377	0.14	54	Glass Production	430	0.15	65	CS	PS
Malta	-	NO	NO	NO	-	NO	NO	NO	NA	NA
Netherlands	-	1 095	0.13	142	-	1 437	0.07	96	CS	CS
Poland	Glass Production	1 058	0.16	169	Glass Production	2 944	0.16	471	T1	D
Portugal	-	615	0.14	84	-	1 712	0.09	159	T3	OTH
Romania	Glass Production	926	0.16	150	Glass Production	411	0.14	58	T2	CS,D
Slovakia	Used Carbonates	18	0.44	8	Used Carbonates	35	0.42	15	T3	PS
Slovenia	Glass Production	25	0.13	3	Glass Production	83	0.13	11	T3	D
Spain	Glass Production	2 866	0.13	374	Glass Production	4 445	0.11	471	T3	CS,D,PS
Sweden	-	NE	NE	54	-	NE	NE	16	T3	CS,D
United Kingdom	Glass Production	1 942	0.21	406	Glass Production	2 091	0.17	361	T3	CS
EU-28	**-**	**NE**	**NE**	**4 262**	**Glass Production**	**33 769**	**0.12**	**4 215**	**-**	**-**
Iceland	-	NO	NO	NO	-	NO	NO	NO	NA	NA
United Kingdom (KP)	Glass Production	1 942	0.21	406	Glass Production	2 091	0.17	361	T3	CS
EU-28+ISL	**-**	**NE**	**NE**	**4 262**	**Glass Production**	**33 769**	**0.12**	**4 215**	**-**	**-**

Presented methods and emission factor information refer to the last inventory year. Abbreviations explained in the chapter 'Units and abbreviations'.

Not all countries show production as the activity data for this emissions category. Gap-filled values were calculated for EU glass production and the EU IEF.

4.2.1.4 2A4 Other process uses of carbonates

CO_2 emissions from 2A4 Other process uses of carbonates contributed only 0.2% of total EU 28+ISL (without LULUCF) emissions in 2016. Emissions from this sector in 2016 were 16% lower than 1990 levels. It is not necessarily useful to compare specific shares of emissions due to the fact that each country's estimates are mostly composed by several sources with independent estimation methods, using partly higher tiers, partly default methods.

Table 4.10 2A4 Other process uses of carbonates: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016		Method	Emission factor Informa-tion
	1990	2015	2016		kt CO2	%	kt CO2	%		
Austria	624	420	439	4.2%	-185	-30%	19	5%	T1,T3	D,PS
Belgium	136	202	182	1.8%	47	34%	-19	-10%	T3	CS,PS
Bulgaria	607	996	951	9.2%	344	57%	-45	-5%	T1,T2	D,PS
Croatia	6	40	36	0.3%	30	517%	-4	-11%	T2	D
Cyprus	44	9	11	0.1%	-33	-76%	2	25%	CS,T1	CS,D
Czech Republic	114	254	341	3.3%	227	199%	86	34%	T1,T3	D,PS
Denmark	77	61	71	0.7%	-7	-9%	10	16%	CS,T2,T3	CS,D
Estonia	0	8	3	0.0%	3	934%	-5	-62%	T1,T2,T3	D,PS
Finland	63	140	139	1.3%	76	120%	-1	-1%	T1,T3	CS,D
France	488	374	373	3.6%	-115	-24%	-1	0%	T1,T2,T3	CS,D,PS
Germany	1 458	1 043	1 088	10.5%	-369	-25%	45	4%	T1,T2	CS,D
Greece	590	310	309	3.0%	-281	-48%	-1	0%	CS,T1	CS,D
Hungary	449	261	276	2.7%	-173	-39%	15	6%	T2,T3	CS,D,PS
Ireland	5	1	1	0.0%	-4	-82%	0	-2%	T3	PS
Italy	2 544	830	753	7.3%	-1 790	-70%	-77	-9%	T2	CS,PS
Latvia	69	8	9	0.1%	-60	-86%	1	13%	T1,T2	D,PS
Lithuania	240	15	18	0.2%	-222	-93%	3	21%	T1,T2	CS,D,PS
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	0	0	0	0.0%	0	-70%	0	119%	T1	D
Netherlands	690	980	1 001	9.7%	311	45%	20	2%	CS,T1	D
Poland	771	1 817	1 945	18.8%	1 173	152%	128	7%	T1,T2	CS,D
Portugal	226	355	337	3.3%	111	49%	-18	-5%	T1,T3	OTH
Romania	38	288	327	3.2%	289	755%	40	14%	OTH,T2,T3	D,PS
Slovakia	447	297	306	3.0%	-141	-31%	9	3%	T3	PS
Slovenia	20	16	17	0.2%	-4	-18%	1	8%	T2	D
Spain	1 358	1 074	993	9.6%	-365	-27%	-81	-8%	T1,T2,T3	CS,D,PS
Sweden	16	20	15	0.1%	-1	-7%	-5	-25%	T3	D
United Kingdom	641	606	391	3.8%	-250	-39%	-215	-35%	T3	CS
EU-28	**11 720**	**10 424**	**10 331**	**100%**	**-1 390**	**-12%**	**-93**	**-1%**	**-**	**-**
Iceland	1	1	1	0.0%	0	11%	0	8%	T3	PS
United Kingdom (KP)	641	606	391	3.8%	-250	-39%	-215	-35%	T3	CS
EU-28 + ISL	**11 721**	**10 425**	**10 332**	**100%**	**-1 390**	**-12%**	**-93**	**-1%**	**-**	**-**

Presented methods and emission factor information refer to the last inventory year. Abbreviations explained in the Chapter 'Units and abbreviations'.

4.2.2 Chemical industry (CRF Source Category 2B)

The key categories in the chemical industry include:

Table 4.11: Key source categories for level and trend analyses and share of MS emissions using higher tier methods for sector 2B (Table excerpt)

Source category gas	kt CO_2 equ.		Trend	Level		share of higher Tier
	1990	2016		1990	2016	
2.B.1 Ammonia Production (CO_2)	33361	23935	0	L	L	92%
2.B.2 Nitric Acid Production (N_2O)	49572	3953	T	L	0	100%
2.B.3 Adipic Acid Production (N_2O)	57555	331	T	L	0	100%

Source category gas	kt CO_2 equ.		Trend	Level		share of higher Tier
	1990	2016		1990	2016	
2.B.8 Petrochemical and Carbon Black Production (CO_2)	14953	14946	T	L	L	88%
2.B.9 Fluorochemical Production (HFCs)	29034	475	T	L	0	
2.B.9 Fluorochemical Production (Unspecified mix of HFCs and PFCs)	5567	62	T	0	0	
2.B.10 Other chemical industry (CO_2)	5913	9956	T	0	L	92%

The key category 2B1 Ammonia production accounts for the CO_2 emissions that occur during the production of ammonia, which is used in both its pure form and as a feedstock for the production of a wide variety of other chemicals. The key category 2B2 Nitric acid production accounts for N_2O that is emitted as a by-product of the high temperature catalytic oxidation of ammonia (NH_3) in the production of nitric acid. The key category 2B3 Adipic acid production accounts for the N_2O emitted as a by-product when a cyclohexanone/cyclohexanol mixture is oxidized by nitric acid. The key category Petrochemical and Carbon Black Production (2B8) includes the CO_2 emissions associated with a wide range of petrochemicals including methanol and ethylene and carbon black manufacture.

Figure 4.8 shows chemical industry CO_2 emissions while Table 4.12 presents a summary of emissions as CO_2, N_2O, CH_4 and total emissions as CO_2 equivalents. Ammonia production accounts for more than half of the chemical industry's CO_2 emissions.

Figure 4.8 2B Chemical industry CO_2 emissions

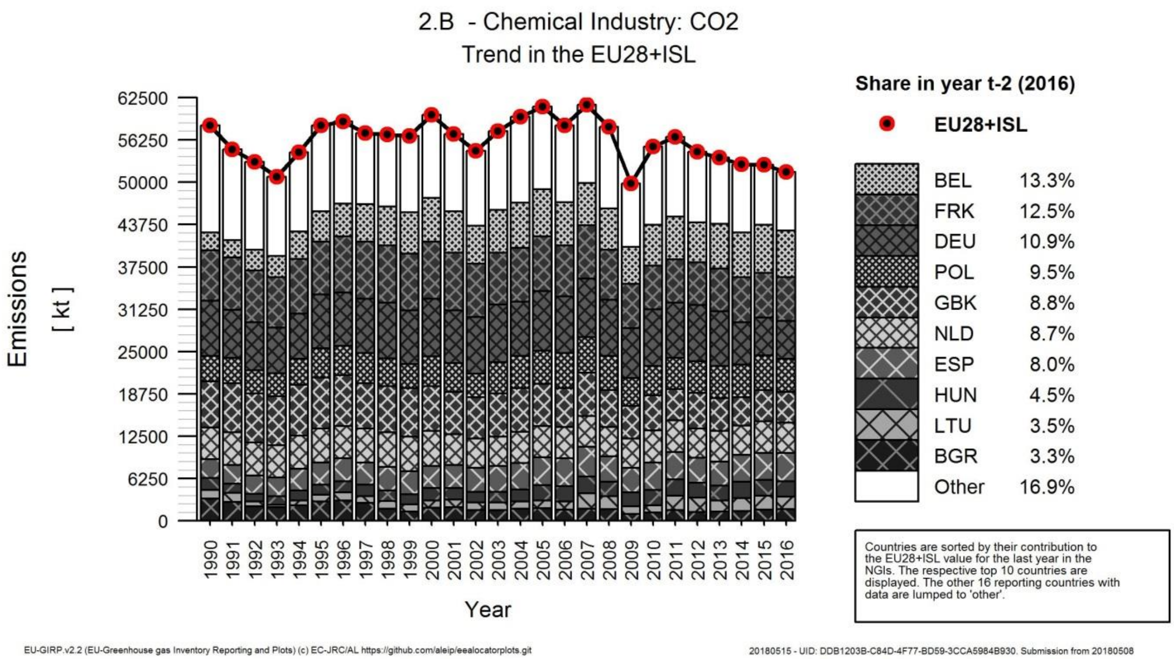


Table 4.12 shows chemical industry CO_2, CH_4, N_2O and total GHG emissions (which includes F-gases) as CO_2e. Between 1990 and 2016 GHG emissions from the chemical industry sector have decreased markedly largely due to the significant reduction in N_2O emissions which fell by 94%. The greatest absolute decreases in N_2O emissions were in UK, France and Germany.

Table 4.12 2B Chemical industry: EU-28+ISL CO_2, N_2O, CH_4 and total emissions as CO_2 equivalents

Member State	GHG emissions in 1990 (kt CO2 equivalents)	GHG emissions in 2016 (kt CO2 equivalents)	CO2 emissions in 1990 (kt)	CO2 emissions in 2016 (kt)	N2O emissions in 1990 (kt CO2 equivalents)	N2O emissions in 2016 (kt CO2 equivalents)	CH4 emissions in 1990 (kt CO2 equivalents)	CH4 emissions in 2016 (kt CO2 equivalents)
Austria	1 555	805	643	722	877	36	35	47
Belgium	10 076	8 514	2 590	6 861	3 807	1 001	0	6
Bulgaria	4 943	1 838	3 283	1 724	1 647	113	13	NO,NA
Croatia	1 538	658	778	548	754	110	6	0
Cyprus	NO	NO	NO	NO	NO	NO	NO	NO
Czech Republic	2 944	1 527	1 783	1 222	1 125	283	36	22
Denmark	1 003	1	1	1	1 003	NO,NA	NO,NA	NO,NA
Estonia	308	NO	308	NO	NO	NO	NO	NO
Finland	1 862	1 271	270	1 053	1 592	218	NO,NA	NO,NA
France	36 909	7 670	7 479	6 443	23 654	892	81	44
Germany	35 459	6 932	8 109	5 617	21 335	670	334	496
Greece	2 931	477	681	462	1 066	15	1	NO,NA
Hungary	4 867	2 388	1 759	2 321	3 090	27	18	40
Ireland	1 986	NO	990	NO	995	NO	NO	NO
Italy	10 546	3 078	2 577	1 463	6 418	116	61	4
Latvia	NA,NO	NA,NO	NO	NO	NO	NO	NO	NO
Lithuania	2 176	2 037	1 278	1 828	893	210	5	NO
Luxembourg	NO	NO	NO	NO	NO	NO	NO	NO
Malta	0	0	0	0	NO,NA	NO,NA	NO,NA	NO,NA
Netherlands	17 524	6 160	4 713	4 478	6 825	1 025	380	434
Poland	7 378	5 779	3 802	4 903	3 536	839	40	37
Portugal	1 735	723	1 211	672	498	25	26	27
Romania	9 748	1 365	5 563	1 015	4 135	342	50	8
Slovakia	2 020	1 471	878	1 348	1 142	122	0	1
Slovenia	70	49	66	49	NO	NO	4	NO,NA
Spain	8 774	4 727	2 773	4 125	2 829	436	131	166
Sweden	915	206	111	147	803	58	1	1
United Kingdom	45 183	4 801	6 768	4 523	23 797	27	214	73
EU-28	**212 450**	**62 477**	**58 416**	**51 526**	**111 820**	**6 564**	**1 436**	**1 404**
Iceland	47	NO	0	NO	46	NO	NO,NA	NO
United Kingdom (KP)	45 183	4 801	6 768	4 523	23 797	27	214	73
EU-28 + ISL	**212 497**	**62 477**	**58 416**	**51 526**	**111 867**	**6 564**	**1 436**	**1 404**

Presented methods and emission factor information refer to the last inventory year. Abbreviations explained in the Chapter 'Units and abbreviations'. Note that emissions from F-gases are included in the total.

Table 4.13 lists information on recalculations in 2B Chemical industry for 1990 and 2015 showing explanations for large recalculations.

Table 4.13 2B Chemical Industry: Contribution of MS to EU recalculated emissions for 1990 and 2015 (difference between latest submission and previous submission in kt of CO_2 equivalents and percent)

	1990		2015		Main explanations
	kt CO_2e	%	kt CO_2e	%	
Austria	-	-	-2	-0.3	2.B.1 Ammonia Production Due to updated data of urea used, from 2005–2015, the time series for CO_2 emissions in sector 2.B.1 also changed by +5.2 kt CO_2e in 2015. 2. B.10.2 Other Chemical Industry Due to a transcription error emissions for 2015 changed by -7.1 kt CO_2e.
Belgium	-	-	99	1.4	Re-allocation emissions from 1A2c to 2B10 in Flemish region
Bulgaria	-	-	-	-	
Croatia	7	0.9	35	6.6	Technical correction
Cyprus	-	-	-	-	
Czech Republic	-	-	0	0.0	Updated activity data
Denmark	-0	-33.2	-0	-3.6	2B10 Catalyst production 1990-1995 estimated using linear regression instead of the constant average 1997-2012. This results in decreases between 0.1-0.3 Gg CO_2. Change in methodology from 2015 results in small decrease in 2015.
Estonia	-	-	-	-	

	1990		2015		Main explanations
	kt CO_2e	%	kt CO_2e	%	
Finland	-0	-0.0	-4	-0.5	Preliminary activity data corrected.
France	116	1.6	80	1.2	2B1: correction of consumption and emissions data for a site 2B10: Addition of N_2O emissions at a HSO4NO production site
Germany	-	-	-0	-0.0	
Greece	-	-	-	-	
Hungary	-	-	-	-	
Ireland	-	-	-	-	
Italy	-	-	-0	-0.0	Minor recalculation occurred for the production of HCFC22 because of the updating of data communicated: as a consequence, the IEF has changed.
Latvia	-	-	-	-	
Lithuania	-	-	25	1.2	Recalculation in urea use in Agriculture sector.
Luxembourg	-	-	-	-	
Malta	-	-	-	-	
Netherlands	-	-	-3	-0.1	The recalculation in this source category is due to final improved activity data.
Poland	-	-	-	-	
Portugal	10	0.8	14	2.2	We start to estimate Titanium Dioxide related emissions.
Romania	1 355	32.2	247	31.9	Recalculation have been made for the entire period 1989-2015 due to an improvement in the activity data used in the CO_2 emissions estimates from category 2.B.1 Ammonia Production. CO_2 emissions are calculated based on natural gas consumption (energy and non-energy use). From CO_2 emissions from ammonia production are subtracted, in addition to the CO_2 emissions resulting from the use of urea as a fertilizer, which are included in the Agriculture sector in H and the annual amount of CO_2 used for the production of urea exported. (CRF category 2B.1)
Slovakia	-	-	-	-	
Slovenia	-	-	-	-	
Spain	-	-	827	25.9	2B10 New estimates added for Spain: hydrogen production plants outside refineries, 2B7 Small CO_2 recalculations due to error correction
Sweden	-15	-11.6	-3	-1.6	Results of allocation project and corrected data.
United Kingdom	3	0.0	11	0.2	Review of operator data from EUETS resulting in revised activity data for natural gas use in ammonia production; titanium dioxide - correction to the CEF for pet coke
EU28	1 475	2.6	1 328	2.6	
Iceland	-	-	-	-	
United Kingdom (KP)	3	0.0	11	0.2	Review of operator data from EUETS resulting in revised activity data for natural gas use in ammonia production; titanium dioxide - correction to the CEF for pet coke
EU28+ISL	1 475	2.6	1 328	2.6	

(*) contribution of the recalculation as percentage of the total emissions of category 2B for the respective year and MS

4.2.2.1 2B1 Ammonia production

In most instances, anhydrous ammonia is produced by catalytic steam reforming of natural gas (CH_4) or fuel oil. At plants using this process CO_2 is primarily released during regeneration of the CO_2 scrubbing solution, with additional but relatively minor emissions resulting from condensate stripping.

CO_2 emissions from ammonia production contributed 0.6 % of total EU-28+ISL emissions in 2016. Emissions decreased by 2% in 2016 and by 28% since 1990.

Figure 4.9 2B1 Ammonia production: CO_2 emissions

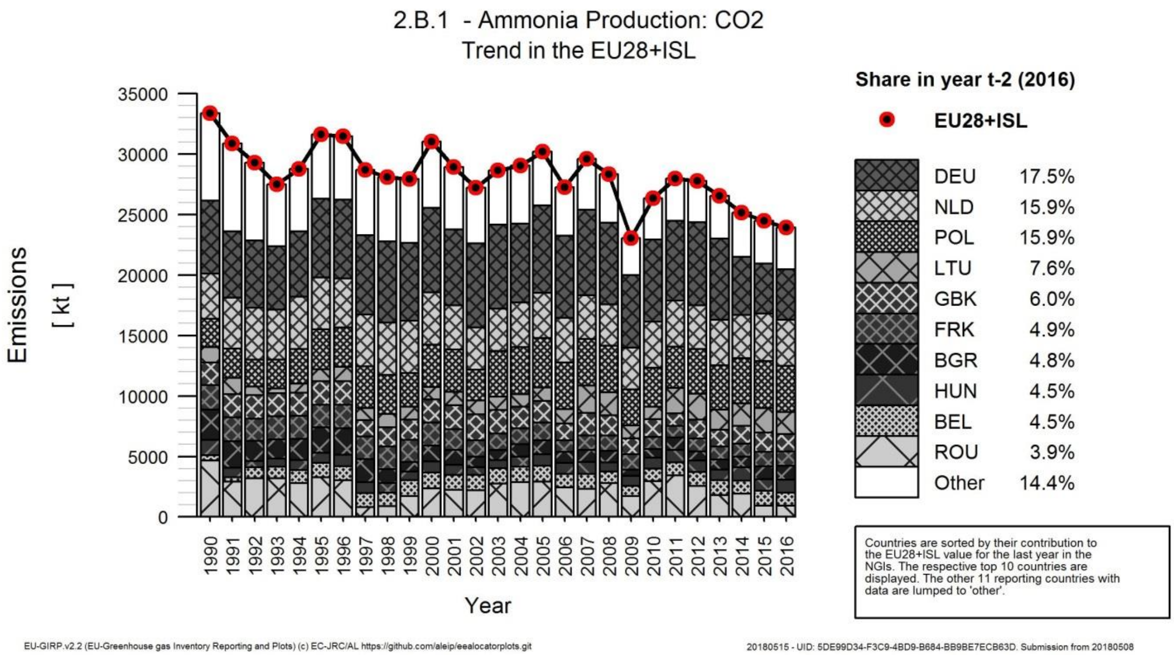


Figure 4.9 and Table 4.15 show that in 2016 Germany was responsible for 17.5% of this category's emissions. The next largest contributors, Poland and Netherlands both contribute 16%. Bulgaria, Germany, Romania, Italy and Ireland have all had large reductions in absolute terms since 1990. The reasons for these reductions include shifting to low emitting technology and production decreases and the cessation of production in Ireland. The largest growth in emissions between 1990 and 2016 were in Poland, Belgium, Lithuania and Slovakia.

In line with the IPCC guidelines all emissions (energy and non-energy use of feedstocks/fuels) from ammonia production should be reported in 2B1. While the EU Member States are largely consistent with this approach there are some exceptions. To improve transparency on how the Member States allocate emissions between the Energy and IPPU sector, the following points provide information on the approach taken by the six Member States with largest ammonia production emissions. Two of the six do make a split between energy and IPPU for ammonia production emissions.

- Germany (17.5% of 2B1), does make a split between energy and IPPU – this is in order to be fully consistent with the German energy balance and because the quality of the energy statistics has improved.
- Netherlands (15.9% of 2B1), uses natural gas as feedstock and includes all emissions under 2B1.
- Poland (15.9% of 2B1), CO_2 emissions are estimated on the data on natural gas use in this process.
- Lithuania (7.6% of 2B1), uses natural gas as feedstock and includes all emissions under 2B1.
- United Kingdom (6.0% of 2B1), emissions from both feedstock and fuel use of natural gas are both reported under 2B1, in line with the requirements of the 2006 Guidelines.
- France (4.9% of 2B1), does make a split between energy and IPPU and has stated that the split between energy use and non-energy use data in the energy balance is not reliable and therefore uses the overall energy consumption from energy balance and applies its own split. Only CO_2 emissions from non-energy consumption of natural gas are included in 2B1. Emissions linked to the consumption of natural gas for energy purposes are reported in energy section 1A2.

Table 4.14 2B1 Ammonia production: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016		Method	Emission factor Informa-tion
	1990	2015	2016		kt CO2	%	kt CO2	%		
Austria	467	510	527	2.2%	60	13%	18	3%	T2	PS
Belgium	423	1 213	1 066	4.5%	643	152%	-147	-12%	T3	D,PS
Bulgaria	2 508	1 085	1 138	4.8%	-1 370	-55%	53	5%	T2	PS
Croatia	559	572	548	2.3%	-11	-2%	-24	-4%	T3	PS
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czech Republic	991	742	686	2.9%	-305	-31%	-56	-8%	T1	CS
Denmark	NO	NO	NO	-	-	-	-	-	NA	NA
Estonia	308	NO	NO	-	-308	-100%	-	-	NA	NA
Finland	93	NO	NO	-	-93	-100%	-	-	NA	NA
France	2 019	1 153	1 183	4.9%	-836	-41%	30	3%	T1,T2,T3	CS,D,PS
Germany	6 025	4 135	4 182	17.5%	-1 843	-31%	47	1%	T3	PS
Greece	652	241	152	0.6%	-500	-77%	-89	-37%	T1a	CS
Hungary	1 255	960	1 078	4.5%	-177	-14%	118	12%	T3	D
Ireland	990	NO	NO	-	-990	-100%	-	-	NA	NA
Italy	1 892	496	643	2.7%	-1 249	-66%	147	30%	T2	PS
Latvia	NO	NO	NO	-	-	-	-	-	NA	NA
Lithuania	1 254	2 044	1 828	7.6%	574	46%	-217	-11%	T3	CS
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	3 730	3 921	3 815	15.9%	85	2%	-106	-3%	T3	CS
Poland	2 344	3 870	3 814	15.9%	1 469	63%	-57	-1%	T2	CS
Portugal	540	NO	NO	-	-540	-100%	-	-	NA	NA
Romania	4 678	946	937	3.9%	-3 741	-80%	-9	-1%	T3	PS
Slovakia	332	639	564	2.4%	232	70%	-75	-12%	T3	PS
Slovenia	NO	NO	NO	-	-	-	-	-	NA	NA
Spain	408	348	333	1.4%	-75	-18%	-14	-4%	T3	PS
Sweden	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom	1 895	1 602	1 442	6.0%	-453	-24%	-160	-10%	T3	CS
EU-28	**33 361**	**24 477**	**23 935**	**100%**	**-9 427**	**-28%**	**-542**	**-2%**	**-**	**-**
Iceland	NA	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	1 895	1 602	1 442	6.0%	-453	-24%	-160	-10%	T3	CS
EU-28 + ISL	**33 361**	**24 477**	**23 935**	**100%**	**-9 427**	**-28%**	**-542**	**-2%**	**-**	**-**

The method and emission factor information shown here only refers to the last inventory year.
Abbreviations explained in the Chapter 'Units and abbreviations'.

Table 4.15 shows information on methods applied, activity data, emission factors for CO_2 emissions from 2B1 Ammonia production for 1990 to 2016. Not all countries show ammonia production as activity data for this emissions category so gap-filled values for EU ammonia production and the EU IEF was calculated. In 2016 of the seventeen countries which report ammonia production emissions all but one are estimated with higher Tier methods (country or plant specific emission factors and/or Tier 2 or Tier 3), which accounts for 97% of emissions in this category.

Table 4.15 2B1 Ammonia production: Information on methods applied, activity data, emission factors for CO_2 emissions

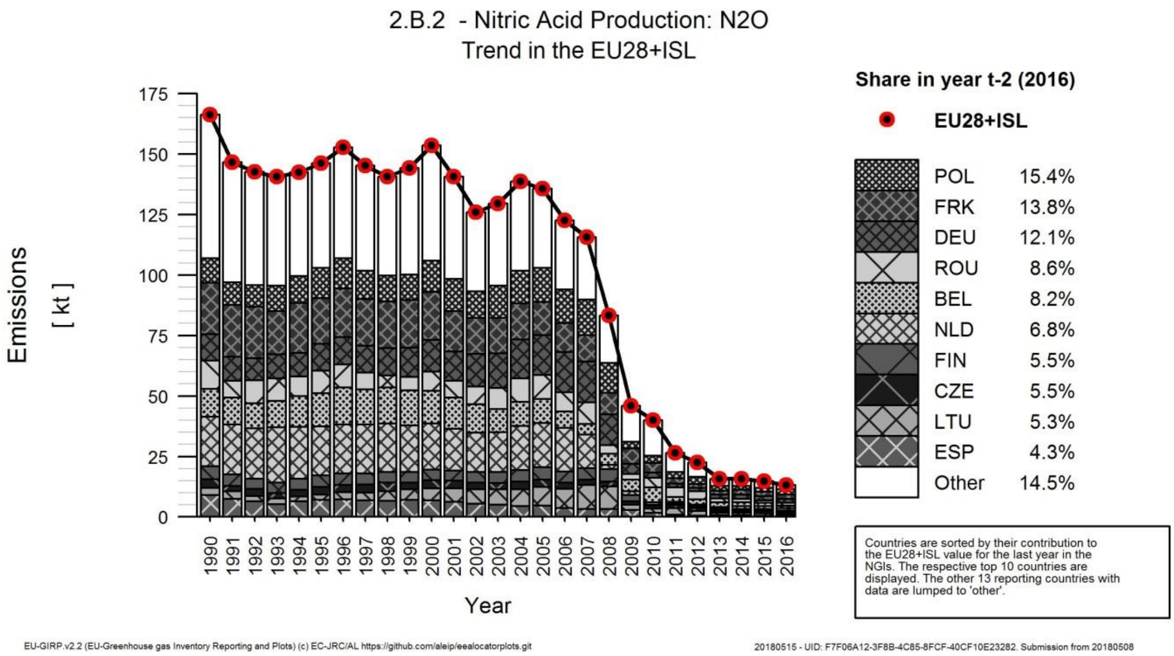
Member State	1990				2016				Method	Emission Factor Informa-tion
	Activity Data		Implied Emission Factorn (t/t)	CO2 Emission (kt)	Activity Data		Implied Emission Factor (t/t)	CO2 Emission (kt)		
	Description	(kt)			Description	(kt)				
Austria	Ammonia Production	461	1.01	467	Ammonia Production	551	0.96	527	T2	PS
Belgium	Ammonia Production	360	1.17	423	Ammonia Production	911	1.17	1 066	T3	D,PS
Bulgaria	-	C	C	2 508	-	C	-	1 138	T2	PS
Croatia	Ammonia Production	345	2.24	559	Ammonia Production	420	2.02	548	T3	PS
Cyprus	-	NO	NO	NO	-	NO	NO	NO	NA	NA
Czech Republic	Ammonia Production	336	3.27	991	Ammonia Production	210	3.27	686	T1	CS
Denmark	-	NO	NO	NO	-	NO	NO	NO	NA	NA
Estonia	Ammonia Production	294	1.44	308	Ammonia Production	NO	NO	NO	NA	NA
Finland	Ammonia Production	28	3.27	93	Ammonia Production	NO	NO	NO	NA	NA
France	Ammonia Production	1 928	1.05	2 019	Ammonia Production	1 105	1.07	1 183	T1,T2,T3	CS,D,PS
Germany	Ammonia Production	2 705	2.41	6 025	Ammonia Production	2 954	1.80	4 182	T3	PS
Greece	Ammonia Production	313	2.08	652	Ammonia Production	91	1.66	152	T1a	CS
Hungary	Natural Gas Consumption	25 334	0.06	1 255	Natural Gas Consumption	20 135	0.06	1 078	T3	D
Ireland	Natural Gas Feedstocks	430	2.30	990	Natural Gas Feedstocks	NO	NO	NO	NA	NA
Italy	Ammonia Production	1 455	1.94	1 892	Ammonia Production	564	1.85	643	T2	PS
Latvia	Ammonia Production	NO	NO	NO	Ammonia Production	NO	NO	NO	NA	NA
Lithuania	Ammonia Production	568	2.27	1 254	Ammonia Production	915	2.14	1 828	T3	CS
Luxembourg	Ammonia Production	NO	NO	NO	Ammonia Production	NO	NO	NO	NA	NA
Malta	-	NO	NO	NO	-	NO	NO	NO	NA	NA
Netherlands	-	C	C	3 730	-	C	C	3 815	T3	CS
Poland	Ammonia Production	1 532	1.53	2 344	Ammonia Production	2 626	1.45	3 814	T2	CS
Portugal	-	C	C	540	-	C	NO	NO	NA	NA
Romania	Natural Gas Consumption	2 101	2.23	4 678	Natural Gas Consumption	459	2.04	937	T3	PS
Slovakia	Ammonia Production	360	1.71	332	Ammonia Production	404	1.95	564	T3	PS
Slovenia	-	NO	NO	NO	-	NO	NO	NO	NA	NA
Spain	Ammonia Production	573	1.24	408	Ammonia Production	496	1.24	333	T3	PS
Sweden	-	NO	NO	NO	-	NO	NO	NO	NA	NA
United Kingdom	Ammonia Production	1 328	1.43	1 895	Ammonia Production	959	1.50	1 442	T3	CS
EU-28	**-**	**NE**	**NE**	**33 361**	**Ammonia Production**	**17 216**	**1.39**	**23 935**	**-**	**-**
Iceland	-	IE	NA,NO	NA	-	NO	NO	NO	NA	NA
United Kingdom (KP)	Ammonia Production	1 328	1.43	1 895	Ammonia Production	959	1.50	1 442	T3	CS
EU-28+ISL	**-**	**NE**	**NE**	**33 361**	**Ammonia Production**	**17 216**	**1.39**	**23 935**	**-**	**-**

Presented methods and emission factor information refer to the last inventory year. Abbreviations explained in the Chapter 'Units and abbreviations'. Not all countries show production as the activity data for this emissions category. Gap-filled values were calculated for EU ammonia production and the EU IEF for 2016.

4.2.2.2 2B2 Nitric acid production

N_2O can be emitted in the production of nitric acid as a by-product of the high temperature catalytic oxidation of ammonia (NH_3). Emissions have decreased by 11% in 2016 and by 92% since 1990. All countries have had marked reductions from this source notably post 2007 when pollution control measures were introduced. N_2O emissions from nitric acid production contributed less than 0.1% of total EU 28+ISL (without LULUCF) emissions in 2016. (Figure **4.10** and Table 4.16). The Netherlands and France had the greatest reductions in absolute terms, due to the implementation of technical measures at all Dutch nitric acid plants and due to the improvement of the process and catalyst efficiency in France. Production stopped in Denmark (middle of 2004) and ceased in Ireland in 2002 due to the insolvency of Irish Fertiliser Industries.

Figure 4.10 2B2 Nitric acid production N_2O emissions



The substantial decrease in N_2O emissions seen since 2007 is largely due to technical measures that have been implemented at all nitric acid plants. Special catalysts and improvement of the process efficiency led to a continuation of the trend in emissions. This trend of declining N_2O emissions has slowed in recent years with emissions decreasing by -11% between 2015 and 2016. Twenty countries reported these emissions in 2016, 5 of which reported small emission increases in this period.

Table 4.16 2B2 Nitric acid production: Member States' contributions to N_2O emissions

Member State	N2O Emissions in kt CO2 equiv.			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016		Method	Emission factor Informa-tion
	1990	2015	2016		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	877	47	36	0.9%	-841	-96%	-11	-24%	T3	PS
Belgium	3 440	375	326	8.2%	-3 114	-91%	-49	-13%	T3	PS
Bulgaria	1 647	126	113	2.9%	-1 534	-93%	-12	-10%	T3	PS
Croatia	754	311	109	2.8%	-645	-86%	-202	-65%	T2	PS
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czech Republic	1 050	280	216	5.5%	-834	-79%	-64	-23%	T3	PS
Denmark	1 003	NO	NO	-	-1 003	-100%	-	-	NA	NA
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	1 592	259	218	5.5%	-1 373	-86%	-40	-16%	T3	PS
France	6 316	523	544	13.8%	-5 772	-91%	21	4%	T2,T3	CS,D,PS
Germany	3 258	504	477	12.1%	-2 781	-85%	-26	-5%	T3	PS
Greece	1 066	20	15	0.4%	-1 051	-99%	-5	-24%	CS	CS
Hungary	3 090	50	27	0.7%	-3 063	-99%	-23	-46%	T3	PS
Ireland	995	NO	NO	-	-995	-100%	-	-	NA	NA
Italy	2 005	36	50	1.3%	-1 955	-98%	14	41%	T2	D,PS
Latvia	NO	NO	NO	-	-	-	-	-	NA	NA
Lithuania	893	258	210	5.3%	-683	-77%	-48	-19%	T3	PS
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	6 085	370	270	6.8%	-5 815	-96%	-101	-27%	T2	PS
Poland	3 041	517	607	15.4%	-2 434	-80%	90	18%	T2	CS
Portugal	498	38	25	0.6%	-473	-95%	-13	-35%	D	PS
Romania	3 473	336	342	8.6%	-3 132	-90%	6	2%	T2,T3	D,PS
Slovakia	1 142	140	121	3.1%	-1 020	-89%	-18	-13%	T3	PS
Slovenia	NO	NO	NO	-	-	-	-	-	NA	NA
Spain	2 704	171	170	4.3%	-2 534	-94%	-1	0%	T3	PS
Sweden	782	36	52	1.3%	-731	-93%	16	43%	T2	PS
United Kingdom	3 860	29	25	0.6%	-3 836	-99%	-4	-15%	T3	CS
EU-28	**49 572**	**4 425**	**3 953**	**100%**	**-45 619**	**-92%**	**-472**	**-11%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	3 860	29	25	0.6%	-3 836	-99%	-4	-15%	T3	CS
EU-28 + ISL	**49 572**	**4 425**	**3 953**	**100%**	**-45 619**	**-92%**	**-472**	**-11%**	**-**	**-**

Presented methods and emission factor information refer to the last inventory year. Abbreviations explained in the Chapter 'Units and abbreviations'.

Table 4.17 shows information on methods applied, activity data, emission factors for N_2O emissions from 2B2 Nitric acid production for 1990 to 2016. The table shows that while most countries report nitric acid production as activity data; for some? countries this information is confidential. The IEFs are shown as kg N_2O per tonne of production as recommended by the ERT. A gap filled EU IEF has not been calculated because the standard deviation divided by mean is less than 50%. The low IEFs are mainly due to the implementation of improved abatement technologies in the different MS and the closure of some older plants. The table also shows that all emissions are estimated with higher tier methods (country or plant specific emission factors and/or Tier 2 or Tier 3).

Table 4.17 2B2 Nitric acid production: Information on methods applied, activity data, emission factors for N_2O emissions

Member State	1990				2016				Method	Emission Factor Informa-tion
	Activity Data		Implied Emission Factor (kg/t)	N2O Emissions (kt CO2 equiv.)	Activity Data		Implied Emission Factor (kg/t)	N2O Emissions (kt CO2 equiv.)		
	Description	(kt)			Description	(kt)				
Austria	Nitric Acid Production	530	5.6	877	Nitric Acid Production	568	0.2	36	T3	PS
Belgium	Nitric Acid Production	1436	8.0	3440	Nitric Acid Production	1965	0.6	326	T3	PS
Bulgaria	-	C	C	1647	-	C	-	113	T3	PS
Croatia	Nitric Acid Production	332	7.6	754	Nitric Acid Production	293	1.3	109	T2	PS
Cyprus	-	NO	NO	NO	-	NO	NO	NO	NA	NA
Czech Republic	Nitric Acid Production	530	6.6	1050	Nitric Acid Production	563	1.3	216	T3	PS
Denmark	-	450	7.5	1003	-	NO	NO	NO	NA	NA
Estonia	Nitric Acid Production	NO	NO	NO	Nitric Acid Production	NO	NO	NO	NA	NA
Finland	Nitric Acid Production	549	9.7	1592	Nitric Acid Production	596	1.2	218	T3	PS
France	Nitric Acid Production	3200	6.6	6316	Nitric Acid Production	1986	0.9	544	T2,T3	CS,D,PS
Germany	Nitric Acid Production	1698	6.4	3258	Nitric Acid Production	2541	0.6	477	T3	PS
Greece	Nitric Acid Production	511	7.0	1066	Nitric Acid Production	116	0.4	15	CS	CS
Hungary	Nitric Acid Production	732	14.2	3090	Nitric Acid Production	718	0.1	27	T3	PS
Ireland	Nitric Acid Production	339	9.9	995	Nitric Acid Production	NO	NO	NO	NA	NA
Italy	Nitric Acid Production	1037	6.5	2005	Nitric Acid Production	426	0.4	50	T2	D,PS
Latvia	Nitric Acid Production	NO	NO	NO	Nitric Acid Production	NO	NO	NO	NA	NA
Lithuania	Nitric Acid Production	355	8.4	893	Nitric Acid Production	1081	0.7	210	T3	PS
Luxembourg	Nitric Acid Production	NO	NO	NO	Nitric Acid Production	NO	NO	NO	NA	NA
Malta	-	NO	NO	NO	-	NO	NO	NO	NA	NA
Netherlands	-	C	C	6085	-	C	C	270	T2	PS
Poland	Nitric Acid Production	1577	6.5	3041	Nitric Acid Production	2340	0.9	607	T2	CS
Portugal	-	C	C	498	-	C	C	25	D	PS
Romania	Nitric Acid Production	1261	9.2	3473	Nitric Acid Production	668	1.7	342	T2,T3	D,PS
Slovakia	Nitric Acid Production	401	9.6	1142	Nitric Acid Production	569	0.7	121	T3	PS
Slovenia	Nitric Acid Production	NO	NO	NO	Nitric Acid Production	NO	NO	NO	NA	NA
Spain	Nitric Acid Production	1329	6.8	2704	Nitric Acid Production	688	0.8	170	T3	PS
Sweden	Nitric Acid Production	374	7.0	782	Nitric Acid Production	248	0.7	52	T2	PS
United Kingdom	Nitric Acid Production	2408	5.4	3860	Nitric Acid Production	1170	0.1	25	T3	CS
EU-28	-	19049	2.6	49572	-	16537	0.2	3953	-	-
Iceland	-	NO	NO	NO	-	NO	NO	NO	NA	NA
United Kingdom (KP)	Nitric Acid Production	2408	5.4	3860	Nitric Acid Production	1170	0.1	25	T3	CS
EU-28+ISL	-	19049	2.6	49572	-	16537	0.2	3953	-	-

Presented methods and emission factor information refer to the last inventory year. Abbreviations explained in the Chapter 'Units and abbreviations'.

4.2.2.3 2B3 Adipic acid production

Adipic acid production emits N_2O as a by-product when a cyclohexanone/cyclohexanol mixture is oxidized by nitric acid. N_2O emissions from adipic acid production now account for less than 0.01% of total EU 28+ISL (without LULUCF) emissions. Between 1990 and 2016, N_2O emissions from this source decreased by 99.4% (Figure 4.11 and Table 4.18). Only France, Germany and Italy continue to produce adipic acid and all three countries were able to decrease emissions from this source category significantly due to the retrofitting of installations with abatement technologies.

Figure 4.11 2B3 Adipic acid production N_2O emissions

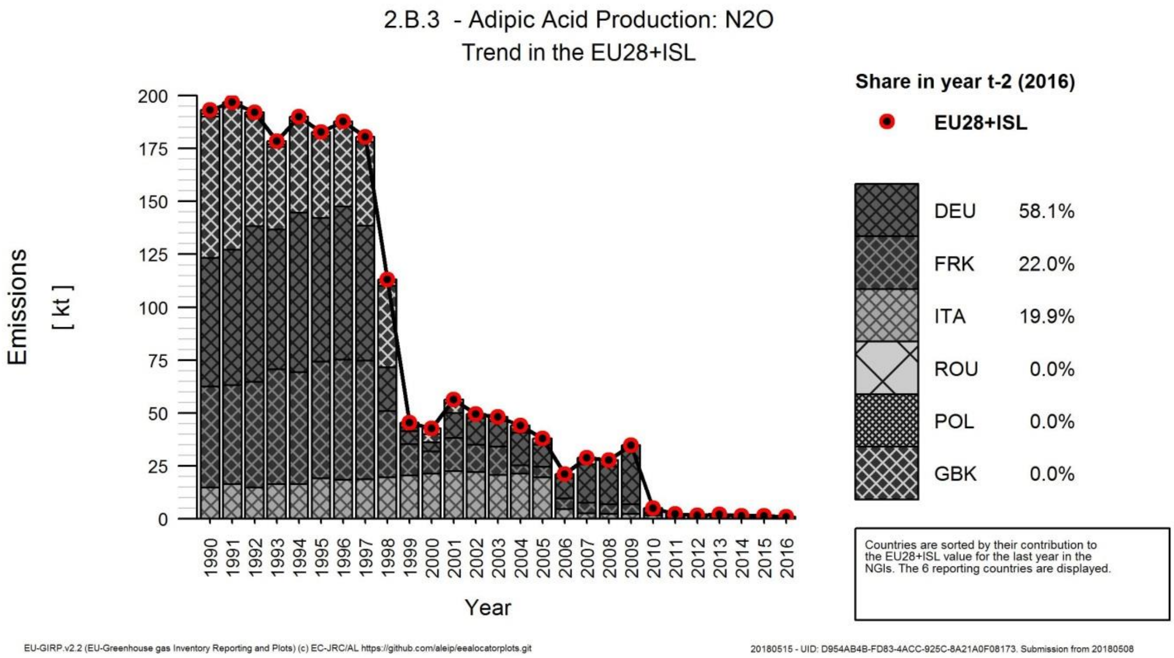


Table 4.18 2B3 Adipic acid production: Member States' contributions to N_2O emissions

Member State	N2O Emissions in kt CO2 equiv.			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016		Method	Emission factor Informa-tion
	1990	2015	2016		kt CO2 equiv.	%	kt CO2 equiv.	%		
France	14 232	67	73	22.0%	-14 160	-99%	6	8%	T2,T3	CS,D,PS
Germany	18 077	251	193	58.1%	-17 884	-99%	-58	-23%	T3	PS
Italy	4 402	110	66	19.9%	-4 336	-99%	-44	-40%	T2	D,PS
Poland	358	NO	NO	-	-358	-100%	-	-	NA	NA
Romania	552	NO	NO	-	-552	-100%	-	-	NA	NA
United Kingdom	19 935	NO	NO	-	-19 935	-100%	-	-	NA	NA
EU-28	**57 555**	**428**	**331**	**100%**	**-57 223**	**-99%**	**-97**	**-23%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	19 935	NO	NO	-	-19 935	-100%	-	-	NA	NA
EU-28 + ISL	**57 555**	**428**	**331**	**100%**	**-57 223**	**-99%**	**-97**	**-23%**	**-**	**-**

Presented methods and emission factor information refer to the last inventory year. Abbreviations explained in the Chapter 'Units and abbreviations'.

Table 4.19 shows information on methods applied, activity data, emission factors for N_2O emissions from 2B3 Adipic acid production for 1990 to 2016. Adipic acid production is used as activity data but the information is confidential in France and Germany. The implied emission factors per tonne of adipic acid produced is only provided by Italy with 0.3 t/t for 1990 and 0.003 t/t for 2016. In 2016 all emissions are estimated with higher Tier methods.

Table 4.19 2B3 Adipic acid production: methods, activity data, emission factors for N_2O emissions

Member State	1990				2016				Method	Emission Factor Informa-tion
	Activity Data		Implied Emission Factorn (t/t)	N2O 'Emissions' (kt CO2 equiv.)	Activity Data		Implied Emission Factor (t/t)	N2O 'Emissions' (kt CO2 equiv.)		
	Description	(kt)			Description	(kt)				
France	Adipic Acid Production	C	C	14 232	Adipic Acid Production	C	C	73	T2,T3	CS,D,PS
Germany	Adipic Acid Production	C	C	18 077	Adipic Acid Production	C	C	193	T3	PS
Italy	Adipic Acid Production	49	0.30	4 402	Adipic Acid Production	83	0.00	66	T2	D,PS
Poland	Adipic Acid Production	4	0.30	358	Adipic Acid Production	NO	NO,NA	NO	NA	NA
Romania	Adipic Acid Production	6	0.30	552	Adipic Acid Production	NO	NO	NO	NA	NA
Spain	Adipic Acid Production	NO	NO	NO	Adipic Acid Production	NO	NO	NO	NA	NA
United Kingdom	Adipic Acid Production	C	C	19 935	Adipic Acid Production	NO	NO	NO	NA	NA
EU-28	**-**	**59**	**968.82**	**57 555**	**-**	**83**	**3.98**	**331**	**-**	**-**
Iceland	-	NO	NO	NO	-	NO	NO	NO	NA	NA
United Kingdom (KP)	Adipic Acid Production	C	C	19 935	Adipic Acid Production	NO	NO	NO	NA	NA
EU-28+ISL	**-**	**59**	**968.82**	**57 555**	**-**	**83**	**3.98**	**331**	**-**	**-**

Presented methods and emission factor information refer to the last inventory year. Abbreviations explained in the Chapter 'Units and abbreviations'.

4.2.2.4 2B8 Petrochemical and carbon black production

Europe has a significant petrochemical industry, with production of all of the chemicals that are in the 2006 IPCC Guidelines. Eighteen countries report CO_2 emissions from this category for at least part of the period 1990-2016 with this source being a key category of CO_2 emissions in terms of emissions level and trend for EU 28+ISL.

CO_2 emissions from 2B8 Petrochemical and carbon black production contributed 0.35% of total EU 28+ISL (without LULUCF) emissions in 2016. Emissions decreased by -4% in 2016 and are now at the same level as 1990. Belgium, United Kingdom, and Spain contribute the largest share of emissions. In the United Kingdom a series of site closures in recent years has reduced emissions by 39% since 1990. In Belgium emissions have more than doubled over the same period.

Figure 4.12 2B8 Petrochemical and carbon black production: EU-28+ISL CO_2 emissions

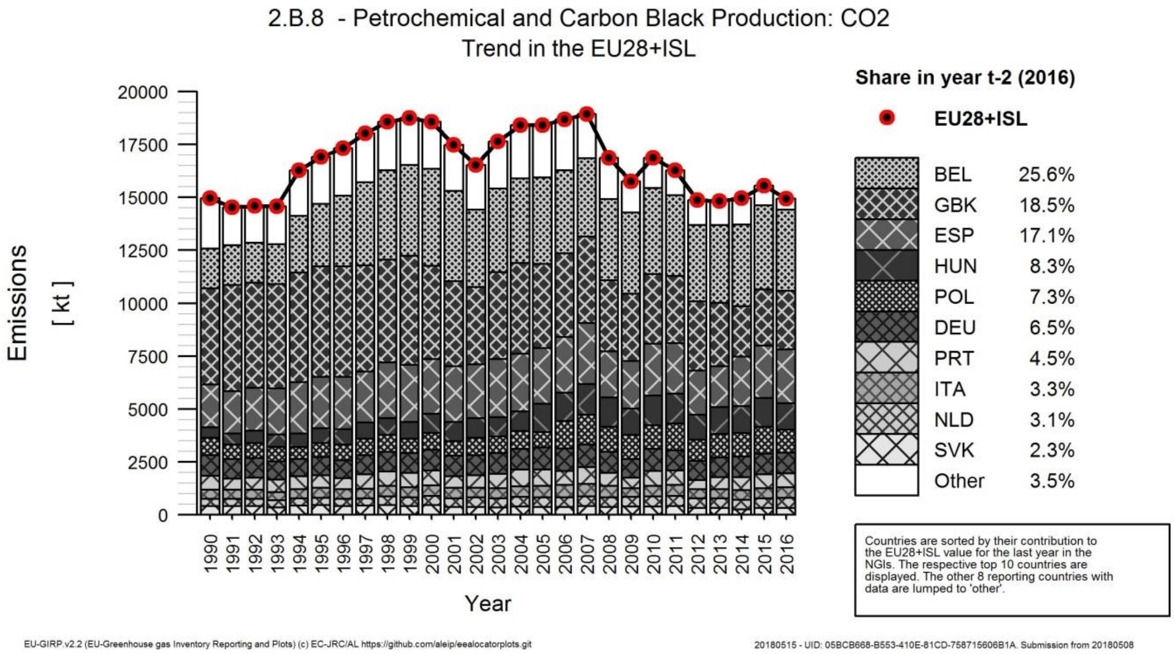


Table 4.20: 2B8 Petrochemical and carbon black production CO_2

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016		Method	Emission factor Informa-tion
	1990	2015	2016		kt CO2	%	kt CO2	%		
Austria	NO,IE	NO,IE	NO,IE	-	-	-	-	-	NA	NA
Belgium	1 882	3 957	3 832	25.6%	1 950	104%	-125	-3%	T3	PS
Bulgaria	346	NO,NA	NO,NA	-	-346	-100%	-	-	NA	NA
Croatia	220	0	0	0.0%	-220	-100%	0	106%	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czech Republic	792	715	303	2.0%	-490	-62%	-412	-58%	T1,T3	D,PS
Denmark	NO	NO	NO	-	-	-	-	-	NA	NA
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	NO,NA	NA,NO	NO,NA	-	-	-	-	-	NA	NA
France	371	212	225	1.5%	-145	-39%	13	6%	T1,T2,T3	CS,D,PS
Germany	974	973	972	6.5%	-2	0%	-1	0%	T1,T2	CS,D
Greece	29	NO,NA	NO,NA	-	-29	-100%	-	-	NA	NA
Hungary	504	1 366	1 243	8.3%	739	147%	-123	-9%	T3	PS
Ireland	NO	NO	NO	-	-	-	-	-	NA	NA
Italy	422	462	497	3.3%	75	18%	35	7%	T2	CR,PS
Latvia	NO	NO	NO	-	-	-	-	-	NA	NA
Lithuania	24	NO	NO	-	-24	-100%	-	-	NA	NA
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	336	454	458	3.1%	122	36%	4	1%	CS	CS
Poland	806	1 271	1 089	7.3%	283	35%	-181	-14%	T1	D
Portugal	672	665	672	4.5%	0	0%	7	1%	NO	NO
Romania	574	NO	NO	-	-574	-100%	-	-	NA	NA
Slovakia	429	332	338	2.3%	-91	-21%	6	2%	T2	CS,PS
Slovenia	16	NO	NO	-	-16	-100%	-	-	NA	NA
Spain	2 019	2 469	2 550	17.1%	531	26%	81	3%	T1,T3	D,PS
Sweden	NO,IE,NA	NO,IE,NA	NO,IE,NA	-	-	-	-	-	NA	NA
United Kingdom	4 537	2 666	2 767	18.5%	-1 769	-39%	102	4%	CS,T1	CS,D
EU-28	**14 953**	**15 540**	**14 946**	**100%**	**-6**	**0%**	**-594**	**-4%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	4 537	2 666	2 767	18.5%	-1 769	-39%	102	4%	CS,T1	CS,D
EU-28 + ISL	**14 953**	**15 540**	**14 946**	**100%**	**-6**	**0%**	**-594**	**-4%**	**-**	**-**

Presented methods and emission factor information refer to the last inventory year. Abbreviations explained in the Chapter 'Units and abbreviations'.

4.2.2.5 Chemical industry – Fluorochemical production (CRF Source Category 2.B.9)

Table 4.21 Key categories for sector 2B9 (Table excerpt)

Source category gas	kt CO_2 equ.		Trend	Level		share of higher Tier
	1990	2016		1990	2016	
2.B.9 Fluorochemical Production: no classification (HFCs)	29034	475	T	L	0	100
2.B.9 Fluorochemical Production: no classification (Unspecified mix of HFCs and PFCs)	5567	62	T	0	0	100

In this subcategory, by-product emissions and fugitive emissions are to be reported. F-gas emissions from 2.B.9 - Fluorochemical Production account for 0.1 % of total EU-28+ISL GHG emissions (without LULUCF) in 2016. Compared to 1990, HFC emissions decreased by 98% (following table).

As regards by-product emissions, the generation of HFC-23 as a by-product during the manufacture of HCFC-22 and HFC-32 is relevant due to its high global warming potential of 14,800. It is estimated that in 1990 the HFC-23 released from HCFC-22 plants was at most 4 percent of the global production of HCFC-22 (U.S. EPA, 2001[21]), in the absence of abatement measures. Before the mid-1990s, ten HCFC-22 plants were operated in Europe. At that time HFC-23 by-products were partly captured and processed to Halon-1301, partly captured and sold as refrigerants and fire extinguishing agents but emissions were also relatively high. In the late 1990s, HFC-23 emissions accounted for about half of the EU's F-gas emissions. Due to the closure of a number of HCFC production plants and the installation of abatement systems in the remaining facilities, HFC-23 emissions have largely been reduced.

Other fluorinated greenhouse gases can occur as by-products in fluorochemical manufacture including e.g. CF4, C2F6 and SF_6.

Fugitive HFC emissions are released during the production process of F-gases. Hence certain amounts of emissions of all types of F-gases that are manufactured in the EU are reported in this subcategory. In the last decades the production processes have been optimized in all facilities so that this type of emissions has been largely reduced as well.

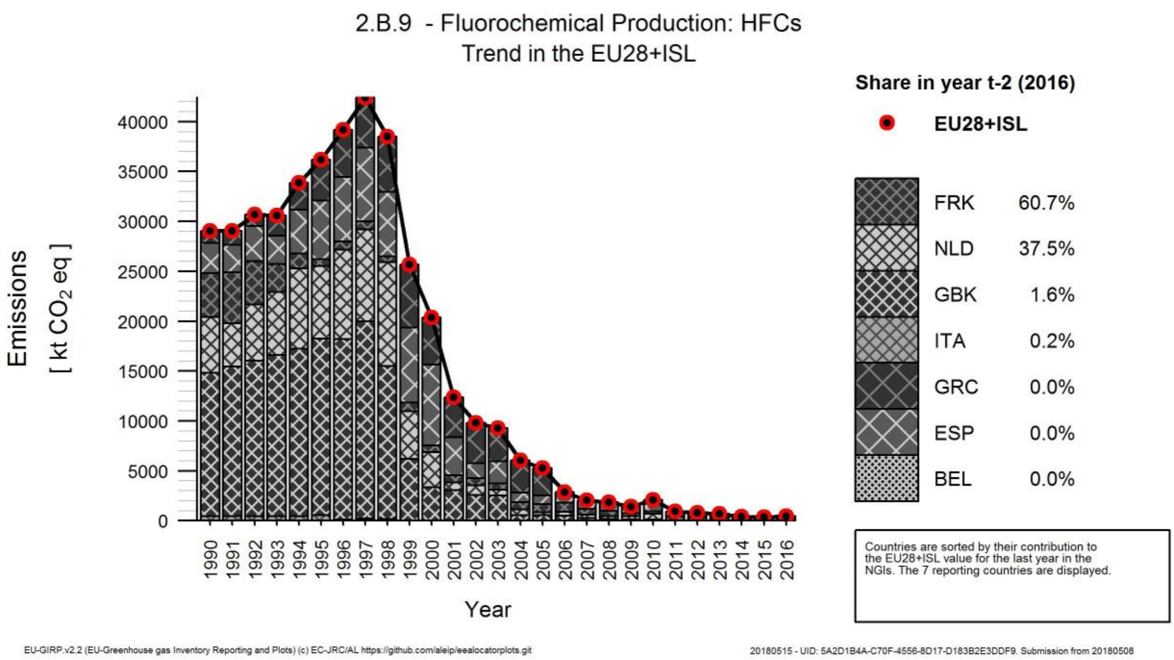
[21] U.S. EPA (2001). Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-1999. United States Environmental Protection Agency, Report No. EPA 236-R-01-001, Washington, U.S.A., 2001.

Table 4.22: 2B9 Fluorochemical production – HFCs: Member States' contributions to HFC emissions and information on method applied, activity data and emission factor

Member State	HFCs Emissions in kt CO2 equiv.				Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 1995-2016		Change 2015-2016		Method	Emission factor Informa-tion
	1990	1995	2015	2016		kt CO2 equiv.	%	kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	-	-	-	-	-	-	-	-	-	-	-	-	-
Belgium	NO	NO	3	NO	-	-	-	-	-	-3	-100%	NA	NA
Bulgaria	NA	NA	NA	NA	-	-	-	-	-	-	-	NA	NA
Croatia	NO	NO	NO	NO	-	-	-	-	-	-	-	NA	NA
Cyprus	NO	NO	NO	NO	-	-	-	-	-	-	-	NA	NA
Czech Republic	NO	NO	NO	NO	-	-	-	-	-	-	-	NA	NA
Denmark	NO	NO	NO	NO	-	-	-	-	-	-	-	NA	NA
Estonia	NO	NO	NO	NO	-	-	-	-	-	-	-	NA	NA
Finland	NO	NO	NO	NO	-	-	-	-	-	-	-	NA	NA
France	4 374	666	209	288	60.7%	-4 085	-93%	-377	-57%	80	38%	T3	PS
Germany	IE	IE	IE	IE	-	-	-	-	-	-	-	NA	NA
Greece	1 183	4 115	NO	NO	-	-1 183	-100%	-4 115	-100%	-	-	NA	NA
Hungary	NO	NO	NO	NO	-	-	-	-	-	-	-	NA	NA
Ireland	NO	NO	NO	NO	-	-	-	-	-	-	-	NA	NA
Italy	444	549	1	1	0.2%	-443	-100%	-548	-100%	0	-6%	CS	PS
Latvia	NA	NA	NA	NA	-	-	-	-	-	-	-	NA	NA
Lithuania	NO	NO	NO	NO	-	-	-	-	-	-	-	NA	NA
Luxembourg	NO	NO	NO	NO	-	-	-	-	-	-	-	NA	NA
Malta	NO,NA	NO,NA	NA,NO	NO,NA	-	-	-	-	-	-	-	NA	NA
Netherlands	5 606	7 298	148	178	37.5%	-5 428	-97%	-7 119	-98%	30	20%	T1,T2	CS,PS
Poland	NO	NO	NO	NO	-	-	-	-	-	-	-	NO	NO
Portugal	NO	NO	NO	NO	-	-	-	-	-	-	-	NA	NA
Romania	NO	NO	NO	NO	-	-	-	-	-	-	-	NA	NA
Slovakia	NO	NO	NO	NO	-	-	-	-	-	-	-	NA	NA
Slovenia	NO	NO	NO	NO	-	-	-	-	-	-	-	NA	NA
Spain	3 040	5 867	NO	NO	-	-3 040	-100%	-5 867	-100%	-	-	NA	NA
Sweden	-	-	-	-	-	-	-	-	-	-	-	-	-
United Kingdom	14 387	17 680	11	8	1.6%	-14 380	-100%	-17 673	-100%	-3	-29%	T2	PS
EU-28	**29 034**	**36 174**	**372**	**475**	**100%**	**-28 559**	**-98%**	**-35 699**	**-99%**	**103**	**28%**	**-**	**-**
Iceland	NO	NO	NO	NO	-	-	-	-	-	-	-	NA	NA
United Kingdom (KP)	14 387	17 680	11	8	1.6%	-14 380	-100%	-17 673	-100%	-3	-29%	T2	PS
EU-28 + ISL	**29 034**	**36 174**	**372**	**475**	**100%**	**-28 559**	**-98%**	**-35 699**	**-99%**	**103**	**28%**	**-**	**-**

Presented methods and emission factor information refer to the last inventory year.
Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

Figure 4.13 2B9 Fluorochemical production – emissions of HFCs



F-gas emissions from 2B9 have been decreasing strongly after a peak in 1998 due to improved abatement measures and the closure of several production plants. Today France accounts for the highest share of emissions from this subcategory (61%), followed by the Netherlands (38%).

Germany also reports an unspecified mix of HFC and PFC emissions from this subcategory. Since 1990 these emissions decreased by 99%.

Table 4.23: 2B9 Fluorochemical production: Member States' contributions to Unspecified mix of HFC and PFC emissions and information on method applied, activity data and emission factor

Member State	Unspecified mix of HFCs and PFCs Emissions in kt CO2 equiv.				Share in EU-28+ISL	Change 1990-2016		Change 1995-2016		Change 2015-2016		Method	Emission factor Informa-tion
	1990	1995	2015	2016	Emissions in 2016	kt CO2 equiv.	%	kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	-	-	-	-	-	-	-	-	-	-	-	-	-
Belgium	-	-	-	-	-	-	-	-	-	-	-	NA	NA
Bulgaria	NA	NA	NA	NA	-	-	-	-	-	-	-	NA	NA
Croatia	NO	NO	NO	NO	-	-	-	-	-	-	-	NA	NA
Cyprus	NO	NO	NO	NO	-	-	-	-	-	-	-	NA	NA
Czech Republic	NO	NO	NO	NO	-	-	-	-	-	-	-	NA	NA
Denmark	NO	NO	NO	NO	-	-	-	-	-	-	-	NA	NA
Estonia	NO	NO	NO	NO	-	-	-	-	-	-	-	NA	NA
Finland	NO	NO	NO	NO	-	-	-	-	-	-	-	NA	NA
France	NO,NA	NO,NA	NO,NA	NO,NA	-	-	-	-	-	-	-	NA	NA
Germany	5 567	5 335	58	62	100.0%	-5 505	-99%	-5 273	-99%	3	6%	T3	PS
Greece	NO	NO	NO	-	-	-	-	-	-	-	-	-	-
Hungary	NO	NO	NO	NO	-	-	-	-	-	-	-	NA	NA
Ireland	NO	NO	NO	NO	-	-	-	-	-	-	-	NA	NA
Italy	-	-	-	-	-	-	-	-	-	-	-	-	-
Latvia	NA	NA	NA	NA	-	-	-	-	-	-	-	NA	NA
Lithuania	NO	NO	NO	NO	-	-	-	-	-	-	-	NA	NA
Luxembourg	NO	NO	NO	NO	-	-	-	-	-	-	-	NA	NA
Malta	NA	NA	NA	NA	-	-	-	-	-	-	-	NA	NA
Netherlands	NO	NO	NO	NO	-	-	-	-	-	-	-	NA	NA
Poland	NO	NO	NO	NO	-	-	-	-	-	-	-	NO	NO
Portugal	NO	NO	NO	NO	-	-	-	-	-	-	-	NA	NA
Romania	NO	NO	NO	NO	-	-	-	-	-	-	-	NA	NA
Slovakia	NO	NO	NO	NO	-	-	-	-	-	-	-	NA	NA
Slovenia	NO	NO	NO	NO	-	-	-	-	-	-	-	NA	NA
Spain	NO	NO	NO	NO	-	-	-	-	-	-	-	NA	NA
Sweden	-	-	-	-	-	-	-	-	-	-	-	-	-
United Kingdom	NO	NO	NO	NO	-	-	-	-	-	-	-	NA	NA
EU-28	**5 567**	**5 335**	**58**	**62**	**100%**	**-5 505**	**-99%**	**-5 273**	**-99%**	**3**	**6%**	**-**	**-**
Iceland	NO	NO	NO	NO	-	-	-	-	-	-	-	NA	NA
United Kingdom (KP)	NO	NO	NO	NO	-	-	-	-	-	-	-	NA	NA
EU-28 + ISL	**5 567**	**5 335**	**58**	**62**	**100%**	**-5 505**	**-99%**	**-5 273**	**-99%**	**3**	**6%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

Figure 4.14 2B9 Fluorochemical production – emissions of unspecified mix of HFC and PFC

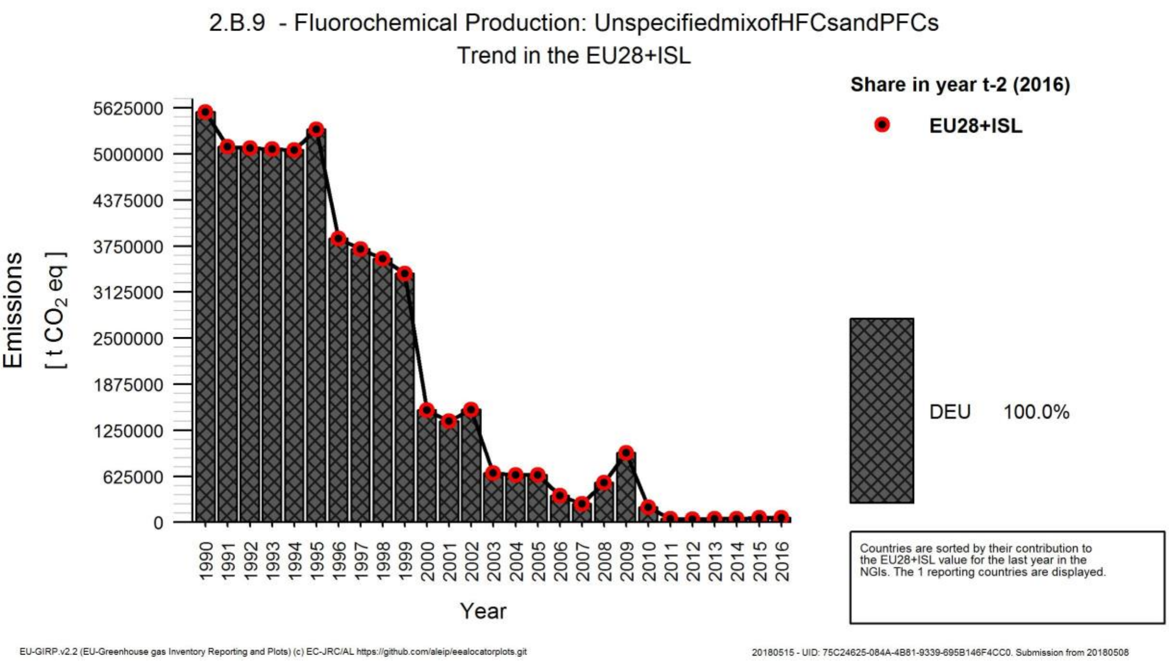


Table 4.24: 2B Chemical production: Contribution of MS to EU recalculations in HFCs for 1990 and 2015 (difference between latest submission and previous submission in kt of CO_2 equivalents and percent)

	1990		2015		Main explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
Austria	0.0	0.0	0.0	0.0	NA
Belgium	0.0	0.0	2.8	1 063.5	Revised figures received from the company concerned
Bulgaria					NA
Croatia	0.0	0.0	0.0	0.0	NA
Cyprus					NA
Czech Republic	0.0	0.0	0.0	0.0	NA
Denmark	0.0	0.0	0.0	0.0	NA
Estonia	0.0	0.0	0.0	0.0	NA
Finland	0.0	0.0	0.0	0.0	NA
France	0.0	0.0	0.0	0.0	NA
Germany	0.0	0.0	0.0	0.0	NA
Greece	0.0	0.0	0.0	0.0	NA
Hungary	0.0	0.0	0.0	0.0	NA
Ireland	0.0	0.0	0.0	0.0	NA
Italy	0.0	0.0	0.1	4.3	NA
Latvia	0.0	0.0	0.0	0.0	NA
Lithuania	0.0	0.0	0.0	0.0	NA
Luxembourg	0.0	0.0	0.0	0.0	NA
Malta	0.0	0.0	0.0	0.0	NA
Netherlands	0.0	0.0	0.0	0.0	NA
Poland	0.0	0.0	0.0	0.0	NA
Portugal	0.0	0.0	0.0	0.0	NA
Romania	0.0	0.0	0.0	0.0	NA
Slovakia	0.0	0.0	0.0	0.0	NA
Slovenia	0.0	0.0	0.0	0.0	NA
Spain	0.0	0.0	0.0	0.0	NA

	1990		2015		Main explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
Sweden	0.0	0.0	0.0	0.0	NA
United Kingdom	0.0	0.0	0.0	0.0	NA
EU28	0.0	0.0	2.9	0.8	
Iceland	0.0	0.0	0.0	0.0	NA
United Kingdom (KP)	0.0	0.0	0.0	0.0	NA
EU28+ISL	0.0	0.0	2.9	0.8	

4.2.2.6 2B10 Other chemical industry

Thirteen countries reported CO_2, CH_4 or N_2O emissions in this category which contributed 15.6 Mt of CO_2e in 2016 or 0.4% of total EU 28+ISL (without LULUCF) emissions. Between 1990 and 2016, CO_2 emissions from this source more than doubled (Table 4.25 and Table 4.26) while CH_4 and N_2O emissions both decreased by about 57% and 70% respectively. This category contains a wide range of emissions and sources as shown in Table 4.25.

Table 4.25 2B10 Other: CO_2, CH_4 and N_2O emissions for 1990 and 2016

Member State	2.B.10 Other	CO_2 emissions [kt]	CH_4 emissions [kt CO_2 equ]	N_2O emissions [kt CO_2 equ]	Total emissions [kt CO_2 equ]	CO_2 emissions [kt]	CH_4 emissions [kt CO_2 equ]	N_2O emissions [kt CO_2 equ]	Total emissions [kt CO_2 equ]
		1990	1990	1990	1990	2016	2016	2016	2016
AUT	10. Other (please specify)	138.56	7.30	NA	145.86	147.57	7.33	NA	154.90
	CO_2 from Nitric Acid Production	0.41	NA	NA	0.41	0.41	NA	NA	0.41
	Other chemical bulk production	138.15	7.30	NA	145.44	147.16	7.33	NA	154.49
BEL	10. Other (please specify)	285.15	NA	8.94	294.09	1962.67	6.29	18.23	1987.19
	Other non-specified	285.15	NA	8.94	294.09	1962.67	6.29	18.23	1987.19
BGR	10. Other (please specify)	NA	NA	NA		NA	NA	NA	
CYP	10. Other (please specify)	NO	NO	NO		NO	NO	NO	
CZE	10. Other (please specify)	IE	NO	NO		233.58	NO	NO	233.58
	Other non energy use in chemical industry	IE	NO	NO		220.49	NO	NO	220.49
	Non selective catalytic reduction	IE	NO	NO		13.09	NO	NO	13.09
DEU	10. Other (please specify)	NA	NA	IE		NA	NA	IE	
	Other	NA	NA	IE		NA	NA	IE	
DNM	10. Other (please specify)	0.57	NA	NA	0.57	1.39	NA	NA	1.39

Member State	2.B.10 Other	CO_2 emissions [kt]	CH_4 emissions [kt CO_2 equ]	N_2O emissions [kt CO_2 equ]	Total emissions [kt CO_2 equ]	CO_2 emissions [kt]	CH_4 emissions [kt CO_2 equ]	N_2O emissions [kt CO_2 equ]	Total emissions [kt CO_2 equ]
		1990	1990	1990	1990	2016	2016	2016	2016
	Production of catalysts	0.57	NA	NA	0.57	1.39	NA	NA	1.39
ESP	10. Other (please specify)	NO,NA	NA	NA		853.12	NA	NA	853.12
	Other No-Specify	NO	NA	NA		853.12	NA	NA	853.12
EST	10. Other (please specify)	NO	NO	NO		NO	NO	NO	
FIN	10. Other (please specify)	177.28	NO	NO	177.28	1052.60	NO	NO	1052.60
	Phosphoric Acid Production	24.54	NO	NO	24.54	33.05	NO	NO	33.05
	Hydrogen Production	116.22	NO	NO	116.22	937.85	NO	NO	937.85
	Limestone and Dolomite Use	36.52	NO	NO	36.52	81.71	NO	NO	81.71
	Chemicals Production	NO	NO	NO		NO	NO	NO	
FRK	10. Other (please specify)	4511.35	76.81	532.65	5120.81	4669.53	43.50	150.71	4863.73
GBE	10. Other (please specify)	NO	185.65	2.10	187.75	NO	62.77	1.48	64.25
	Chemical industry - other	NO	185.65	2.10	187.75	NO	62.77	1.48	64.25
GRC	10. Other (please specify)	NA,NO	NA	NA		309.95	NA	NA	309.95
	Sulfuric acid	NA	NA	NA		NA	NA	NA	
	Hydrogen production	NO	NA	NA		309.95	NA	NA	309.95
HRV	10. Other (please specify)	NO	NO	NO		NO	NO	NO	
HUN	10. Other (please specify)	NO	NO	NO		NO	NO	NO	
IRL	10. Other (please specify)								
ITA	10. Other (please specify)	NA	NA	NA		NA	NA	NA	
	other (indirect emissions)	NA	NA	NA		NA	NA	NA	
	Soda Ash (CO emissions only)	NA	NA	NA		NA	NA	NA	
LTU	10. Other (please specify)	NO	NO	NO		NO	NO	NO	
	Sulfuric acid production	NO	NO	NO		NO	NO	NO	
LUX	10. Other (please specify)	NO	NO	NO		NO	NO	NO	
LVA	10. Other (please specify)	NO	NO	NO		NO	NO	NO	

Member State	2.B.10 Other	CO_2 emissions [kt]	CH_4 emissions [kt CO_2 equ]	N_2O emissions [kt CO_2 equ]	Total emissions [kt CO_2 equ]	CO_2 emissions [kt]	CH_4 emissions [kt CO_2 equ]	N_2O emissions [kt CO_2 equ]	Total emissions [kt CO_2 equ]
		1990	1990	1990	1990	2016	2016	2016	2016
MLT	10. Other (please specify)	0.17	NA	NA	0.17	0.03	NA	NA	0.03
	Carbide use	0.17	NA	NA	0.17	0.03	NA	NA	0.03
NLD	10. Other (please specify)	583.27	NO	NO	583.27	204.94	NO	NO	204.94
	Other process emissions	583.27	NO	NO	583.27	204.94	NO	NO	204.94
POL	10. Other (please specify)	NO	NO	NO		NO	NO	NO	
PRT	10. Other (please specify)	1.41	NO		1.41	2.12	NO		2.12
	2.B.10.b Ammonium Sulphate	NO	NO	NO		NO	NO	NO	
	2.B.10.c Explosives	NO	NO	NO		NO	NO	NO	
	2.B.10.d Solvent use in plastic products manufacturing	NO	NO	NO		NO	NO	NO	
	2.B.10.a Sulphuric Acid	NO	NO	NO		NO	NO	NO	
ROU	10. Other (please specify)	NO	NO	NO		NO	NO	NO	
	Other - non-specified	NO	NO	NO		NO	NO	NO	
SVK	10. Other (please specify)	116.99	0.05	0.06	117.10	383.16	0.17	0.20	383.53
	Hydrogen Production	116.99	0.05	0.06	117.10	383.16	0.17	0.20	383.53
SVN	10. Other (please specify)	NO	NO	NO		NO	NO	NO	
SWE	10. Other (please specify)	99.56	0.70	20.71	120.97	137.57	0.77	6.58	144.92
	Pharmaceutical industry	NA	NE	14.90	14.90	NA	NE	5.66	5.66
	Other non-specified	NE	NE	NE		NE	NE	NE	
	Other organic chemical products	50.28	0.63	NA	50.92	61.12	0.70	NA	61.81
	Base chemicals for plastic industry	NE	NE	3.54	3.54	NE	NE	NE	
	Other inorganic chemical products	49.27	0.07	2.27	51.61	76.46	0.08	0.91	77.45
	Sulphuric acid production	NE	NA	NA		NE	NA	NA	
EU 28		**7316**	**464**	**596**	**8376**	**15245**	**198**	**204**	**15647**
ISL	10. Other (please specify)	0.36	NA	46.49	46.85	NO	NO	NO	
	Silicium production	0.36	NA	NA	0.36	NO	NO	NO	

Member State	2.B.10 Other	CO_2 emissions [kt]	CH_4 emissions [kt CO_2 equ]	N_2O emissions [kt CO_2 equ]	Total emissions [kt CO_2 equ]	CO_2 emissions [kt]	CH_4 emissions [kt CO_2 equ]	N_2O emissions [kt CO_2 equ]	Total emissions [kt CO_2 equ]
		1990	1990	1990	1990	2016	2016	2016	2016
	Fertilizer production	NA	NA	46.49	46.49	NO	NO	NO	
GBK	10. Other (please specify)	NO	185.65	2.10	187.75	NO	62.77	1.48	64.25
	Chemical industry - other	NO	185.65	2.10	187.75	NO	62.77	1.48	64.25
EU 28+ISL		**7317**	**464**	**689**	**8470**	**15245**	**198**	**204**	**15647**

Abbreviations explained in the Chapter 'Units and abbreviations'.

Table 4.25 provides an overview of change between 1990 and 2016 at an aggregated level. Due to the heterogeneity of emission sources in this category, it is not possible to interpret aggregate trends in a meaningful way.

Table 4.26 2B10 Other: CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016		Method	Emission factor Informa-tion
	1990	2015	2016		kt CO2	%	kt CO2	%		
Austria	139	136	148	1.5%	9	7%	12	9%	T3	PS
Belgium	285	1 914	1 963	19.7%	1 678	588%	49	3%	T3	PS
Bulgaria	NA	NA	NA	-	-	-	-	-	NA	NA
Croatia	NO	NO	NO	-	-	-	-	-	NA	NA
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czech Republic	IE	223	234	2.3%	234	∞	11	5%	T1	CS
Denmark	1	2	1	0.0%	1	144%	0	-7%	T2	PS
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	177	912	1 053	10.6%	875	494%	141	15%	CS,T2,T3	CS,PS
France	4 511	4 886	4 670	46.9%	158	4%	-216	-4%	T1,T2,T3	CS,D,PS
Germany	NA	NA	NA	-	-	-	-	-	NA	NA
Greece	NA,NO	255	310	3.1%	310	∞	55	22%	T1	CS
Hungary	NO	NO	NO	-	-	-	-	-	NA	NA
Ireland	-	-	-	-	-	-	-	-	-	-
Italy	NA	NA	NA	-	-	-	-	-	NA	NA
Latvia	NO	NO	NO	-	-	-	-	-	NA	NA
Lithuania	NO	NO	NO	-	-	-	-	-	NA	NA
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	0	0	0	0.0%	0	-80%	0	-51%	T1	D
Netherlands	583	280	205	2.1%	-378	-65%	-75	-27%	T1	D
Poland	NO	NO	NO	-	-	-	-	-	NA	NA
Portugal	NO	NO	NO	-	-	-	-	-	NA	NA
Romania	NO	NO	NO	-	-	-	-	-	NA	NA
Slovakia	117	365	383	3.8%	266	228%	18	5%	T3	CS
Slovenia	NO	NO	NO	-	-	-	-	-	NA	NA
Spain	NO,NA	837	853	8.6%	853	∞	16	2%	T3	PS
Sweden	100	146	138	1.4%	38	38%	-9	-6%	T3	PS
United Kingdom	NO	NO	NO	-	-	-	-	-	NA	NA
EU-28	**5 913**	**9 955**	**9 956**	**100%**	**4 043**	**68%**	**1**	**0%**	**-**	**-**
Iceland	0	NO	NO	-	0	-100%	-	-	NA	NA
United Kingdom (KP)	NO	NO	NO	-	-	-	-	-	NA	NA
EU-28 + ISL	**5 913**	**9 955**	**9 956**	**100%**	**4 043**	**68%**	**1**	**0%**	**-**	**-**

Presented methods and emission factor information refer to the last inventory year. Abbreviations explained in the Chapter 'Units and abbreviations'.

Table 4.27 2B10 Other: N_2O emissions

Member State	N2O Emissions in kt CO2 equiv.			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016		Method	Emission factor Informa-tion
	1990	2015	2016		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	NA	NA	NA	-	-	-	-	-	NA	NA
Belgium	9	17	18	10.3%	9	104%	1	5%	T3	PS
Bulgaria	NA	NA	NA	-	-	-	-	-	NA	NA
Croatia	NO	NO	NO	-	-	-	-	-	NA	NA
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czech Republic	NO	NO	NO	-	-	-	-	-	NA	NA
Denmark	NA	NA	NA	-	-	-	-	-	NA	NA
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	NO	NO	NO	-	-	-	-	-	NA	NA
France	533	294	151	85.0%	-382	-72%	-144	-49%	T2,T3	CS,D,PS
Germany	IE	IE	IE	-	-	-	-	-	NA	NA
Greece	NA	NA	NA	-	-	-	-	-	NA	NA
Hungary	NO	NO	NO	-	-	-	-	-	NA	NA
Ireland	-	-	-	-	-	-	-	-	-	-
Italy	NA	NA	NA	-	-	-	-	-	NA	NA
Latvia	NO	NO	NO	-	-	-	-	-	NA	NA
Lithuania	NO	NO	NO	-	-	-	-	-	NA	NA
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NA	NA	NA	-	-	-	-	-	NA	NA
Netherlands	NO	NO	NO	-	-	-	-	-	NA	NA
Poland	NO	NO	NO	-	-	-	-	-	NA	NA
Portugal	NO	NO	NO	-	-	-	-	-	NA	NA
Romania	NO	NO	NO	-	-	-	-	-	NA	NA
Slovakia	0	0	0	0.1%	0	235%	0	5%	T3	D
Slovenia	NO	NO	NO	-	-	-	-	-	NA	NA
Spain	NA	NA	NA	-	-	-	-	-	NA	NA
Sweden	21	5	7	3.7%	-14	-68%	2	31%	T3	PS
United Kingdom	2	1	1	0.8%	-1	-29%	0	5%	T3	CS
EU-28	**564**	**318**	**177**	**100%**	**-387**	**-69%**	**-141**	**-44%**	**-**	**-**
Iceland	46	NO	NO	-	-46	-100%	-	-	NA	NA
United Kingdom (KP)	2	1	1	0.8%	-1	-29%	0	5%	T3	CS
EU-28 + ISL	**611**	**318**	**177**	**100%**	**-434**	**-71%**	**-141**	**-44%**	**-**	**-**

Presented methods and emission factor information refer to the last inventory year. Abbreviations explained in the Chapter 'Units and abbreviations'.

Table 4.28: 2B10 Other: CH_4 emissions

Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016		Method	Emission factor Informa-tion
	1990	2015	2016		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	7	7	7	6.1%	0	0%	0	3%	T3	PS
Belgium	NA	7	6	5.2%	6	∞	-1	-9%	T3	PS
Bulgaria	NA	NA	NA	-	-	-	-	-	NA	NA
Croatia	NO	NO	NO	-	-	-	-	-	NA	NA
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czech Republic	NO	NO	NO	-	-	-	-	-	NA	NA
Denmark	NA	NA	NA	-	-	-	-	-	NA	NA
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	NO	NO	NO	-	-	-	-	-	NA	NA
France	77	48	43	36.0%	-33	-43%	-5	-10%	T2,T3	CS,D,PS
Germany	NA	NA	NA	-	-	-	-	-	NA	NA
Greece	NA	NA	NA	-	-	-	-	-	NA	NA
Hungary	NO	NO	NO	-	-	-	-	-	NA	NA
Ireland	-	-	-	-	-	-	-	-	-	-
Italy	NA	NA	NA	-	-	-	-	-	NA	NA
Latvia	NO	NO	NO	-	-	-	-	-	NA	NA
Lithuania	NO	NO	NO	-	-	-	-	-	NA	NA
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NA	NA	NA	-	-	-	-	-	NA	NA
Netherlands	NO	NO	NO	-	-	-	-	-	NA	NA
Poland	NO	NO	NO	-	-	-	-	-	NA	NA
Portugal	NO	NO	NO	-	-	-	-	-	NA	NA
Romania	NO	NO	NO	-	-	-	-	-	NA	NA
Slovakia	0	0	0	0.1%	0	235%	0	5%	T3	D
Slovenia	NO	NO	NO	-	-	-	-	-	NA	NA
Spain	NA	NA	NA	-	-	-	-	-	NA	NA
Sweden	1	C	1	0.6%	0	10%	1	∞	T1,T3	D,PS
United Kingdom	186	50	63	51.9%	-123	-66%	12	25%	CS	CS
EU-28	**271**	**113**	**121**	**100%**	**-150**	**-55%**	**8**	**7%**	**-**	**-**
Iceland	NA	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	186	50	63	51.9%	-123	-66%	12	25%	CS	CS
EU-28 + ISL	**271**	**113**	**121**	**100%**	**-150**	**-55%**	**8**	**7%**	**-**	**-**

Presented methods and emission factor information refer to the last inventory year. Abbreviations explained in the Chapter 'Units and abbreviations'.

Table 4.29 provides an overview of all sources reported under 2B10 Other Chemical Industry for the year 2016 and for all gases. The largest contributors to the total emissions are France, Belgium and Finland.

Table 4.29 2B10 Other: Overview of sources reported under this source category for 2016

Member State	2.B.10 Other Chemical Industry	CO2 emissions [kt]	CH4 emissions [kt]	N2O emissions [kt]	Total emissions [kt CO2 equivalents	Share in EU-28 Total
		2016	2016	2016	2016	2016
Austria	10. Other (please specify), CO2 from Nitric Acid Production, Other chemical bulk production	148	0	NA	155	2%
Belgium	10. Other (please specify), Other non-specified	1963	0	0	1987	19%
Bulgaria	10. Other (please specify)	NA	NA	NA	-	-
Croatia	10. Other (please specify)	NO	NO	NO	-	-
Cyprus	10. Other (please specify)	NO	NO	NO	-	-
Czech Republic	10. Other (please specify), Other non energy use in chemical industry, Non selective catalytic reduction	234	NO	NO	234	2%
Denmark	10. Other (please specify), Production of catalysts	1	NA	NA	1	0.01%
Estonia	10. Other (please specify)	NO	NO	NO	-	-
Finland	10. Other (please specify), Phosphoric Acid Production, Hydrogen Production, Limestone and Dolomite Use, Chemicals Production	1053	NO	NO	1053	10%
France	10. Other (please specify)	4670	2	1	4864	47%
Germany	10. Other (please specify), Other	NA	NA	IE	-	-
Greece	10. Other (please specify), Sulfuric acid, Hydrogen production	310	NA	NA	310	3%
Hungary	10. Other (please specify)	NO	NO	NO	-	-
Ireland	10. Other (please specify)				-	-
Italy	10. Other (please specify), other (indirect emissions), Soda Ash (CO emissions only)	NA	NA	NA	-	-
Latvia	10. Other (please specify)	NO	NO	NO	-	-
Lithuania	10. Other (please specify), Sulfuric acid production	NO	NO	NO	-	-
Luxembourg	10. Other (please specify)	NO	NO	NO	-	-
Malta	10. Other (please specify)	0	NA	NA	0	0%
Netherlands	10. Other (please specify), Other process emissions	205	NO	NO	205	2%
Poland	10. Other (please specify)	NO	NO	NO	-	-
Portugal	10. Other (please specify), 2.B.10.b Ammonium Sulphate, 2.B.10.c Explosives, 2.B.10.d Solvent use in plastic products manufacturing, 2.B.10.a Sulphuric Acid	2	NO		2	0.0%
Romania	10. Other (please specify), Other - non-specified	NO	NO	NO	-	-
Slovakia	10. Other (please specify), Hydrogen Production	383	0	0	384	4%
Slovenia	10. Other (please specify)	NO	NO	NO	-	-
Spain	10. Other (please specify), Other No-Specify	853	NA	NA	853	8%
Sweden	10. Other (please specify), Pharmaceutical industry, Other non-specified, Other organic chemical products, Base chemicals for plastic industry, Other inorganic chemical products, Sulphuric acid production	138	0	0	145	1%
United Kingdom	10. Other (please specify), Chemical industry - other	NO	3	0	64	1%
EU 28 - Total		**9958**	**5**	**1**	**10256**	**100%**
Island	10. Other (please specify), Silicium production, Fertilizer production	NO	NO	NO	-	-
Great Britain	10. Other (please specify), Chemical industry - other	NO	3	0	64	1%
EU 28+ISL - Total		**9958**	**5**	**1**	**10256**	**100%**

Abbreviations explained in the Chapter 'Units and abbreviations'.

4.2.2.7 Non-key sources

Non key sources in the chemical sector include: 2B4 Caprolactam, glyoxal and glyoxylic acid production; 2B5 Carbide production; 2B6 Titanium dioxide production and 2B7 Soda ash production are grouped here for comparison. In 2016 sixteen countries reported emissions from these categories which contributed 4.8 Mt of CO_2 equivalent or 0.1% of total EU 28+ISL (without LULUCF) emissions.

4.2.3 Metal Industry (CRF Source Category 2C)

This source category includes two key sources, namely CO_2 emissions from 2C1 Iron and Steel Production and PFC emissions from 2C3 Aluminium Production (***Table 4.30***).

Table 4.30: Key source categories for level and trend analyses and share of MS emissions using higher tier methods for sector 2C (Table excerpt).

Source category gas	kt CO_2 equ.		Trend	Level		share of higher Tier
	1990	2016		1990	2016	
2.C.1 Iron and Steel Production: no classification (CO_2)	95382	62641	T	L	L	96 %
2.C.3 Aluminium Production: no classification (PFCs)	21277	560	T	L	0	100 %

Table 4.31 summarises information by Member State on total GHG emissions, CO_2, SF_6 and PFC emissions from Metal Production. Between 1990 and 2016, CO_2 emissions from 2C Metal Production decreased by approx. 33%. The absolute decrease of CO_2 emissions was largest in Germany, Romania and Belgium.

Table 4.31 2C Metal Industry: Member States' contributions to total GHG, CO_2, HFC, PFC and SF_6 emissions

Member State	GHG emissions in 1990 (kt CO2 equivalents)	GHG emissions in 2016 (kt CO2 equivalents)	CO2 emissions in 1990 (kt)	CO2 emissions in 2016 (kt)	HFC emissions in 1990 (kt CO2 equivalents)	HFC emissions in 2016 (kt CO2 equivalents)	PFC emissions in 1990 (kt CO2 equivalents)	PFC emissions in 2016 (kt CO2 equivalents)	SF6 emissions in 1990 (kt CO2 equivalents)	SF6 emissions in 2016 (kt CO2 equivalents)
Austria	8 177	10 450	6 786	10 447	-	-	1 149	NO	242	2
Belgium	10 349	4 326	10 336	4 303	-	-	-	-	-	-
Bulgaria	1 629	223	1 603	223	NA	NA	NA	NA	NA	NA
Croatia	1 583	1	339	1	NO	NO	1 240	NO	NO	NO
Cyprus	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Czech Republic	9 670	7 311	9 655	7 297	NO	NO	NO	NO	NO	NO
Denmark	60	0	30	0	-	-	NO	NO	30	NO
Estonia	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Finland	1 976	2 188	1 976	2 188	NO	-	NO	-	NO	NO,NA
France	10 595	4 529	6 239	4 350	NO,NA	NO,NA	3 567	109	781	60
Germany	28 164	17 317	25 080	17 094	-	61	2 889	95	180	44
Greece	1 203	1 224	1 012	1 135	NO	-	190	88	NO	-
Hungary	3 699	871	3 316	867	NO	NO	376	NO	NO	NO
Ireland	26	NO	26	NO	NO	NO	NO	NO	NO	NO
Italy	6 421	1 764	4 378	1 710	NO	10	1 975	NO	NO	NO
Latvia	70	NO	70	NO	NO	NO	NO	NO	NO	NO
Lithuania	17	1	17	1	NO	NO	NO	NO	NO	NO
Luxembourg	985	122	985	122	-	-	-	-	-	-
Malta	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Netherlands	3 090	77	452	63	NO	NO	2 638	14	NO	NO
Poland	5 931	2 570	5 767	2 552	NA	NA	142	NO,NA	NA,NO	4
Portugal	130	86	124	70	NO,NA	NO	NO,NA	NO	NO,NA	NO
Romania	14 218	4 125	11 388	4 115	NO	NO	2 808	5	NA,NO	NO,NA
Slovakia	4 901	4 851	4 586	4 844	NO	NO	315	6	NO	NO
Slovenia	551	218	343	198	-	-	208	20	-	-
Spain	4 628	3 807	3 438	3 702	NA,NO	NO,NA	1 164	85	NA,NO	NO,NA
Sweden	3 879	3 140	3 268	3 090	NO	NO	569	30	23	20
United Kingdom	9 396	2 590	7 401	2 481	NO	2	1 553	14	387	75
EU-28	**131 347**	**71 793**	**108 614**	**70 855**	**NA,NO**	**74**	**20 783**	**468**	**1 642**	**206**
Iceland	844	1 772	348	1 677	NO	NO	495	92	NO	NO
United Kingdom (KP)	9 396	2 590	7 401	2 481	NO	2	1 553	14	387	75
EU-28 + ISL	**132 192**	**73 566**	**108 962**	**72 532**	**NA,NO**	**74**	**21 277**	**560**	**1 642**	**206**

Presented methods and emission factor information refer to the last inventory year.
Note: Total GHG emissions given in this table include CO_2, N_2O, CH_4, HFC, PFC and SF_6.
Abbreviations explained in the Chapter 'Units and abbreviations'.

Figure 4.15: 2C Metal Industry CO_2 – Trend in EU-28 + Iceland

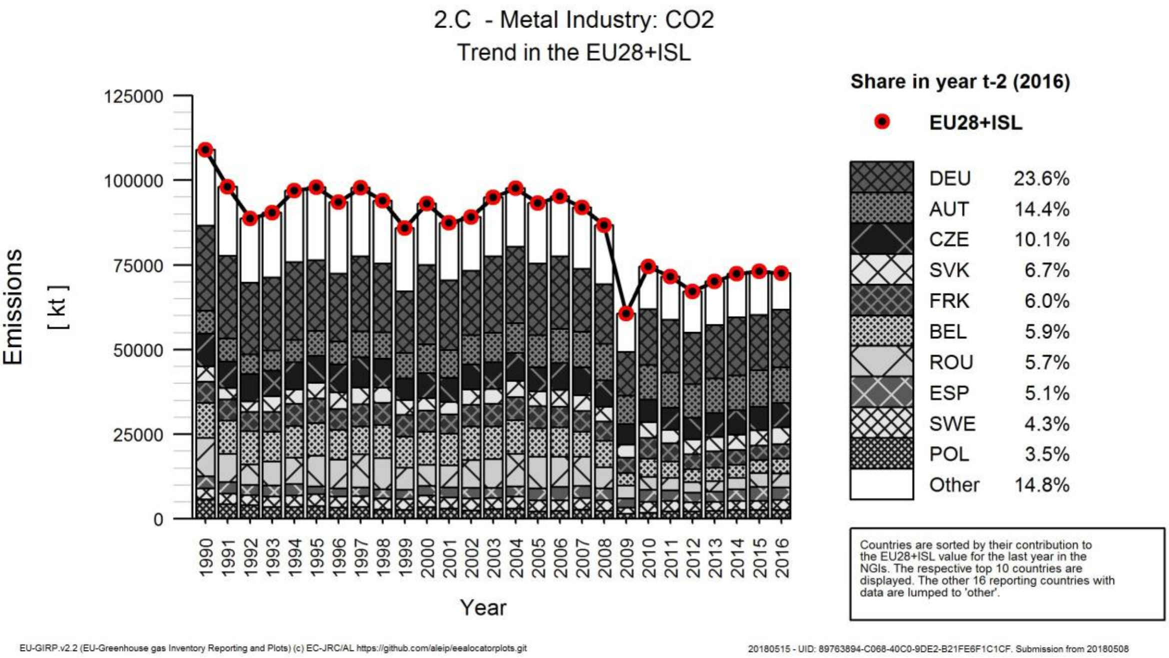


Table **4.31** provides information on the contribution of Member States to EU recalculations of CO_2 emissions from 2C Metal Production for 1990 and 2015, including main explanations.

Table 4.32: 2C Metal Production: Contribution of MS to EU recalculations in CO_2 for 1990 and 2015 (difference between latest submission and previous submission in kt of CO_2 and percent of sector total)

	1990		2015		Main explanations
	kt CO_2	**%**	**kt CO_2**	**%**	
Austria	-1	-0.0	41	0.4	revised energy balance
Belgium	8	0.1	-	-	Small correction of emissions of CO_2 in category 2C1 in the Flemish region in 2010, the difference is explained by the rounding of numbers. Small emissions in CO_2 of 1 company are added in category 2C7 for the period of 1990 till 1993. An estimation has been made based on the production and emission factors obtained by the producer.
Bulgaria	-	-	-	-	
Croatia	-	-	-	-	
Cyprus	-	-	-	-	
Czech Republic	9	0.1	80	1.2	Recalculation due to new obtained activity data was performed for 1990-1999. The transparency of reporting was increased due to this recalculation.
Denmark	-	-	0	13.7	Activity data for 2015 was not available prior to the last inventory submission and the 2015 activity was therefore assumed equal to that of 2014. For this submission, actual 2015 data are obtained resulting in an increase of 0.02 Gg CO_2 (13.7 %).
Estonia	-	-	-	-	
Finland	-	-	-43	-2.0	Emissions for 2013-2015 were recalculated for zinc, copper and nickel production. One erroneous fuel combustion figure was discovered in iron and steel industry. Correction of this error (in 1.A.2a) was reflected in 2.C.1. This recalculation does not have any effect on total CO_2 emissions, because process

	1990		2015		Main explanations
	kt CO_2	%	kt CO_2	%	
					emissions (2.C.1) are calculated by subtracting energy based emissions (in this case fuels used by rolling mills, belonging to 1.A.2a) from total reported ETS emissions of this plant. Around 41.1 kt of CO_2 emissions were reallocated from 2.C.1 to 1.A.2a.
France	1 507	31.8	168	4.2	Recalculation according to UNFCCC review and Saturday Paper: - 2C1a: addition of scrap metal, and modification of the electrode consumation ratio per ton of steel produced, and change of the ratio of cast iron per ton of steel produced in electric arc furnaces. Addition of scrap metal, iron ore, and dolomite used in basic oxygen furnaces. Change in allocation of emissions from carbonates used in electric arc furnaces to 2C1a instead of 2C1f. - 2C1b: addition of iron ore and sinter in blast furnaces - 2C1d: addition of sinter, and change of allocation of limestone use: change from CRF 2A4d to 2C1d.
Germany	-	-	-1 529	-8.6	Revised production statistics; revised calculation method (2.C.5)
Greece	-	-	-	-	
Hungary	-	-	-	-	
Ireland	-	-	-	-	
Italy	-	-	-0	-0.0	
Latvia	-0	-0.2	-0	-21.6	CO_2 emissions from 2.C.1 Iron and steel sector were recalculated for all timeseries due to correction of emissions from carbon electrodes consumption which were multiplied by conversion factor (44.0098/12.011) 2 times.
Lithuania	-	-	-	-	
Luxembourg	-	-	-	-	
Malta	-	-	-	-	
Netherlands	-2 223	-83.1	-889	-94.0	Reallocation of procesemissions to 1.A.2.
Poland	-	-	-15	-0.6	Update of AD for production of steel in electric furnaces, ferroalloys production and zinc production.
Portugal	16	14.6	-2	-2.2	A correction was made in the carbon content of billets in ETS data. Previously it was considered a carbon content of 0.0109 t C/t steel. The value has been revised to 0.0025 t C/t steel. The carbon content of iron and steel scrap reported in ETS has changed from 0.0109 t C/t scrap to 0.0021 t C/t scrap. Even though ETS data is not corrected, in order to assure consistency we correct not only the last year data but also the entire series.
Romania	-	-	-	-	
Slovakia	-	-	-	-	
Slovenia	-	-	-	-	
Spain	34	1.0	1	0.0	Correction of natural gas consumption in pig iron production due to a unit conversion mistake in previous edition.
Sweden	-16	-0.5	-3	-0.1	Change of data source/updated data.
United Kingdom	-3	-0.0	31	0.7	Pet coke use in electric arc furnaces: revised interpretation of EU ETS data & revision to reported point source data; revision to DUKES data for I&S flaring in blast furnaces.
EU28	-669	-0.6	-2 159	-2.9	
Iceland	-	-	-	-	

	1990		2015		Main explanations
	kt CO_2	%	kt CO_2	%	
United Kingdom (KP)	-3	-0.0	31	0.7	Pet coke use in electric arc furnaces: revised interpretation of EU ETS data & revision to reported point source data; revision to DUKES data for I&S flaring in blast furnaces
EU28+ISL	-669	-0.6	-2 159	-2.9	

In the current submission no recalculations were performed in PFC emissions from 2C – Metal production.

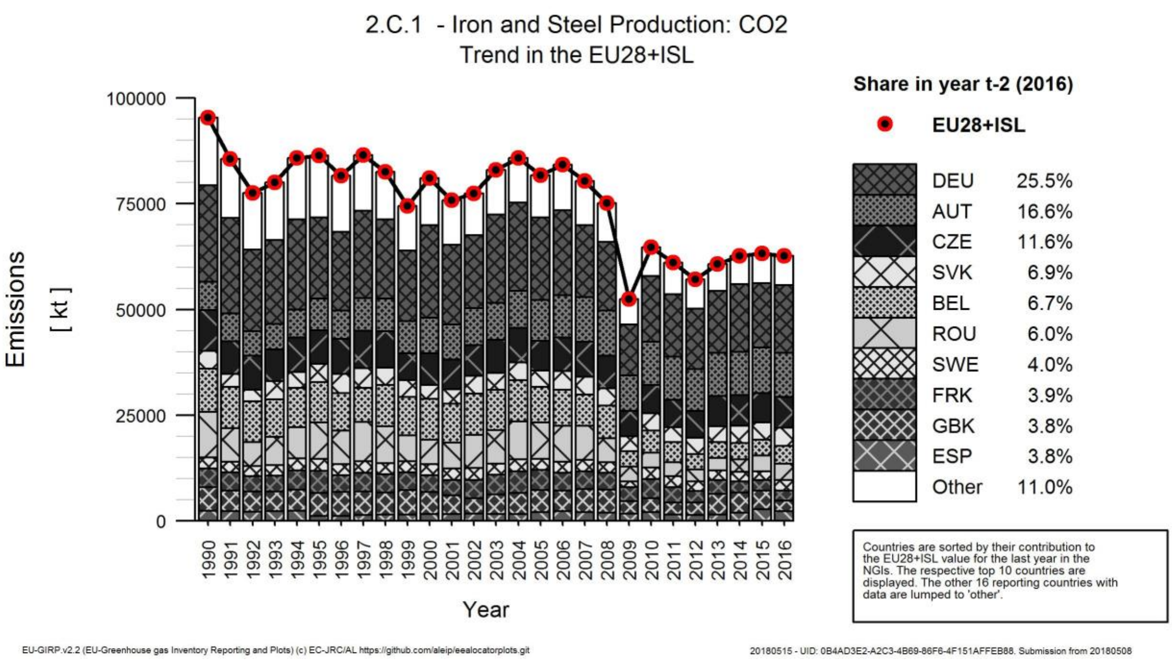
4.2.3.1 2C1 Iron and steel production

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, using coke or other forms of carbon as fuel and reducing agent. In most iron furnaces, the process is aided by the use of carbonate fluxes (limestone). Additional emissions occur as the limestone or dolomite flux releases CO_2 during reduction of pig iron in the blast furnace. Coke plays the dual role of fuel and reducing agent. Member States use different methods for the allocation of emissions that are described in Table **4.34**.

CO_2 emissions from 2C1 Iron and Steel Production amounted to approx. 1.46% of total GHG emissions (without LULUCF) in 2016. Germany accounts for 26% of these emissions in the EU-28. Romania had the largest decrease in absolute terms between 1990 and 2016 while increases were encountered in Austria, Slovakia and Finland and (on a small scale) Slovenia.

The overall emission trend between 1990 and 2016 roughly follows the trend of emissions from Germany that fluctuates due to varying production figures. Between 1990 and 2016, overall CO_2 emissions from iron and steel production decreased by 33% (Table 4.33). Between 2015 and 2016 emissions decreased by 0.94%.

Figure 4.16 2C1 Iron and Steel Production: CO_2 emissions



CO_2 emissions from iron and steel industry are reported by all Member States except Cyprus, Malta, Estonia, and Ireland (which reported emissions from this sector in 1990). All follow higher-tier methods and most use country or plant specific methods (see Table **4.33**).

Table 4.33 2C1 Iron and Steel Production: Member States' contributions to CO_2 emissions and information on method applied and emission factor

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016		Method	Emission factor Informa-tion
	1990	2015	2016		kt CO2	%	kt CO2	%		
Austria	6 610	10 781	10 418	16.6%	3 807	58%	-364	-3%	T1,T3	CS,PS
Belgium	10 278	3 706	4 224	6.7%	-6 054	-59%	518	14%	CS,T3	PS
Bulgaria	1 283	37	36	0.1%	-1 247	-97%	-1	-4%	T2	CS
Croatia	46	14	1	0.0%	-45	-98%	-13	-92%	T2	CS
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czech Republic	9 643	6 953	7 287	11.6%	-2 356	-24%	334	5%	CS,T2	D,PS
Denmark	30	NO	NO	-	-30	-100%	-	-	NA	NA
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	1 967	2 122	2 171	3.5%	204	10%	49	2%	CS,T3	CS
France	4 349	2 479	2 465	3.9%	-1 884	-43%	-14	-1%	T2	CS
Germany	22 810	15 202	15 976	25.5%	-6 834	-30%	774	5%	T2	CS
Greece	105	61	74	0.1%	-31	-30%	12	20%	CS	PS
Hungary	3 153	1 166	867	1.4%	-2 286	-73%	-299	-26%	T3	PS
Ireland	26	NO	NO	-	-26	-100%	-	-	NA	NA
Italy	3 124	1 327	1 473	2.4%	-1 651	-53%	147	11%	T2	CR,CS,PS
Latvia	70	1	NO	-	-70	-100%	-1	-100%	NA	NA
Lithuania	17	2	1	0.0%	-16	-91%	-1	-28%	T2	D
Luxembourg	985	123	119	0.2%	-866	-88%	-3	-3%	CS,T2	CS
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	44	16	11	0.0%	-33	-75%	-5	-33%	T2	CS
Poland	5 073	2 033	2 023	3.2%	-3 051	-60%	-10	0%	T2,T3	CS
Portugal	118	83	60	0.1%	-58	-49%	-23	-28%	T2	PS
Romania	10 781	3 759	3 771	6.0%	-7 010	-65%	12	0%	T3	CS
Slovakia	4 168	4 028	4 335	6.9%	167	4%	307	8%	T2	PS
Slovenia	44	53	56	0.1%	12	28%	3	5%	T2	PS
Spain	2 435	2 808	2 350	3.8%	-85	-3%	-458	-16%	T2	CS,PS
Sweden	2 632	2 128	2 515	4.0%	-117	-4%	387	18%	T2,T3	PS
United Kingdom	5 592	4 351	2 408	3.8%	-3 183	-57%	-1 942	-45%	T2	CS
EU-28	**95 382**	**63 234**	**62 640**	**100%**	**-32 741**	**-34%**	**-593**	**-1%**	**-**	**-**
Iceland	NO	0	1	0.0%	1	∞	0	76%	T1	D
United Kingdom (KP)	5 592	4 351	2 408	3.8%	-3 183	-57%	-1 942	-45%	T2	CS
EU-28 + ISL	**95 382**	**63 234**	**62 641**	**100%**	**-32 741**	**-34%**	**-593**	**-1%**	**-**	**-**

Presented methods and emission factor information refer to the last inventory year.
Abbreviations explained in the Chapter 'Units and abbreviations'.

For this category, it is not useful to give an average IEF across the Member States because of their varying emission allocation (the split between process and combustion related emissions for pig iron production, which is an important sub-category). Activity data, implied implied emission factors and CO_2 emissions for the various Member States and sub-categories are provided in Table **4.34**.

Table4.17 2C1 Iron and Steel Production: Implied emission factors

Member State	1990				Member State	2016				Method	Emission factor informa-tion
	category	Activity data (kt)	Implied Emission Factor (t/t)	CO_2 Emissions (kt)		category	Activity data (kt)	Implied Emission Factor (t/t)	CO_2 Emissions (kt)		
Austria	**Iron and steel production**			6610	**Austria**	**Iron and steel production**			10418		
	Steel	3921	1.68	6591		Steel	6766	1.53	10382	T1,T3	CS,PS
	Pig Iron	3444	NO,IE	IE		Pig Iron	5634	NO,IE	IE	NA	NA
	Direct reduced iron	NO	NO	NO		Direct reduced iron	NO	NO	NO	NA	NA
	Sinter	NO	NO	NO		Sinter	NO	NO	NO	NA	NA
	Pellet	NO	NO	NO		Pellet	NO	NO	NO	NA	NA
	Other			20		Other			36		
	Electric Furnace Steel	370	0.1	20		Electric Furnace Steel	666	0.1	36	T3	PS
Belgium	**Iron and steel production**			10278	**Belgium**	**Iron and steel production**			4224		
	Steel	11570	0.75	8689		Steel	7766	0.53	4150	CS,T3	PS
	Pig Iron	9415	NA,IE	IE		Pig Iron	4869	IE,NA	IE	NA	NA
	Direct reduced iron	NO	NO	NO		Direct reduced iron	NO	NO	NO	NA	NA
	Sinter	13075	0.12	1589		Sinter	5230	0.01	67	CS,T3	PS
	Pellet	660	NO,IE	IE		Pellet	NO	NO	NO	NA	NA
	Other			IE		Other			6		
	Use of electrodes	NA	NO,IE	IE		Use of electrodes	1769	0.004	6	CS,T3	PS
Bulgaria	**Iron and steel production**			1283	**Bulgaria**	**Iron and steel production**			36		
	Steel	2180	0.59	1283		Steel	549	0.07	36	T2	CS
	Pig Iron	1143	NO,IE	IE		Pig Iron	NO	NO	NO	NA	NA
	Direct reduced iron	NO	NO	NO		Direct reduced iron	NO	NO	NO	NA	NA
	Sinter	C	NO,IE	IE		Sinter	NO	NO	NO	NA	NA
	Pellet	NO	NO	NO		Pellet	NO	NO	NO	NA	NA
	Other			NA		Other			NA		
Croatia	**Iron and steel production**			46	**Croatia**	**Iron and steel production**			1		
	Steel	171	0.27	46		Steel	24	0.04	1	T2	CS

Member State	1990 category	Activity data (kt)	Implied Emission Factor (t/t)	CO_2 Emissions (kt)	Member State	2016 category	Activity data (kt)	Implied Emission Factor (t/t)	CO_2 Emissions (kt)	Method	Emission factor informa-tion
	Pig Iron	209	IE,NO	IE		Pig Iron	NO	NO	NO	NA	NA
	Direct reduced iron	NO	NO	NO		Direct reduced iron	NO	NO	NO	NA	NA
	Sinter	NO	NO	NO		Sinter	NO	NO	NO	NA	NA
	Pellet	NO	NO	NO		Pellet	NO	NO	NO	NA	NA
	Other			NO		Other			NO		
Cyprus	**Iron and steel production**			NO	**Cyprus**	**Iron and steel production**			NO		
	Steel	NO	NO	NO		Steel	NO	NO	NO	NA	NA
	Pig Iron	NO	NO	NO		Pig Iron	NO	NO	NO	NA	NA
	Direct reduced iron	NO	NO	NO		Direct reduced iron	NO	NO	NO	NA	NA
	Sinter	NO	NO	NO		Sinter	NO	NO	NO	NA	NA
	Pellet	NO	NO	NO		Pellet	NO	NO	NO	NA	NA
	Other			NO		Other			NO		
Czech Republic	**Iron and steel production**			9643	**Czech Republic**	**Iron and steel production**			7287		
	Steel	8190	IE,NA	IE		Steel	5336	IE,NA	IE	NA	NA
	Pig Iron	6106	IE,NA	IE		Pig Iron	4177	IE,NA	IE	NA	NA
	Direct reduced iron	NO	NO	NO		Direct reduced iron	NO	NO	NO	NA	NA
	Sinter	8469	IE,NA	IE		Sinter	6010	IE,NA	IE	NA	NA
	Pellet	NO	NO	NO		Pellet	NO	NO	NO	NA	NA
	Other			9643		Other			7287		
	Use of limestone and dolomite	891	1	462		Use of limestone and dolomite	1039	1	894	CS	PS
	Metallurgical coke	7125	1	9180		Metallurgical coke	2209	3	6393	T2	D
Denmark	**Iron and steel production**			30	**Denmark**	**Iron and steel production**			NO		
	Steel	614	0.05	30		Steel	NO	NO	NO	NA	NA
	Pig Iron	NO	NO	NO		Pig Iron	NO	NO	NO	NA	NA
	Direct reduced iron	NO	NO	NO		Direct reduced iron	NO	NO	NO	NA	NA
	Sinter	NO	NO	NO		Sinter	NO	NO	NO	NA	NA

Member State	1990 category	Activity data (kt)	Implied Emission Factor (t/t)	CO_2 Emissions (kt)	Member State	2016 category	Activity data (kt)	Implied Emission Factor (t/t)	CO_2 Emissions (kt)	Method	Emission factor informa-tion
	Pellet	NO	NO	NO		Pellet	NO	NO	NO	NA	NA
	Other			-		Other			-		
Estonia	**Iron and steel production**			NO	Estonia	**Iron and steel production**			NO		
	Steel	NO	NO	NO		Steel	NO	NO	NO	NA	NA
	Pig Iron	NO	NO	NO		Pig Iron	NO	NO	NO	NA	NA
	Direct reduced iron	NO	NO	NO		Direct reduced iron	NO	NO	NO	NA	NA
	Sinter	NO	NO	NO		Sinter	NO	NO	NO	NA	NA
	Pellet	NO	NO	NO		Pellet	NO	NO	NO	NA	NA
	Other			NO		Other			NO		
Finland	**Iron and steel production**			1967	Finland	**Iron and steel production**			2171		
	Steel	2861	0.69	1967		Steel	4048	0.54	2171	CS,T3	CS
	Pig Iron	NO	NO,IE	IE		Pig Iron	NO	NO,IE	IE	NA	NA
	Direct reduced iron	NO	NO	NO		Direct reduced iron	NO	NO	NO	NA	NA
	Sinter	NA	IE,NO	IE		Sinter	NA	NO,IE	IE	NA	NA
	Pellet	NO	NO	NO		Pellet	NO	NO	NO	NA	NA
	Other			NO		Other			NO		
	Other Iron and Steel Production.Other non-specified	487	NO	NO		Other Iron and Steel Production.Other non-specified	765	NO	NO	NA	NA
France	**Iron and steel production**			4349	France	**Iron and steel production**			2465		
	Steel	19073	0.09	1713		Steel	14451	0.08	1201	T2	CS
	Pig Iron	14088	0.09	1317		Pig Iron	9653	0.04	432	T2	CS
	Direct reduced iron	NO	NO	NO		Direct reduced iron	NO	NO	NO	NA	NA
	Sinter	22000	0.06	1319		Sinter	13151	0.06	802	T2	CS
	Pellet	NO	NO	NO		Pellet	NO	NO	NO	NA	NA
	Other			NO		Other			31		
Germany	**Iron and steel production**			22810	Germany	**Iron and steel production**			15976		

Member State	1990 category	Activity data (kt)	Implied Emission Factor (t/t)	CO_2 Emissions (kt)	Member State	2016 category	Activity data (kt)	Implied Emission Factor (t/t)	CO_2 Emissions (kt)	Method	Emission factor informa-tion
	Steel	43939	0.52	22810		Steel	42080	0.38	15976	T2	CS
	Pig Iron	32263	NO,IE	IE		Pig Iron	27873	NO,IE	IE	NA	NA
	Direct reduced iron	IE	IE	IE		Direct reduced iron	IE	IE	IE	NA	NA
	Sinter	IE	IE	IE		Sinter	IE	IE	IE	NA	NA
	Pellet	NO	NO	NO		Pellet	NO	NO	NO	NA	NA
	Other			NO		Other			NO		
Greece	**Iron and steel production**			105	**Greece**	**Iron and steel production**			74		
	Steel	999	0.10	105		Steel	1158	0.06	74	CS	PS
	Pig Iron	NO	NO	NO		Pig Iron	NO	NO	NO	NA	NA
	Direct reduced iron	NO	NO	NO		Direct reduced iron	NO	NO	NO	NA	NA
	Sinter	NO	NO	NO		Sinter	NO	NO	NO	NA	NA
	Pellet	NO	NO	NO		Pellet	NO	NO	NO	NA	NA
	Other			NO		Other			NO		
Hungary	**Iron and steel production**			3153	**Hungary**	**Iron and steel production**			867		
	Steel	2963	0.12	346		Steel	1274	0.12	153	T3	PS
	Pig Iron	1697	1.65	2427		Pig Iron	863	1.65	505	T3	PS
	Direct reduced iron	NO	NO	NO		Direct reduced iron	NO	NO	NO	NA	NA
	Sinter	72	5.28	380		Sinter	41	5.08	208	T3	PS
	Pellet	IE	IE	IE		Pellet	IE	IE	IE	NA	NA
	Other			NO		Other			NO		
Iceland	**Iron and steel production**			NO	**Iceland**	**Iron and steel production**			1		
	Steel	NO	NO	NO		Steel	8	0.08	1	T1	D
	Pig Iron	NO	NO	NO		Pig Iron	NO	NO	NO	NA	NA
	Direct reduced iron	NO	NO	NO		Direct reduced iron	NO	NO	NO	NA	NA
	Sinter	NO	NO	NO		Sinter	NO	NO	NO	NA	NA
	Pellet	NO	NO	NO		Pellet	NO	NO	NO	NA	NA
	Other			NO		Other			-		

Member State	1990				Member State	2016				Method	Emission factor informa-tion
	category	Activity data (kt)	Implied Emission Factor (t/t)	CO_2 Emissions (kt)		category	Activity data (kt)	Implied Emission Factor (t/t)	CO_2 Emissions (kt)		
Ireland	**Iron and steel production**			26	**Ireland**	**Iron and steel production**			NO		
	Steel	326	0.08	26		Steel	NO	NO	NO	NA	NA
	Pig Iron	NO	NO	NO		Pig Iron	NO	NO	NO	NA	NA
	Direct reduced iron	NO	NO	NO		Direct reduced iron	NO	NO	NO	NA	NA
	Sinter	NO	NO	NO		Sinter	NO	NO	NO	NA	NA
	Pellet	NO	NO	NO		Pellet	NO	NO	NO	NA	NA
	Other			NO		Other			NO		
Italy	**Iron and steel production**			3124	**Italy**	**Iron and steel production**			1473		
	Steel	25467	0.05	1346		Steel	23373	0.04	949	T2	CR,CS,PS
	Pig Iron	11852	0.15	1778		Pig Iron	6054	0.09	524	T2	CR,CS,PS
	Direct reduced iron	NO	NO	NO		Direct reduced iron	NO	NO	NO	NA	NA
	Sinter	13577	NO,IE	IE		Sinter	7033	NO,IE	IE	NA	NA
	Pellet	NO	NO	NO		Pellet	NO	NO	NO	NA	NA
	Other			NO		Other			NO		
Latvia	**Iron and steel production**			70	**Latvia**	**Iron and steel production**			NO		
	Steel	550	0.13	70		Steel	NO	NO	NO	NA	NA
	Pig Iron	NO	NO	NO		Pig Iron	NO	NO	NO	NA	NA
	Direct reduced iron	NO	NO	NO		Direct reduced iron	NO	NO	NO	NA	NA
	Sinter	NO	NO	NO		Sinter	NO	NO	NO	NA	NA
	Pellet	NO	NO	NO		Pellet	NO	NO	NO	NA	NA
	Other			NO		Other			NO		
Lithuania	**Iron and steel production**			17	**Lithuania**	**Iron and steel production**			1		
	Steel	NO	NO	NO		Steel	NO	NO	NO	NA	NA
	Pig Iron	NO	NO	NO		Pig Iron	NO	NO	NO	NA	NA
	Direct reduced iron	NO	NO	NO		Direct reduced iron	NO	NO	NO	NA	NA
	Sinter	NO	NO	NO		Sinter	NO	NO	NO	NA	NA
	Pellet	NO	NO	NO		Pellet	NO	NO	NO	NA	NA

Member State	1990 category	Activity data (kt)	Implied Emission Factor (t/t)	CO_2 Emissions (kt)	Member State	2016 category	Activity data (kt)	Implied Emission Factor (t/t)	CO_2 Emissions (kt)	Method	Emission factor informa-tion
	Other			17		Other			1		
	Cast Iron	106	0	17		Cast Iron	2	1	1	T2	D
Luxem-bourg	**Iron and steel production**			985	**Luxem-bourg**	**Iron and steel production**			119		
	Steel	3506	0.12	404		Steel	2175	0.05	119	CS,T2	CS
	Pig Iron	2645	0.08	200		Pig Iron	NO	NO	NO	NA	NA
	Direct reduced iron	NO	NO	NO		Direct reduced iron	NO	NO	NO	NA	NA
	Sinter	4804	0.08	380		Sinter	NO	NO	NO	NA	NA
	Pellet	NO	NO	NO		Pellet	NO	NO	NO	NA	NA
	Other			NO		Other			NO		
Malta	**Iron and steel production**			NO	**Malta**	**Iron and steel production**			NO		
	Steel	NO	NO	NO		Steel	NO	NO	NO	NA	NA
	Pig Iron	NO	NO	NO		Pig Iron	NO	NO	NO	NA	NA
	Direct reduced iron	NO	NO	NO		Direct reduced iron	NO	NO	NO	NA	NA
	Sinter	NO	NO	NO		Sinter	NO	NO	NO	NA	NA
	Pellet	NO	NO	NO		Pellet	NO	NO	NO	NA	NA
	Other			NO		Other			NO		
Nether-lands	**Iron and steel production**			44	**Nether-lands**	**Iron and steel production**			11		
	Steel	5162	0.01	43		Steel	7046	0.00	11	T2	CS
	Pig Iron	NA	NO,IE	IE		Pig Iron	NA	NO,IE	IE	NA	NA
	Direct reduced iron	NA	NO	NO		Direct reduced iron	NO	NO	NO	NA	NA
	Sinter	NA	NO,IE	IE		Sinter	NA	NO,IE	IE	NA	NA
	Pellet	NA	NO,IE	IE		Pellet	NA	NO,IE	IE	NA	NA
	Other			1		Other			0.3		
	Other Iron and Steel Production.Other non-specified	NA	NA	1		Other Iron and Steel Production.Other non-specified	NA	NA	0.3	T2	CS
Poland	**Iron and steel production**			5073	**Poland**	**Iron and steel production**			2023		

Member State	1990 category	Activity data (kt)	Implied Emission Factor (t/t)	CO_2 Emissions (kt)	Member State	2016 category	Activity data (kt)	Implied Emission Factor (t/t)	CO_2 Emissions (kt)	Method	Emission factor informa-tion
	Steel	IE	IE	IE		Steel	IE	IE	IE	NA	NA
	Pig Iron	8657	0.13	1157		Pig Iron	4674	0.16	766	T3	CS
	Direct reduced iron	NO	NO	NO		Direct reduced iron	NO	NO	NO	NA	NA
	Sinter	11779	0.07	841		Sinter	6850	0.04	301	T2	CS
	Pellet	NO	NO	NO		Pellet	NO	NO	NO	NA	NA
	Other			3075		Other			955		
	Basic Oxygen Furnace Steel	7207	0.1	929		Basic Oxygen Furnace Steel	5145	0.1	729	T2	CS
	Electric Furnace Steel	2309	0.04	85		Electric Furnace Steel	4016	0.1	226	T2	CS
	Open-hearth Steel	3945	1	2060		Open-hearth Steel	NO	NO,NA	NO	NA	NA
Portugal	**Iron and steel production**			118	Portugal	**Iron and steel production**			60		
	Steel	621	0.08	50		Steel	1985	0.03	60	T2	PS
	Pig Iron	308	NO	NO		Pig Iron	NO	NO	NO	NA	NA
	Direct reduced iron	NO	NO	NO		Direct reduced iron	NO	NO	NO	NA	NA
	Sinter	338	0.20	68		Sinter	NO	NO	NO	NA	NA
	Pellet	NO	NO	NO		Pellet	NO	NO	NO	NA	NA
	Other			NO		Other			NO		
Romania	**Iron and steel production**			10781	Romania	**Iron and steel production**			3771		
	Steel	9959	1.08	10781		Steel	3435	1.10	3771	T3	CS
	Pig Iron	5916	NO,IE	IE		Pig Iron	1972	NO,IE	IE	NA	NA
	Direct reduced iron	NO	NO	NO		Direct reduced iron	NO	NO	NO	NA	NA
	Sinter	11357	NO,IE	IE		Sinter	2593	NO,IE	IE	NA	NA
	Pellet	NO	NO	NO		Pellet	NO	NO	NO	NA	NA
	Other			NO		Other			NO		
Slovakia	**Iron and steel production**			4168	Slovakia	**Iron and steel production**			4335		
	Steel	3562	1.17	4150		Steel	4599	0.94	4326	T2	PS
	Pig Iron	17	NO,IE	IE		Pig Iron	1	NO,IE	IE	NA	NA

Member State	1990 category	Activity data (kt)	Implied Emission Factor (t/t)	CO_2 Emissions (kt)	Member State	2016 category	Activity data (kt)	Implied Emission Factor (t/t)	CO_2 Emissions (kt)	Method	Emission factor informa-tion
	Direct reduced iron	NO	NO	NO		Direct reduced iron	NO	NO	NO	NA	NA
	Sinter	IE	NO,IE	IE		Sinter	IE	NO,IE	IE	NA	NA
	Pellet	IE	NO,IE	IE		Pellet	IE	NO,IE	IE	NA	NA
	Other			18		Other			9		
	EAF production of steel	311	0.1	18		EAF production of steel	294	0.03	9	T2	PS
Slovenia	**Iron and steel production**			44	Slovenia	**Iron and steel production**			56		
	Steel	632	0.07	44		Steel	643	0.09	56	T2	PS
	Pig Iron	NO	NO,NA	NO		Pig Iron	NO	NO,NA	NO	NA	NA
	Direct reduced iron	NO	NO	NO		Direct reduced iron	NO	NO	NO	NA	NA
	Sinter	NO	NO	NO		Sinter	NO	NO	NO	NA	NA
	Pellet	NO	NO	NO		Pellet	NO	NO	NO	NA	NA
	Other			NO		Other			NO		
Spain	**Iron and steel production**			2435	Spain	**Iron and steel production**			2350		
	Steel	13163	0.07	979		Steel	13448	0.04	584	T2	CS,PS
	Pig Iron	C	C	246		Pig Iron	C	C	304	T2	CS
	Direct reduced iron	IE	IE,NA	IE		Direct reduced iron	IE	IE,NA	IE	NA	NA
	Sinter	C	C	538		Sinter	C	C	212	T2	CS
	Pellet	IE	IE,NA	IE		Pellet	IE	IE,NA	IE	NA	NA
	Other			672		Other			1251		
	Flaring in iron and steel production	C	C	672		Flaring in iron and steel production	C	C	1251	T2	PS
Sweden	**Iron and steel production**			2632	Sweden	**Iron and steel production**			2515		
	Steel	1755	0.09	156		Steel	1730	C,NA	C	T2	PS
	Pig Iron	2736	0.77	2094		Pig Iron	3082	0.67	2075	T3	PS
	Direct reduced iron	109	1.19	129		Direct reduced iron	102	C,NA	C	T3	PS
	Sinter	1058	0.20	212		Sinter	NO	NO	NO	NA	NA
	Pellet	9919	0.00	41		Pellet	24032	0.01	122	T2	PS

Member State	1990				Member State	2016				Method	Emission factor informa-tion
	category	Activity data (kt)	Implied Emission Factor (t/t)	CO_2 Emissions (kt)		category	Activity data (kt)	Implied Emission Factor (t/t)	CO_2 Emissions (kt)		
	Other			-		Other			-		
United Kingdom	**Iron and steel production**			5592	United Kingdom	**Iron and steel production**			2408		
	Steel	17485	0.01	224		Steel	7547	0.02	122	T2	CS
	Pig Iron	12463	0.15	1834		Pig Iron	6142	0.15	920	T2	CS
	Direct reduced iron	NO	NO	NO		Direct reduced iron	NO	NO	NO	NA	NA
	Sinter	C	C	3534		Sinter	C	C	1366	T2	CS
	Pellet	NO	NO	NO		Pellet	NO	NO	NO	NA	NA
	Other			NO		Other			NO		

Presented methods and emission factor information refer to the last inventory year.
Abbreviations explained in the Chapter 'Units and abbreviations'.

As shown in the table, several Member States use IE for some categories. This can be explained by the fact that they make use of carbon balances and several processes occur within the same industrial site, which makes differentiation into the various subcategories difficult. For example, several countries include emissions from the production of pig iron (which occurs at integrated iron and steel production sites) under “steel production”. Similarly, Italy reports emissions from sinter production under 2.C.1.b Pig iron.

According to the 2006 IPCC guidelines, all emissions from iron and steel production should be reported under category 2.C.1, irrespective of their role as reducing agent or fuel.

However, some Member States report emissions from blast furnace gas and from converter gas under 1A2a instead of 2C1 because this can be interpreted as emissions from energy supply.

Thus, for an overview of total emissions it seems to be more convenient to take into account all emissions covered by the combined category 1A2a + 2C1. Resulting emissions for this combined category are given in Table 4.34.

Table 4.34 CO_2 Emissions (2016) of from iron and steel production: 1A2a, 2C1 and combined (sum of both categories). The column "Share 2C1" denotes the ratio of emissions under 2C1 and combined emissions.

Member State	CO_2 emissions in kt			Share in EU28+ISL emissions in 2016	Share 2C1
	1A2a	2C1	Combined		
Austria	1 420	10 418	11 838	7%	88%
Belgium	1 181	4 224	5 404	3%	78%
Bulgaria	114	36	149	0%	24%
Croatia	34	1	35	0%	3%
Cyprus	NO,IE	NO	-	-	-
Czech Republic	1 747	7 287	9 034	6%	81%
Denmark	92	NO	92	0%	-
Estonia	3	NO	3	0%	-
Finland	926	2 171	3 097	2%	70%
France	11 324	2 465	13 789	9%	18%
Germany	37 210	15 976	53 186	33%	30%
Greece	121	74	194	0%	38%
Hungary	169	867	1 036	1%	84%
Ireland	2	NO	2	0%	-
Italy	10 609	1 473	12 083	8%	12%
Latvia	3	NO	3	0%	-
Lithuania	NO	1	1	0%	100%
Luxembourg	267	119	386	0%	31%
Malta	NO,IE	NO	-	-	-
Netherlands	4 752	11	4 763	3%	0%
Poland	5 043	2 023	7 066	4%	29%
Portugal	88	60	147	0%	41%
Romania	1 277	3 771	5 049	3%	75%
Slovakia	2 786	4 335	7 121	4%	61%
Slovenia	202	56	258	0%	22%
Spain	5 529	2 350	7 879	5%	30%
Sweden	1 229	2 515	3 744	2%	67%
United Kingdom	10 024	2 408	12 432	8%	19%
EU-28	**96 151**	**62 640**	**158 791**	**100%**	**39%**
Iceland	2	1	2	0%	29%
United Kingdom (KP)	10 024	2 408	12 432	8%	19%
EU-28 + ISL	**96 153**	**62 641**	**158 794**	**100%**	**39%**

Abbreviations explained in the Chapter 'Units and abbreviations'.

It can be seen that the ratio of emissions under 2C1 and combined emissions (see column "Share 2C1" in Table **4.34**) varies across Member States. This indicates that the boundary between 1A2a and 2C1 is not uniformly interpreted by Member States. The eight Member States with largest CO_2 emissions from iron and steel production allocate their emissions in the following ways:

- Germany: Approx. 30 % of emissions are reported under 2C1. This category comprises process-related CO_2 emissions (including emissions from carbonate use). However, emissions from energy-related use of top gas and converter gas are reported under the respective sub-categories of sector 1.
- United Kingdom: Major share of emissions (81 %) is reported under 1A2a. Emissions from sintering (coke breeze and carbonates), from flared blast furnace gas and from electric and ladle arc furnances are reported under 2C1.

- France: Major share of emissions (82 %) is reported under 1A2a. Emissions from sinter production are reported under 1A2a.
- Austria: 88 % of emissions are reported under 2C1. Generally, all emissions from iron and steel production are reported under this category, irrespective of their role as reducing agent or fuel, but emissions related to the coke oven and to on-site power plants are reported under category 1A2a.
- Italy: Major share of emissions (88 %) is reported under 1A2a. CO_2 emissions due to the consumption of coke, coal and other reducing agents used in the iron and steel industry have been accounted for as fuel consumption and reported in the energy sector. In sector 2C1, emissions are reported from carbonates used in sinter plants and in basic oxygen furnaces, emissions related to steel and pig iron scraps and emissions from graphite electrodes consumed in electric arc furnaces.
- Czech Republic: 81 % of emissions are reported under category 2C1. It also includes emissions from limestone and dolomite use.
- Spain: Major share of emissions (70 %) is reported under 1A2a, including emissions from coke production.
- Poland: 71 % of emissions are reported under 1A2a. Generally, all fuels are reported under this category, but CO_2 emissions from coke in the blast furnace are reported under category 2C1.

4.2.3.2 2C3 Aluminium production

This category includes PFC emissions from aluminium production. Two PFCs, tetrafluoromethane (CF_4) and hexafluoroethane (C_2F_6), are known to be emitted from the process of primary aluminium smelting. These PFCs are formed during the phenomenon known as the anode effect, when the aluminium oxide concentration in the reduction cell electrolyte is low.

Information on CO_2 emissions from Aluminium production can be found at the end of this section.

Table 4.35 summarises information by Member States on emission trends for the key source PFCs from 2C3 Aluminium Production. PFC emissions from 2C3 Aluminium production account for 0.01 % of total EU-28+ISL GHG emissions (without LULUCF) in 2016. Between 1990 and 2016, PFC emissions from this source decreased by 97 %. In 2016, France contributed the highest share among the EU-28+ISL, amounting to 20 % of overall emissions, followed by Germany (17%), Iceland (16%), Greece (16 %) and Spain (15 %). Of the 11 countries reporting PFC emissions under this category in 2016, seven use plant or country-specifc emission factors.

Table 4.35 2C3 Aluminium Production: Member States' contributions to PFC emissions and information on method applied and emission factor

Member State	PFCs Emissions in kt CO2 equiv.			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016		Method	Emission factor Informa-tion
	1990	2015	2016		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	1 149	NO	NO	-	-1 149	-100%	-	-	NA	NA
Belgium	-	-	-	-	-	-	-	-	NA	NA
Bulgaria	-	-	-	-	-	-	-	-	NA	NA
Croatia	1 240	NO	NO	-	-1 240	-100%	-	-	NA	NA
Cyprus	-	-	-	-	-	-	-	-	NA	NA
Czech Republic	-	-	-	-	-	-	-	-	NA	NA
Denmark	NO	NO	NO	-	-	-	-	-	NA	NA
Estonia	NO	-	-	-	-	-	-	-	NA	NA
Finland	NO	-	-	-	-	-	-	-	NA	NA
France	3 567	62	109	19.5%	-3 458	-97%	47	76%	T2,T3	CS,PS
Germany	2 889	95	95	17.0%	-2 793	-97%	1	1%	-	-
Greece	190	66	88	15.8%	-102	-54%	22	34%	T3	PS
Hungary	376	NO	NO	-	-376	-100%	-	-	NA	NA
Ireland	NO	NO	NO	-	-	-	-	-	NA	NA
Italy	1 975	NO	NO	-	-1 975	-100%	-	-	NA	NA
Latvia	-	-	-	-	-	-	-	-	NA	NA
Lithuania	NO	-	-	-	-	-	-	-	NA	NA
Luxembourg	-	-	-	-	-	-	-	-	NA	NA
Malta	-	-	-	-	-	-	-	-	-	-
Netherlands	2 638	7	14	2.4%	-2 624	-99%	7	110%	T2	CS
Poland	142	NO	NO	-	-142	-100%	-	-	NA	NA
Portugal	NO	NO	NO	-	-	-	-	-	NA	NA
Romania	2 808	7	5	1.0%	-2 803	-100%	-1	-17%	T2	D,PS
Slovakia	315	9	6	1.2%	-308	-98%	-2	-24%	T2	PS
Slovenia	208	16	20	3.5%	-188	-90%	4	26%	T3	CS,D
Spain	1 164	86	85	15.2%	-1 079	-93%	-1	-1%	T2	D
Sweden	569	34	30	5.4%	-538	-95%	-4	-11%	T2	D
United Kingdom	1 553	11	14	2.5%	-1 539	-99%	3	27%	T2	PS
EU-28	**20 783**	**392**	**468**	**84%**	**-20 314**	**-98%**	**76**	**19%**	**-**	**-**
Iceland	495	104	92	16.4%	-403	-81%	-12	-11%	NA	NA
United Kingdom (KP)	1 553	11	14	2.5%	-1 539	-99%	3	27%	T2	PS
EU-28 + ISL	**21 277**	**496**	**560**	**100%**	**-20 717**	**-97%**	**64**	**13%**	**-**	**-**

Presented methods and emission factor information refer to the last inventory year.
Abbreviations explained in the Chapter 'Units and abbreviations'.

All Member States reduced their emissions from this source between 1990 and 2016. France, Germany, Italy, the Netherlands, Romania, Spain and the United Kingdom had the largest decreases in absolute terms. The decreasing trend of PFC emissions from this key source between 1990 and 2016 is due to production stop or decline and due to process improvements. The emission peak in 2002 (see Figure 4.18) can be explained by technological changes and sub-optimal conditions of operation (in France and in the Netherlands).

In the review of the 2014 inventory submission of the European Union, the ERT recommended that the European Union provide in the NIR adequate methodology overviews to enable the ERT to make a thorough review of the AD and EF used in the aluminium production emission estimations provided by Greece, the Netherlands and Sweden. This information is provided below. Additional information can be found in the individual NIRs (Greece: page 223, Netherlands: page 157, Sweden: page 267). An overview of methods can also be found in Annex III to this year's inventory submission.

Greece: The estimation of emissions from aluminium production is performed in close collaboration with the sole plant operating in Greece and since 2013 ETS verified reports are also provided to the inventory team. Carbon dioxide emissions from primary aluminium production are calculated using a highly detailed methodology, tracking the carbon content throughout the process. The methodology is based on the 2006 IPCC Tier 3 method, with small interventions that increase the certainty of the estimations. The equations are described in Greece's NIR.

Data are provided by the plant for years 2005-2012. Since detailed data for the previous years are not available, emissions of years 1990-2004 have been recalculated using the Overlap method in line with the IPCC GPG. It should be noted that the production methodology applied is Centre Worked Prebake with Feed Point System (PFPB methodology). Data since 2013 are provided by the verified ETS reports.

Aluminium production data are directly provided by the plant and are considered confidential. However, publicly available data from the US Geological Survey, the UN Commodity Statistics Database and the Greek Mining Enterprises Association are also used for QA/QC reasons. According to the recommendation made by the previous ERTs, Greece is reporting aluminium production based on these data, although the estimations are based on the more detailed and accurate production quantities provided directly by the plant. It should be mentioned that the reported values are the ones provided by the US Geological Survey, since they cover the whole of the time-series.

PFC emissions estimates are based on anode effect performance by calculating the anode effect overvoltage statistic (Overvoltage method) and are provided directly to the inventory team by the sole plant operating in Greece. 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 EF is estimated based on Eq. 3.11 of Chapter 3/GPG (EF=Over-Voltage Coefficient*AEO/CE). The Over-Voltage Coefficient value used by the plant is 1.16 (the updated default one of 2006 IPCC Guidelines), while the Anode Effect Overvoltage (AEO) and Current Efficiency (CE) are measured for each series of electrolytic cells (there are three series). The C2F6 emissions are then calculated by using the following formula: C2F6 = 0.1•CF4.

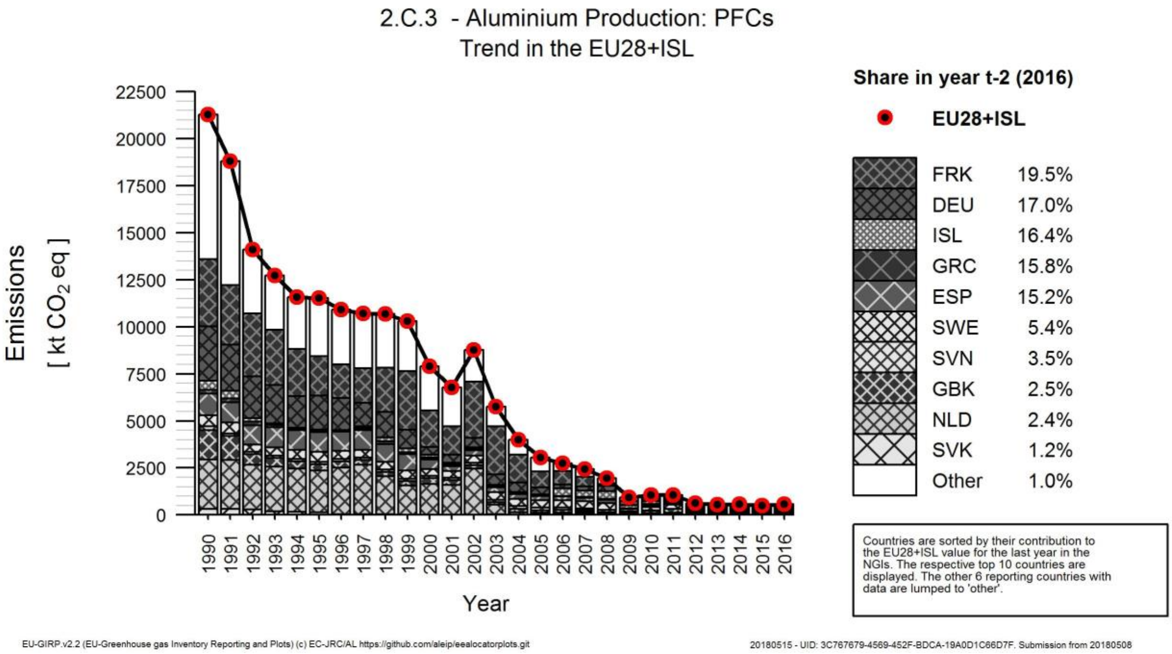
The Netherlands: Estimations of the PFC emissions from primary aluminium production reported by these two facilities are based on the IPCC Tier 2 method for the complete period 1990‑2016. Emission factors are plant-specific and confidential and are based on measured data.

Sweden: The two different processes for aluminium production, prebaked (CWPB) and Söderberg (VSS), have substantially different emission factors for PFCs. Estimates of emissions are based on the number of ovens and the number and duration of anode effects. This activity data is considered to be of good quality.

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. The activity data and emissions can be found on page 268 of Sweden's NIR 2018.

Besides PFC emissions, aluminium production is a source of CO_2 emissions. Of the countries which reported CO_2 emissions from aluminium production for 2016, two use a Tier 1 method, two use a Tier 2 method, seven use a Tier 3 method and one uses a country-specific method. One country uses the default emission factor, four use country-specific emission factors and seven use plant-specifc emission factors. Information on the reported CO_2 emissions can be found in the overview table in chapter 4.2.3. Information on activity data can be found in the CRF tables. Further details, e.g. on assumptions made by the various countries, can be found in the countries' NIRs.

Figure 4.18 2C3 Aluminium Production: PFC emissions



4.2.3.3 2C7 Other

Under this category, various emissions are reported which cannot be attributed to another category under 2C. Specifically, this includes the process emissions from the non-ferro sector (including lead and zinc) in Belguim, Silicium production in Spain, Copper and nickel smelting in Finland, emissions of CO_2 from one plant producing copper, lead and zinc, and one metal recycling plant mainly producing lead by melting used batteries and recovering the lead in Sweden and CO_2 emissions from anode burn-off during the baking process of anodes (used for aluminium production) in Slovenia.

Information on the emissions from this category is given in the overview table in chapter 4.2.3.

4.2.4 Non-energy products from fuels and solvent use (CRF Source Category 2D)

This source category includes greenhouse gas emissions from non-energy producs from fuel and solvent use. Table 4.31 summarises information by Member State on total CO_2 emissions. Between 1990 and 2016, CO_2 emissions from 2D non-energy products from fuels and solvent use decreased by approx. 26%. The absolute decrease of CO_2 emissions was largest in France, Germany and Italy.

Table 4.36: Key source categories for level and trend analyses and share of MS emissions using higher tier methods for sector 2D (Table excerpt).

Source category gas	kt CO_2 equ.		Trend	Level		share of higher Tier
	1990	2016		1990	2016	
2.D.3 Other non-energy products from fuels and solvent use	8384	6014	0	L	0	66 %

Table 4.37: 2D Non-energy products from fuels and solvent use: Member States' contributions to total GHG, CO_2, N_2O- and CH_4 emissions

Member State	GHG emissions in 1990 (kt CO2 equivalents)	GHG emissions in 2016 (kt CO2 equivalents)	CO2 emissions in 1990 (kt)	CO2 emissions in 2016 (kt)	N2O emissions in 1990 (kt CO2 equivalents)	N2O emissions in 2016 (kt CO2 equivalents)	CH4 emissions in 1990 (kt CO2 equivalents)	CH4 emissions in 2016 (kt CO2 equivalents)
Austria	349	205	349	205	NA	NA	NA	NA
Belgium	214	100	214	100	NO,NA	NO,NA	NO,NA	NO,NA
Bulgaria	158	89	158	89	NO,NA	NO,NA	NO,NA	NO,NA
Croatia	235	81	235	81	NA	NA	NA	NA
Cyprus	13	15	13	15	NE,NA	NE,NA	NE,NA	NE,NA
Czech Republic	126	140	126	140	NA,NO	NO,NA	NA,NO	NO,NA
Denmark	166	165	166	164	0	0	0	0
Estonia	38	22	38	22	NO	NO	NO	NO
Finland	220	108	218	107	2	1	0	0
France	2 047	1 186	2 041	1 183	3	3	3	0
Germany	3 332	2 550	3 331	2 549	1	1	NA	NA
Greece	80	29	80	29	NA,NO	NO,NA	NA,NO	NO,NA
Hungary	208	129	208	129	NA,NO	NO,NA	NA,NO	NO,NA
Ireland	93	92	93	92	NO	NO	NO	NO
Italy	1 710	980	1 710	980	NA,NO	NO,NA	NA,NO	NO,NA
Latvia	52	50	52	50	NO,NA	NO,NA	NO,NA	NO,NA
Lithuania	50	51	50	51	NO	NO	NO	NO
Luxembourg	22	32	22	32	NO	NO	NO	NO
Malta	4	0	4	0	NA	NA	NA	NA
Netherlands	188	319	188	319	NO,NA	NO,NA	0	0
Poland	409	747	409	747	NA,NO	NO,NA	NA,NO	NO,NA
Portugal	249	208	249	207	NO	NO	1	1
Romania	1 655	1 107	1 655	1 107	NE	NE	NE	NE
Slovakia	132	84	132	84	NO,NA,NE	NO,NE,NA	NO,NA,NE	NO,NE,NA
Slovenia	8	24	8	24	NA	NA	NA	NA
Spain	954	850	954	850	NO,NA	NA	NO,NA	NA
Sweden	393	442	393	442	NA	NA	NA	NA
United Kingdom	553	352	553	352	NO,NE,IE	NO,NE,IE	NO,IE	NO,IE
EU-28	**13 657**	**10 157**	**13 647**	**10 150**	**5**	**5**	**5**	**2**
Iceland	7	5	7	5	NE,NA	NO,NE,NA	NE,NA	NO,NE,NA
United Kingdom (KP)	553	352	553	352	NO,NE,IE	NO,NE,IE	NO,IE	NO,IE
EU-28 + ISL	**13 664**	**10 163**	**13 654**	**10 156**	**5**	**5**	**5**	**2**

Abbreviations explained in the Chapter 'Units and abbreviations'.

Table **4.31** provides information on the contribution of Member States to EU recalculations of CO_2 emissions from 2D Non-energy products from fuels and solvent use for 1990 and 2015, including main explanations.

Table 4.38: 2D Non-energy products from fuels and solvent use: Contribution of MS to EU recalculations in CO_2 for 1990 and 2015 (difference between latest submission and previous submission in kt of CO_2 and percent of sector total)

	1990		2015		Main explanations
	kt CO_2	%	kt CO_2	%	
Austria	-	-	22	12.1	Emissions from urea use have been moved from 2.G to this category.
Belgium	0	0.0	-1	-0.8	Emissions of 4T-motors are taken into account as process emissions in this category. As Copert version is optimized also these emissions change.
Bulgaria	-7	-4.2	-3	-3.9	Lubricant Use: The recalculations are based on all the quantities of lubricants, obtained by the NSI. Before that only the quantities from road transportation, obtained through the COPERT model, were used. Urea Use: The urea consumption has been recalculated due to the implementation of COPERT 5 model and the update of the vehicle fleet matrix regarding EURO 5 and EURO 6 vehicles. Solvent Use: Bulgaria has accepted the technical correction, performed by the technical expert review team after the ESD review in 2016, which is based on a simple approach using per capita ratios from a group of 9 Member States (Romania, Hungary, Slovakia, Czech Republic, Poland,

	1990		2015		Main explanations
	kt CO_2	%	kt CO_2	%	
					Austria, Italy, Croatia and Bulgaria). The CO_2 emissions result from Bulgaria's reported CO_2 emissions from solvent use under 2G4, which have been subtracted from the CO_2 emission based on average per capita value.
Croatia	45	23.9	15	25.0	Correction of error.
Cyprus	7	113.2	3	32.5	CO_2 emissions have been recalculated due to revision of NMVOCs emissions used for the estimation of CO_2 emissions from Solvent use. The impact of recalculations on emissions is shown on page 122 of the NIR.
Czech Republic	-	-	-	-	
Denmark	0	0.3	1	0.4	Correction of activity data for lubricant use, small changes to calculation method for activity data for paraffin wax use, and correction of an error for road paving with asphalt. A more thorough description can be found on page 349 of Denmark's NIR.
Estonia	-0	-0.6	-0	-0.4	NMVOC and consequently indirect CO_2 emissions from NMVOCs in NFR 2D3a Domestic solvent use (e.g. fungicides), NFR 2D3d Coating applications (e.g. paint), NFR 2D3e Degreasing, NFR 2D3i Other solvent use and NFR 2G Other product use (e.g. tobacco) have been recalculated for years 1990–2015 due to the application of new emission calculation methodology, correction of emissions from the point sources database, correction of statistical activity data.
Finland	0	0.0	-33	-24.1	Emissions of lubricant use for 2015 were recalculated.
France	-559	-21.5	-475	-28.5	2D3: Transfer of a part of CO_2 emissions from CRF 2D3 - solvent use to 2G4. Oxidation of NMVOC: Update of mean carbon contents of NMVOCs combusted in oxidisers, and correction of a mistake for 2015.
Germany	9	0.3	19	0.8	Amongst others: revised AD for paraffin waxes (2.D.1.) and lubricants (2.D.2).
Greece	-	-	-	-	
Hungary	2	1.0	-9	-6.5	Indirect CO_2 emission from NMVOC: revised estimates due to NEC Directive review.
Ireland	16	20.7	-30	-24.5	Some indirect CO_2 from NMVOC moved to 2G and 2H.
Italy	18	1.1	-69	-6.6	Update of activity data.
Latvia	4	8.8	3	7.9	For Solvent use sector recalculations have been done for the whole time series taking into account some of the detected errors after previously submitted report. For instance, now there is used correct Tier 1 EF 400 gNMVOC/kg paint for Other industrial paint application (2D3d_8, see more in NIR Table 4.37) for all time series (previously there was wrong Tier 1 EF – 200 gNMVOC/kg). Similarly, for subcategory Application of glues and adhesives (2D3i_3, see more in NIR Table 4.37) now is used Tier 2 EF 562 gNMVOC/kg solvent (previously there was Tier 1 EF 2 kgNMVOC/Mg product used. Related to the Other Solvent Use (2D3i, see more in NIR Table 4.37) Latvia has reviewed submitted data for year 2015 in CR once again and completed missing data gaps. Minor recalculations were done in 2.D.1 and 2.D.2 sectors in all timeseries due to precising of conversion factor (44.0098/12.011) and activity data by CSB.
Lithuania	-21	-29.5	-	-	NMVOC and CO_2 emissions in Coating applications sub-category for years 1990-2004 were recalculated applying extrapolation.
Luxembourg	-	-	1	3.5	Revision of activity data in 2.D.3.1. Solvent use and 2.D.3.2. Urea-based catalysts
Malta	-	-	0	1.4	The requested quantity of road paving material produced in the year 2015 was not received till the time of the compilation of the 2017 inventory. Thus, in the inventory submitted in the year 2017, it was assumed that this value was equal to the activity data received for the previous year - i.e. 2014. Eventually, the applicable data for the year 2015 was received and entered in the worksheet, thus updating the CRF tables.
Netherlands	-	-	0	0.1	Final energy and fire works statistics.
Poland	-	-	5	0.6	Correction of activity data.

	1990		2015		Main explanations
	kt CO_2	%	kt CO_2	%	
Portugal	1	0.2	21	10.8	Several subsectors have been introduced (accounted for the first time) in sector 2.D.3.a (please check Portugal Informative Inventory Report for more detailled information on CO_2 emissions related to NMVOC). Correction of emissions from the use of urea-based additives in catalytic converters (reported under 2.D.3.c) due to the new stock values and the application of the Copert V used in Road Transport (1.A.3.b)
Romania	359	27.7	641	146.9	Recalculations have been made for the 2000-2015 period. Recalculations were made as a result of due to an improvement in activity data for the consistency of the data used to estimate emissions in preparation of the greenhouse gas inventories with the data used to prepare inventories of air pollutants under Directive 2001/81/EC and under the UNECE Convention on Long-range Transboundary Air Pollution. (CRF Category 2.D.3.a). Recalculation have been made for the 1989-2015 period due to an improvement in the activity data used in the CO_2 emissions estimates from 2D Non-energy products from fuels and solvent use subsector, taking into account emissions from petroleum coke. (CRF Category 2.D.3.d).
Slovakia	-30	-18.5	-33	-26.6	2.D.3 category. Methodological changes in CTRLAP inventory resulted in the recalculation of NMVOC emissions. Recalculation of NMVOC emissions resulted in the recalculation of the respective indirect CO_2 emissions. Recalculation of CO_2 from urea use in vehicles was made. The recalculation was made due the change of activity data in transport categories.
Slovenia	0	0.1	1	4.2	Change in lubricants and urea based catalyst in the road transport.
Spain	-47	-4.7	-18	-2.1	Reallocation of indirect CO_2 emissions from solvent use to indirect emissions under CRF 2 category, some changes according to implementation of EMEP/EEA Guidebook 2016.
Sweden	0	0.0	-27	-5.8	Emissions from solvent use are calculated with three year running average resulting in updated emissions for the last three years (2013, 2014, 2015). In addition, activity data for solvent use and urea used as catalyst is delivered with a delay of one year meaning activity data has been obtained for 2015 and was previously set equal to 2014./ Due to the recurring one year lag of updating the data from the Product Register from the Swedish Chemicals Agency, the reported emissions was updated in submission 2018
United Kingdom	0	0.0	31	10.3	DUKES recalculation to sectoral split for lubricants; Lubricant emission factors moved from a fuel oxidised basis to a fuel used basis.
EU28	-202	-1.5	66	0.7	
Iceland	3	60.0	3	92.3	Now reporting NMVOC converted to CO_2 for solvents use (2D3) following comment from EU review
United Kingdom (KP)	-0	-0.0	31	10.3	DUKES recalculation to sectoral split for lubricants; Lubricant emission factors moved from a fuel oxidised basis to a fuel used basis.
EU28+ISL	-199	-1.4	68	0.7	

4.2.4.1 2D3 Other non-energy products from fuels and solvent use

This chapter provides information on greenhouse gas emissions from other non-energy producs from fuel and solvent use. Solvents are chemical compounds that are used to dissolve substances as paint, glues, ink, rubber, plastic, pesticides or for cleaning purposes. After application (or other procedures of solvent use) most of these substances are released into air.

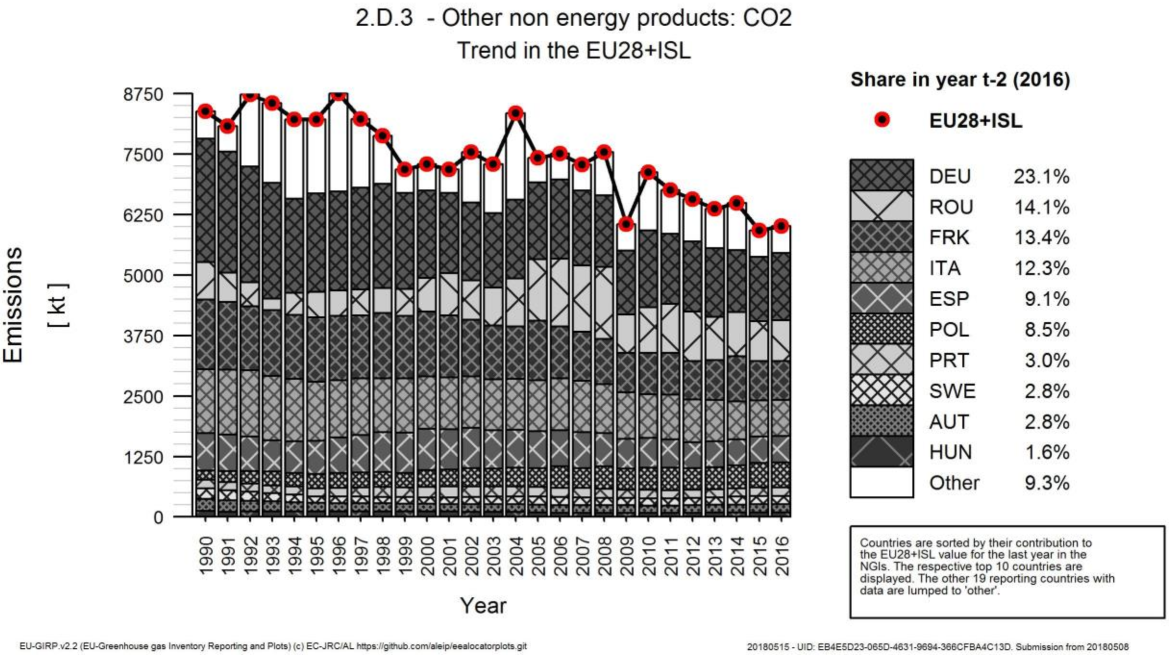
CO_2 emissions from this sector amounted to approximately 0.14% of total GHG emissions (without LULUCF) in 2016. Germany, France, Italy and Romania together account for 63% of all emissions in the EU-28. Emissions from this sector decreased by 28% since 1990, with the biggest decrease in absolute terms in Germany and France. Emissions decreased in most contries. Luxembourg, Poland, Romania and Iceland showed emission increases since 1990. The peak in 2004 is due to an increase of emissions in the United Kingdom. In addition, some countries do not report emissions in this category in 1990, but report emissions, mainly from urea use in the transport sector, for more recent years.

Table 4.39 2D3 Other non-energy products from fuels and solvent use: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016		Method	Emission factor Information
	1990	2015	2016		kt CO2	%	kt CO2	%		
Austria	252	164	167	2.8%	-85	-34%	3	2%	T1,T2	CS,D
Belgium	NO,NA	21	23	0.4%	23	∞	2	9%	M,T3	CS,OTH
Bulgaria	76	72	72	1.2%	-4	-5%	0	0%	T1,T2	CR,D
Croatia	139	57	61	1.0%	-79	-57%	4	7%	OTH,T1	D
Cyprus	12	9	10	0.2%	-3	-21%	0	4%	CS,D	CS,D
Czech Republic	NO,NA	18	19	0.3%	19	∞	1	4%	T1	D
Denmark	94	69	66	1.1%	-28	-29%	-2	-3%	CS,T2,T3	CS,D,OTH
Estonia	21	17	18	0.3%	-3	-15%	1	6%	D,T2	D
Finland	NO	7	8	0.1%	8	∞	2	27%	T1	D
France	1 431	819	805	13.4%	-625	-44%	-14	-2%	T1,T2	CS,D,PS
Germany	2 552	1 331	1 387	23.1%	-1 165	-46%	56	4%	T1	D,NE
Greece	NO,NA	1	1	0.0%	1	∞	0	7%	D	D
Hungary	124	97	96	1.6%	-28	-23%	-1	-1%	T1,T2	D
Ireland	51	48	50	0.8%	-1	-3%	2	3%	T1,T2	D
Italy	1 329	744	742	12.3%	-587	-44%	-3	0%	CR,CS,T2	CR,CS,M,PS
Latvia	29	27	26	0.4%	-3	-10%	-1	-4%	CS,D,T1,T2	D,PS
Lithuania	43	35	37	0.6%	-6	-14%	2	5%	T1,T2,T3	CR,D
Luxembourg	15	24	24	0.4%	8	55%	0	-2%	CS,M	CS,D
Malta	0	0	0	0.0%	0	-61%	0	0%	T1	CR
Netherlands	NO	22	21	0.4%	21	∞	0	-1%	T3	NA
Poland	186	497	512	8.5%	326	175%	15	3%	T1,T3	D
Portugal	177	183	178	3.0%	2	1%	-5	-3%	CR,NO	CR,CS,NO,OTH
Romania	780	819	850	14.1%	69	9%	30	4%	CR,D	CR,CS
Slovakia	81	61	55	0.9%	-26	-32%	-6	-10%	CS	CS
Slovenia	NO,NA	3	4	0.1%	4	∞	0	15%	M	M
Spain	771	548	548	9.1%	-222	-29%	0	0%	T1	D
Sweden	217	170	170	2.8%	-47	-22%	0	0%	T1,T3	CS,D
United Kingdom	NE,NO	58	61	1.0%	61	∞	3	5%	T3	CR,D
EU-28	**8 382**	**5 922**	**6 011**	**100%**	**-2 370**	**-28%**	**89**	**2%**	**-**	**-**
Iceland	3	3	3	0.0%	0	5%	0	4%	D	D
United Kingdom (KP)	NO,NE	58	61	1.0%	61	∞	3	5%	T3	CR,D
EU-28 + ISL	**8 384**	**5 925**	**6 014**	**100%**	**-2 370**	**-28%**	**89**	**2%**	**-**	**-**

Presented methods and emission factor information refer to the last inventory year.
Abbreviations explained in the Chapter 'Units and abbreviations'.

Figure 4.19 2D3 Other non-energy products from fuels and solvent use: CO_2 emissions



For this category, it is not useful to give an average EF across the Member States because of the different methods used, and because of the fact that this category is split into many subcategories with varying EFs. Table 4.39 provides an overview Member States' reporting of CO_2 emissions from 2D3.

Table 4.40 2D3 Other non-energy products from fuels and solvent use: Reporting of CO_2 emissions by Member States

MS	Category	kt
AUT	3. Other (please specify)	166.68
	Solvent use	143.73
	Road paving with asphalt	IE
	Asphalt roofing	IE
	Urea used as a catalyst	22.95
BEL	3. Other (please specify)	22.86
	Solvent use	NA
	Road paving with asphalt	NA
	Asphalt roofing	NA
	Urea used as a catalyst	22.86
	Unspecified	NO
BGR	3. Other (please specify)	72.16
	Solvent use	69.73
	Road paving with asphalt	NA
	Asphalt roofing	NA
	Urea used as a catalyst	2.43
CYP	3. Other (please specify)	9.73
	Dry cleaning	0.06
	Coating applications	5.39
	Chemical products	0.09
	Asphalt roofing	0.02
	Solvent use	2.28
	Road paving with asphalt	0.01
	Printing	0.59
	Urea-based catalysts	1.30
CZE	3. Other (please specify)	18.88
	Solvent use	NO

MS	Category	kt
EST	3. Other (please specify)	17.61
	Solvent use	16.33
	Road paving with asphalt	0.04
	Urea based catalysts for motor vehicles	1.24
FIN	3. Other (please specify)	8.28
	Solvent use	NO
	Road paving with asphalt	NO
	Asphalt roofing	NO
	Use of urea-based catalysts	8.28
FRK	3. Other (please specify)	805.44
	Solvent use	346.09
	Road paving with asphalt	NA
	Asphalt roofing	NE
	Other incl. urea use in SCR	459.36
GBE	3. Other (please specify)	60.90
	Solvent use	NE
	Urea use (road transport)	60.90
	Petroleum coke use	NO
GRC	3. Other (please specify)	0.73
	Solvent use	NA
	Road paving with asphalt	NO
	Asphalt roofing	NO
	Urea used as a catalyst	0.73
HRV	3. Other (please specify)	60.59
	Solvent use	54.46
	Road paving with asphalt	0.02
	Asphalt roofing	0.01

MS	Category	kt
LTU	3. Other (please specify)	37.26
	Solvent use	35.19
	Road paving with asphalt	0.00
	Asphalt roofing	0.01
	Urea-based catalyst	2.06
LUX	3. Other (please specify)	23.89
	Solvent use	15.09
	Urea-based catalysts	8.80
LVA	3. Other (please specify)	25.79
	Urea use	1.00
	Solvent Use	24.66
	Asphalt roofing	0.06
	Road paving with asphalt	0.07
MLT	3. Other (please specify)	0.01
	Solvent use	NA
	Road paving with asphalt	0.01
NLD	3. Other *(please specify)*	21.33
	Other non-specified	NO
	Ureum use in SCR	21.33
POL	3. Other (please specify)	512.25
	Solvent use	489.60
	Urea used as catalyst	22.64
PRT	3. Other (please specify)	178.49
	Solvent use	154.09
	Road paving with asphalt	12.23
	Urea-based catalysts	12.16
ROU	3. Other (please specify)	849.69

MS	Category	kt
	Road paving with asphalt	NA
	Urea used as catalyst	18.88
DEU	3. Other (please specify)	1386.88
	Solvent use	1218.17
	Road paving with asphalt	NE
	Asphalt roofing	NE
	AdBlue	168.70
DNM	3. Other (please specify)	66.46
	Solvent use	57.80
	Road paving with asphalt	0.83
	Asphalt roofing	0.01
	Urea used in catalysts	7.82
ESP	3. Other (please specify)	548.11
	Solvent use	500.80
	Road paving with asphalt	NA
	Asphalt roofing	NA
	Urea-based catalytic converter	47.31

MS	Category	kt
	Urea based CC	6.10
HUN	3. Other (please specify)	95.98
	Other (please specify)	95.98
	Indirect CO_2 from solvents	89.34
	Urea based catalysts	6.64
IRL	3. Other (please specify)	50.01
	Solvent use	40.95
	Urea used as a catalyst	9.06
ITA	3. Other (please specify)	741.71
	Solvent use	683.26
	Road paving with asphalt	NA
	Asphalt roofing	NA
	Urea used in power plants	7.04
	Urea used in engines	51.42

MS	Category	kt
	Solvent use	161.18
	Road paving with asphalt	NE
	Asphalt roofing	NE
	Petroleum coke use	688.51
SVK	3. Other (please specify)	55.42
	Solvent use	47.08
	Road paving with asphalt	NE
	Asphalt roofing	NE
	Urea catalytic converters	8.35
SVN	3. Other (please specify)	3.67
	Asphalt roofing	NA
	Road paving	NA
	Solvent use	NA
	Urea based catalyst	3.67
SWE	3. Other (please specify)	170.44
	Road paving with asphalt	NA
	Asphalt roofing	NA
	Solvent use	132.57
	Urea used as catalyst	37.87

Note: Austria includes emissions from road paving and asphalt roofing under "Solvent use".

4.2.5 Electronics Industry (CRF Source Category 2.E)

2.E Electronics Industry comprises mainly emissions which were formerly reported under 2.F.7 Semiconductor Manufacture. The category includes the following subcategories: 2.E.1 Integrated Circuit or Semiconductor, 2.E.2 TFT Flat Panel Display, 2.E.3 Photovoltaics, 2.E.4 Heat Transfer Fluid and 2.E.5 Other. Out of these, the most important emission source in Europe is the production of integrated circuits and semiconductors (2.E.1). Emissions from photovoltaics industry and heat transfer fluids are reported by very few Member States only. Manufacture of TFT Flat Panel Displays does not take place in the EU.

4.2.6 Product uses as substitutes for ODS (CRF Source Category 2.F) (EU-28+ISL)

This category is similar to the former category 2.F Consumption of Halocarbons and SF_6, except that the former subcategory 2.F.7 Electronics Industry is now reported under 2.E and the former subcategories 2.F.8 Electrical Equipment and 2.F.9 Other sources of SF_6 are now reported under 2.G. Emissions related to the Consumption of Halocarbons (HFCs, PFCs) are reported under this source category. HFCs are predominantly serving as alternatives to ozone depleting substances (ODS) that are being phased out under the Montreal Protocol, and have been introduced to the EU market first at the end of 1990. The main applications of halocarbons include refrigeration and air conditioning, foam blowing, fire protection, aerosols, solvents as well as some other applications. PFCs are used to minor extent in this subcategory but mainly in semiconductor manufacture (2.E.1).

The source category 2.F Product uses as substitutes for ODS includes four key categories which occur in all Member States:

Table 4.41: Key categories for sector 2F (Table excerpt)

Source category gas	kt CO_2 equ.		Trend	Level		share of higher Tier
	1990	2016		1990	2016	
2.F.1 Refrigeration and Air conditioning: no classification (HFCs)	4	97283	T	0	L	95%
2.F.2 Foam Blowing Agents: no classification (HFCs)	0	2957	T	0	0	95%
2.F.3 Fire Protection: no classification (HFCs)	0	3356	T	0	0	95%
2.F.4 Aerosols: no classification (HFCs)	3	5494	T	0	0	95%

Table.4.42 provides information on the contribution of Member States to EU-28+ISL recalculations in HFC from 2F Product uses as substitutes for ODS for 1990 and 2015 and main explanations for the largest recalculations in absolute terms.

Table.4.42 2F Product uses as substitutes for ODS: Contribution of MS to EU recalculations in HFC for 1990 and 2016 (difference between latest submission and previous submission in kt of CO_2 equivalents and percent)

	1990		2015		Main explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
Austria	-	-	-42	-2.5	NA
Belgium	-	-	44	1.6	Revision of emission factors for 2-component spray foam and of export assumptions for 2-component spray foam and canister foam Adjustment of manufacturing and fugitive emissions of technical aerosols because of new information
Bulgaria	-	-	70	6.1	2F1e: Recalculations are due to the revision of the cars over 20 years with air conditioners and their inclusion in the calculations. 2F3: Revision of data as companies, included in a list from National Fire Safety and Protection of Population Service" which have fire extinguishing installations were reviewed. 2F4: technical error has been found in the calculations.
Croatia	-	-	0	0.0	Error corrected
Cyprus	-	-	-83	-23.0	2F: The emissions for the whole period have been recalculated for the 2018 submission due to the following changes: (a) Revised data in the 2017 submissions of the four countries used. (b) Malta was excluded from the calculations of the per capita emission factor due to large fluctuations in the emissions reported. (c) Correction of a mistake identified during 2017 centralised review by the ERT; the 2013 per capita emission factor was used for the estimation of the 2015 instead of the 2014; 2014 population of Cyprus. (d) Spain was excluded from the calculation of the average for 2014 and 2015.
Czech Republic	-	-	-529	-15.3	Updated emission factors, new sources of activity data for category 2.F.1.e
Denmark	-	-	5	0.8	An update of the data for HFC-134a in category 2.F.1.a in 1995-1998 causes recalculations for the entire time-series (1995-2015). An error was corrected for HFC-134a in category 2.F.1.e in 2014 resulting in a decrease of emissions. Changes were also made to HFC-125, HCF-134a and HFC-143a all from category 2.F.1.d. in 2010-2015. The only recalculations to PFCs are for C3F8 in 2014-2015 in category 2.F.1.a.
Estonia	-	-	0	0.2	Stock data and emissions have been recalculated for years 2013–2015, because some of the R404A stock from Refrigerated vehicles was previously not accounted in these years. Stock data and stock emissions have been recalculated for the year 2015, because some of the HFC-227ea stock from Fire protection was previously incorrectly accounted for that year.
Finland	-0	-22.6	-132	-8.5	The emission estimation methodology was changed from Tier 2b to Tier 2a.
France	-	-	-97	-0.5	2F1a: Error corrected 2F1c: Error on retrofits of R22 installations corrected, update of activity data on chillers 2F1d: Update on transport refrigeration 2F1e: Correction of the assumptions of the introduction of R1234yf since 2012 2F1f: Correction of the refrigerants used VRV systems 2F2: Additional data on imports of XPS (blowing agent HFC-152a) were included Update of population data of the « territoires outre-mer » Update of sales data for solvents from one producer.
Germany	-	-	-1	-0.0	mainly: revised statistical data revised use of HFKW-152a for XPS hard foam recalculation of HFKW-236fa input in domestic facilities
Greece	-	-	17	0.3	updated data

	1990		2015		Main explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
Hungary	-	-	118	5.2	Revision of the AD (HCSO statistics)
Ireland	-	-	-1	-0.1	No significant recalculations, minor changes due to updated data
Italy	-	-	2 204	18.0	Update of activity data
Latvia	-	-	-8	-3.3	Recalculations were made due to implementation of F-gases evaluation study which was performed in 2017. During this study amount of refrigerants charged in new and operating systems as well as number of companies per F-gas sectors were revised. The results revealed that within the F-gas research (2016) emissions from commercial and industrial refrigeration were overestimated and emissions from stationary air conditioning and transport refrigeration were underestimated therefore it was necessary to recalculate 2.F.1 emissions for 2010-2015 according to study results. For industrial, transport refrigeration and stationary air conditioning also charged F-gas amounts in new equipment prior to 2010 were recalculated because these data was extrapolated from 2010-2015 known data.
Lithuania	-	-	49	10.2	Recalculations in this category has been done for Commercial, Industrial refrigeration, Mobile Air-Conditioning and Stationary air conditioning because of correction of mistake in the activity data. Correction of activity data on Domestic refrigeration for the period 2010-2015 has been done due to emissions of electrical and electronic equipment from other countries, which are imported to the recycling center were included (according to ERT I.10 recommendation). Recalculations in this category has been done because of included emissions of HFC-23 in Fire Protection sector , according to ERT I.7 recommendation. Emissions from Metered Dose Inhalers category were recalculated due to updated data for 2015.
Luxembourg	-	-	0	0.6	updated activity data
Malta	-	-	-1	-0.3	During the year 2017, it was observed that the documentation available indicated that during the compilation of the 2017 inventory, the data for imports falling under this sector did not feature in the CRF tables. Thus, the applicable data for the year 2015 was requested and entered in the worksheet and the respective CRF tables. During the year 2017, it was observed that the documentation available indicated that during the compilation of the 2017 inventory, the data for imports falling under this sector was equal to the data received in the previous year. Thus, the applicable data for the year 2015 was requested and entered in the worksheet and the respective CRF tables
Netherlands	-	-	37	1.7	Improved activity data
Poland	-	-	21	0.2	Revised activity data available for HFC-32 use in transport refrigeration
Portugal	-	-	230	8.6	Domestic Refrigeration assembly related emissions estimates are related to gross domestic product trend from 2004 onwards. There has been a revision in gross domestic product values from 2014 onwards. The Mobile Air Conditioning stocks have changed. Now we receive data directly from Copert. In fact this is the main driver for the recalculations. Correction of activity data related to foam blowing. We have started to estimate emissions related to "Other Aerosols" (2F4b). Please check 15.03.2018 Portugal NIR.
Romania	-	-	-	-	-
Slovakia	-	-	-0	-0.0	-
Slovenia	-	-	0	0.1	Improved AD

	1990		2015		Main explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
Spain	-	-	209	2.3	Update of activity data in 2F1 and 2F4
Sweden	1	27.6	123	16.0	Reallocation of emissions from 2.F.1.a to 2.F.1.c and 2.F.1.f. Changes from national EF to default EF for emissions from manufacturing and stock. Correction of data export in product. Correction of activity data.
United Kingdom	-	-	113	0.7	No significant change. Small change to emissions from Gibraltar, now using Gibraltar specific activity data for MDI in place of proxy data. EEA no longer provide separate data for F-gases used for solvents and firefighting. Total provided for 2015 differs from previous sum of two categories, therefore new total disaggregated using data for earlier years. no change
EU28	**1**	**23.3**	**2 349**	**2.2**	
Iceland	0	100.0	-2	-1.1	Double counting of two refrigerants was observed and corrected (R-407C and R-410A). Allocation procedures are being revised. Change in methodology for MDI's from 1990-2015. Emissions are now reported the same year as they are sold (i.e. not divided between two years).
United Kingdom (KP)	-	-	91	0.6	No significant change. EEA no longer provide separate data for f-gases used for solvents and fire fighting. Total provided for 2015 differs from previous sum of two categories, therefore new total disaggregated using data for earlier years. Small change to emissions from Gibraltar, now using Gibraltar specific activity data for MDI in place of proxy data.
EU28+ISL	**2**	**27.9**	**2 324**	**2.2**	

For 2.F Product uses as substitutes for ODS, Table.4.43 summarizes information by Member States on emission trends of total GHG emissions as well as on HFCs and PFCs. SF_6 and NF_3 are not used in this subcategory.

Table.4.43 2F Product uses as substitutes for ODS in 1990 and 2016: Member States' and EU-28+ISL total GHG emissions from this category and their split into HFC and PFC emissions

Member State	GHG emissions in 1990 (kt CO2 equivalents)	GHG emissions in 2016 (kt CO2 equivalents)	HFC emissions in 1990 (kt CO2 equivalents)	HFC emissions in 2016 (kt CO2 equivalents)	PFC emissions in 1990 (kt CO2 equivalents)	PFC emissions in 2016 (kt CO2 equivalents)
Austria	NO	1 638	NO	1 638	NO	NO,IE
Belgium	NO	2 937	NO	2 935	NO	2
Bulgaria	NO	1 400	NO	1 400	NO	0.02
Croatia	NO	420	NO	420	NO	NO
Cyprus	NE,NO	279	NO,NE	279	-	-
Czech Republic	NO	3 123	NO	3 122	NO	1
Denmark	NO	615	NO	611	NO	4
Estonia	NO	235	NO	235	NO	-
Finland	0.01	1 389	0.01	1 388	NO	1
France	IE,NO	19 015	NO,IE	19 015	-	-
Germany	IE,NO	10 885	NO,IE	10 877	NO,IE	8
Greece	NO	6 163	NO	6 116	NO	47
Hungary	NO	1 743	NO	1 742	NO	1
Ireland	1	1 188	1	1 188	NO	NO
Italy	NO	14 660	NO	14 660	-	-
Latvia	NE,NO	241	NO,NE	241	NO	NO
Lithuania	NO	654	NO	654	NO	NO
Luxembourg	0.0001	64	0.0001	64	-	-
Malta	NE,IE,NO	256	NO,NE,IE	256	NO	NO
Netherlands	NA,IE,NO	2 239	NO,IE,NA	2 239	NO	NO
Poland	NO	8 970	NO	8 957	NO	13
Portugal	NA,NO	3 075	NO,NA	3 060	NA	15
Romania	0.18	1 894	0.18	1 894	NO	NO
Slovakia	NO	673	NO	673	NO	NO
Slovenia	NO	354	NO	354	NO	NO
Spain	NO	9 721	NO	9 157	NO	7
Sweden	6	883	6	883	NO	1
United Kingdom	NA,IE,NO	15 146	NO,NA,IE	15 146	NO	NO
EU-28	**7**	**109 860**	**7**	**109 205**	**NA,IE,NO**	**98**
Iceland	1	192	1	192	NO	0
United Kingdom (KP)	NA,IE,NO	15 243	NO,IE,NA	15 243	NO	NO
EU-28 + ISL	**7**	**110 149**	**7**	**109 494**	**NA,IE,NO**	**98**

Abbreviations explained in the Chapter 'Units and abbreviations'.

F-gas emissions from 2.F Product uses as substitutes for ODS account for 2.5 % of total EU-28+ISL GHG emissions (without LULUCF) in 2016. HFC emissions in 2016 were about 15000 times higher than in 1990. The main reason for this is the phase-out of ODS such as chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs) under the Montreal Protocol and the replacement of these substances by HFCs (mainly in refrigeration, air conditioning, foam production, fire protection and as aerosol propellants). Moreover, refrigeration and air conditioning sectors have also grown to some extent in Europe in the last decades.

Table.4.43 shows the sub-categories of F-gas emissions from 2.F Product uses as substitutes for ODS by Member States. It shows that 2.F.1 Refrigeration and Air Conditioning is by far the largest sub-category accounting for 89% of F-gas emissions in this source category. While ODS were formerly widely used as aerosols and foam blowing agents, the subcategories 2.F.4 Aerosols/Metered Dose Inhalers contribute today 5% and 2.F.2 Foam blowing agents ca. 2.7 %, respectively. Emissions from fire protection relate to 3.1% of HFC emissions from 2.F.1 in 2016.

Table.4.44 2F Product uses as substitutes for ODS: Member States' sub-categories of HFC emissions for 2016 (kt CO_2 equivalents)

Member State	**2.F Product uses as substitutes**	2.F.1 Refrigeration and air conditioning	2.F.2 Foam blowing agents	2.F.3 Fire protection	2.F.4 Aerosols	2.F.5 Solvents	2.F.6 Other applications
Austria	**1 638**	1 582	17	13	27	NO	-
Belgium	**2 935**	2 738	92	13	91	-	NO
Bulgaria	**1 400**	1 357	22	7	15		-
Croatia	**420**	406	NO	5	9	-	-
Cyprus	**279**	270	1	4	3	-	-
Czech Republic	**3 122**	3 086	6	24	4	2	-
Denmark	**611**	580	14	-	17	-	-
Estonia	**235**	227	2	3	3	0	0
Finland	**1 388**	1 340	6	NO,IE,NA	42	0	0
France	**19 015**	16 624	288	98	1 912	93	NO,IE
Germany	**10 877**	9 594	631	50	602	IE	-
Greece	**6 116**	5 818	193	58	46	-	-
Hungary	**1 742**	1 574	127	7	33	NO	NO
Ireland	**1 188**	1 022	NO	32	134	NO	NO
Italy	**14 660**	12 252	650	1 593	164		-
Latvia	**241**	234	2	0	5	-	-
Lithuania	**654**	626	18	3	8	NO	0
Luxembourg	**64**	59	1	-	3	-	-
Malta	**256**	252	2	1	1	NO	NO
Netherlands	**2 239**	2 064	IE,NA	-	NO	-	175
Poland	**8 957**	8 449	298	83	127	1	-
Portugal	**3 060**	2 964	45	34	17		-
Romania	**1 894**	1 853	0	4	37	NO	NO
Slovakia	**673**	639	2	22	10	NO	-
Slovenia	**354**	346	2	1	5	-	-
Spain	**9 157**	7 688	81	969	419	NO	NO
Sweden	**883**	817	31	1	34	-	-
United Kingdom	**15 146**	12 545	424	329	1 716	79	54
EU-28	**109 205**	**97 007**	**2 956**	**3 354**	**5 484**	**174**	**229**
United Kingdom (KP)	**15 243**	12 630	425	331	1 724	79	54
Iceland	**192**	191	-	NO	1	NO	-
EU-28 + ISL	**109 494**	**97 283**	**2 957**	**3 356**	**5 494**	**174**	**229**

Abbreviations explained in the Chapter 'Units and abbreviations'.

Table 4.45 to Table.4.48 show the contribution of each MS to EU-28+ISL HFC emissions from 2.F by subcategories (2F1, 2F2, 2F3 2F4, 2F5, 2F6). It is evident that 2.F.1 represents the major source of HFC emissions in all Member States.

Table 4.45 2F1 Refrigeration and Air conditioning: Member States' contributions to HFC emissions and information on method applied, activity data and emission factor

Member State	HFCs Emissions in kt CO2 equiv.				Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 1995-2016		Change 2015-2016		Method	Emission factor Information
	1990	1995	2015	2016		kt CO2 equiv.	%	kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	NO	38	1 562	1 582	1.6%	1 582	∞	1 544	4105%	19	1%	T2	D
Belgium	NO	103	2 655	2 738	2.8%	2 738	∞	2 635	2554%	83	3%	T2	CS,D,PS
Bulgaria	NO	3	1 182	1 357	1.4%	1 357	∞	1 354	40665%	175	15%	T2	D
Croatia	NO	29	404	406	0.4%	406	∞	377	1292%	3	1%	T1a,T2	D
Cyprus	NO,NE	1	268	270	0.3%	270	∞	268	22016%	2	1%	NA	NA
Czech Republic	NO	36	2 893	3 086	3.2%	3 086	∞	3 050	8475%	193	7%	T2	CS
Denmark	NO	42	596	580	0.6%	580	∞	538	1276%	-16	-3%	T2	D
Estonia	NO	10	215	227	0.2%	227	∞	217	2185%	12	6%	T2	CS
Finland	0	137	1 356	1 340	1.4%	1 340	12693091%	1 203	881%	-16	-1%	T2	D
France	NO	545	16 466	16 624	17.1%	16 624	∞	16 080	2953%	158	1%	T2	CS
Germany	NO	584	9 746	9 594	9.9%	9 594	∞	9 010	1544%	-152	-2%	T2	CS,D
Greece	NO	42	5 630	5 818	6.0%	5 818	∞	5 776	13638%	189	3%	IE,T2	D,IE
Hungary	NO	40	2 203	1 574	1.6%	1 574	∞	1 535	3885%	-629	-29%	T2	CS,D
Ireland	NO	76	910	1 022	1.1%	1 022	∞	946	1253%	112	12%	T2,T3	CS
Italy	NO	299	12 053	12 252	12.6%	12 252	∞	11 954	4003%	200	2%	T2	CS,D
Latvia	NE	2	210	234	0.2%	234	∞	231	11028%	23	11%	T2	CS,D,OTH
Lithuania	NO	5	502	626	0.6%	626	∞	620	11642%	123	25%	T2	CS,D,PS
Luxembourg	0	3	61	59	0.1%	59	83191077%	56	1712%	-2	-3%	T2	CS,M,PS
Malta	NO,IE	0	241	252	0.3%	252	∞	252	13389424%	11	5%	T2	CS
Netherlands	NO	73	2 049	2 064	2.1%	2 064	∞	1 991	2714%	15	1%	T2	CS
Poland	NO	117	8 463	8 449	8.7%	8 449	∞	8 332	7111%	-14	0%	T2	D
Portugal	NO,NA	79	2 816	2 964	3.0%	2 964	∞	2 886	3673%	148	5%	IE,NO	IE,NO
Romania	NO	2	1 599	1 853	1.9%	1 853	∞	1 851	102524%	254	16%	T2	D
Slovakia	NO	11	702	639	0.7%	639	∞	628	5593%	-63	-9%	T2	CS
Slovenia	NO	5	338	346	0.4%	346	∞	341	6271%	8	2%	T1,T2	CS,D
Spain	NO	NO	7 947	7 688	7.9%	7 688	∞	7 688	∞	-259	-3%	T2	CS
Sweden	4	122	831	817	0.8%	813	18283%	695	569%	-14	-2%	T2	CS,D
United Kingdom	NO	528	13 286	12 545	12.9%	12 545	∞	12 017	2275%	-741	-6%	T2	CS
EU-28	**4**	**2 932**	**97 183**	**97 007**	**100%**	**97 003**	**2177364%**	**94 075**	**3209%**	**-176**	**0%**	**-**	**-**
Iceland	NO	10	204	191	0.2%	191	∞	182	1910%	-13	-6%	T2	D
United Kingdom (KP)	NO	530	13 371	12 630	13.0%	12 630	∞	12 100	2281%	-741	-6%	T2	CS
EU-28 + ISL	**4**	**2 944**	**97 472**	**97 283**	**100%**	**97 279**	**2183564%**	**94 339**	**3205%**	**-189**	**0%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

Note: CY does not indicate method and EF since their emission estimates are based on a methodology currently under revision.

In 2016, HFC emissions from 2F1 were about 33 times higher than in 1995 (Table 4.45 and ***Figure 4.20*** to Figure 4.23).

France, Germany, Italy and the UK are responsible for 53 % of total EU-28+ISL emissions from this source. After a decrease by 5% from 2014 to 2015, emissions remained stable from 2015 to 2016 in EU-28+ISL.

Figure 4.20: 2F1 Refrigeration and Air conditioning: EU-28+ISL HFC emissions

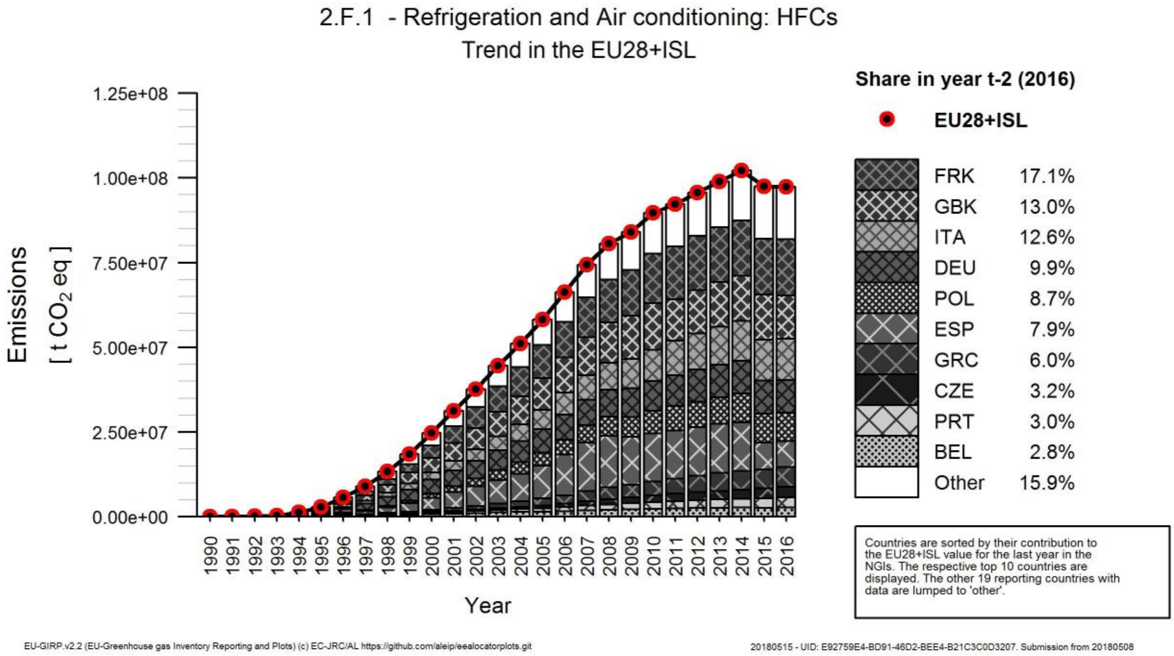


Figure 4.20 shows that emissions in sector 2.F.1 remained stable in 2016. The main HFCs reported in this subcategory are HFC-32, HFC-125, HFC-134a and HFC-143a. They can be used as pure substances (such as HFC-32 and HFC-134a) and in mixtures (e.g. the common refrigerant blend R404A is composed of 44% HFC-125, 4% HFC-134a and 52% HFC-143a).

Major developments in category 2.F.1 are driven by the subcategories 2.F.1a Commercial refrigeration, 2.F.1e Mobile air conditioning and 2.F.1f Stationary air conditioning.

Emission plots for these three prominent subcategories are provided in the following graphs. Please note that 2.F.1a often includes emissions from all types of stationary equipment in Member States (i.e. also industrial refrigeration and partly also stationary air conditioning). After a peak in 2014, emissions from 2.F.1.a decreased slightly in 2016 compared to 2015.

Figure 4.21: 2F1a Commercial refrigeration: EU-28+ISL HFC emissions

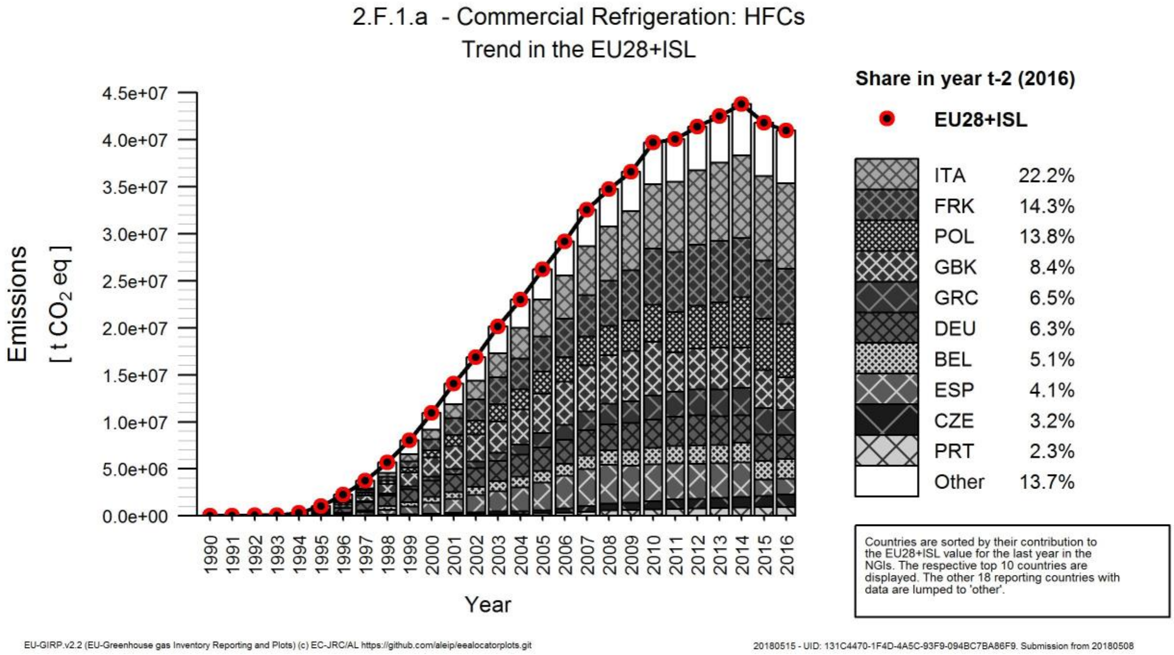


Figure 4.22: 2F1e Mobile air conditioning: EU-28+ISL HFC emissions

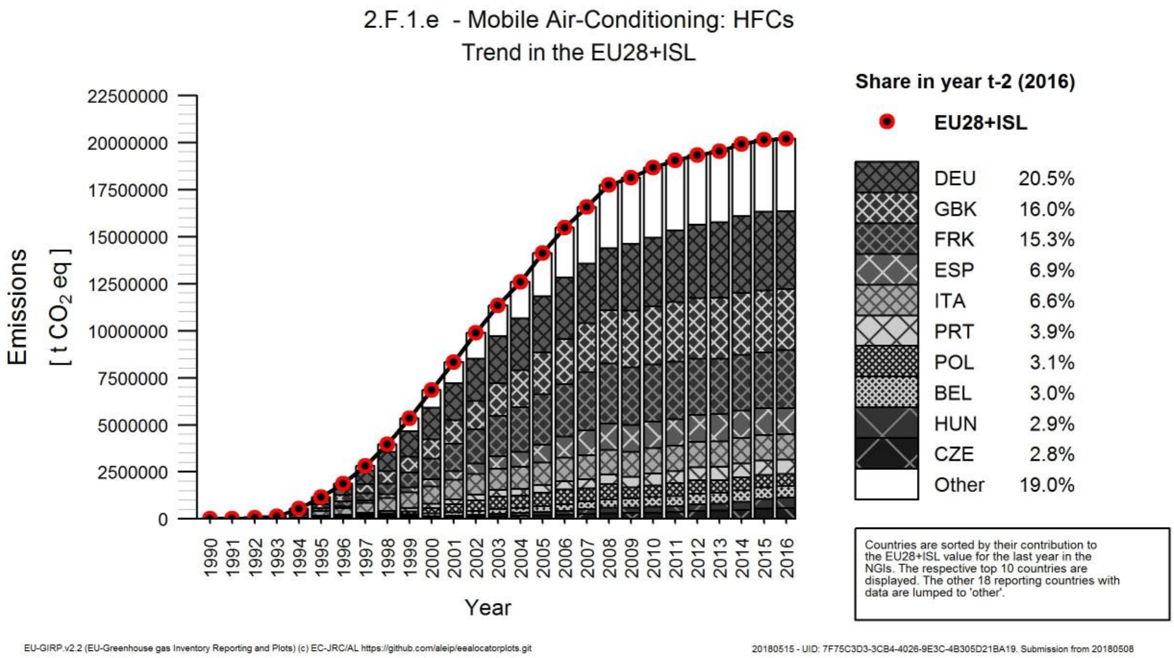


Figure 4.22 illustrates that emissions from mobile Air-Conditioning were rather stable in their overall quantity and share. The introduction of the low-GWP refrigerant R1234yf in new vehicle models is not yet reflected in a decrease of emissions for this subcategory. Germany accounts for more than 20% of emissions from 2F1e followed by the UK (16%) and France (15.3%).

Figure 4.23: 2F1f Stationary air conditioning: EU-28+ISL HFC emissions

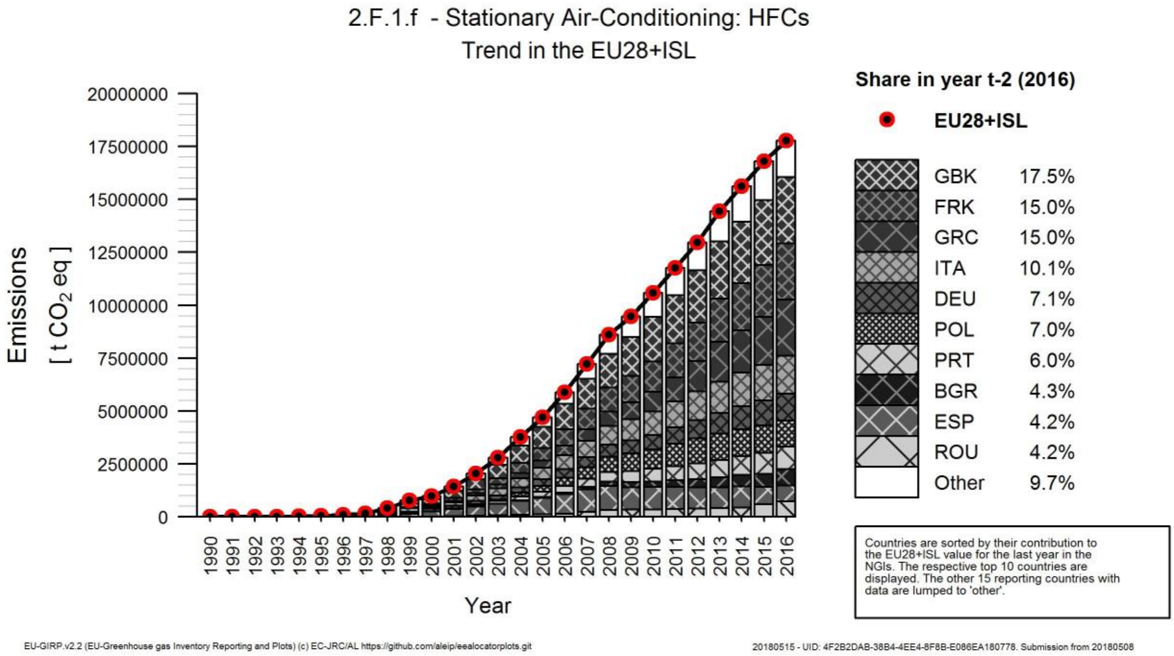


Figure 4.23 shows a consistent trend for sector 2.F.1.f with increasing emissions. This development reflects the growing use of air conditioning equipment, in particular in Southern Europe.

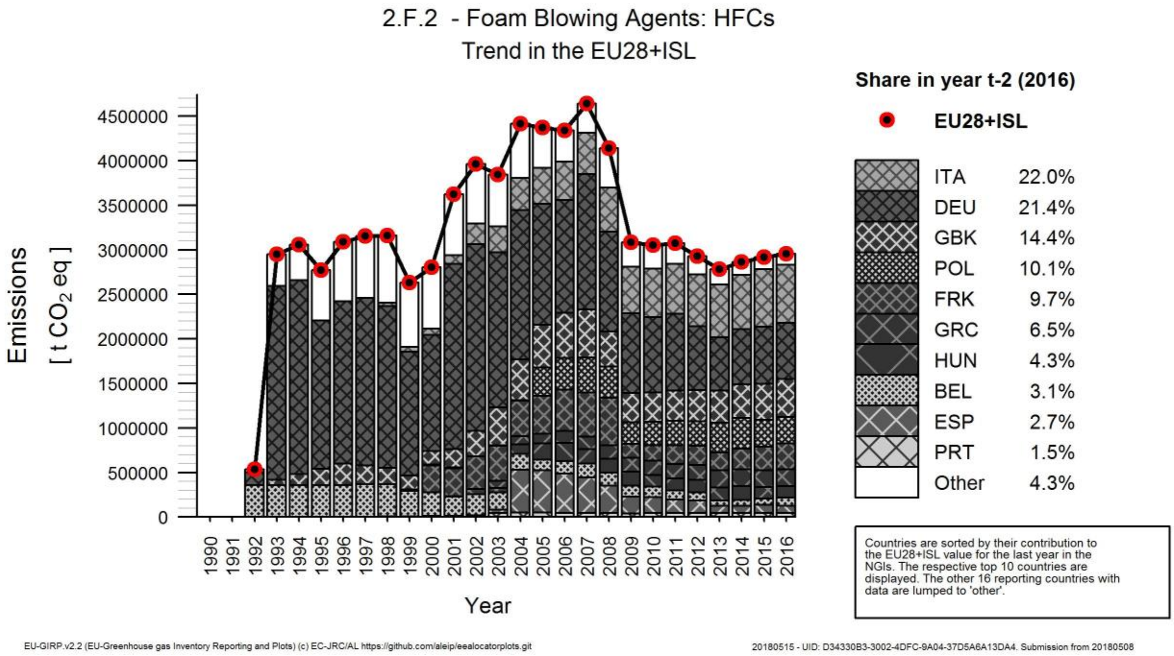
Table 4.46 2F2 Foam Blowing: Member States' contributions to HFC emissions and information on method applied, activity data and emission factor

Member State	HFCs Emissions in kt CO2 equiv.				Share in EU-28+ISL	Change 1990-2016		Change 1995-2016		Change 2015-2016		Method	Emission factor
	1990	1995	2015	2016	Emissions in 2016	kt CO2 equiv.	%	kt CO2 equiv.	%	kt CO2 equiv.	%		Informa-tion
Austria	NO	301	17	17	0.6%	17	∞	-284	-94%	0	-1%	T2	D
Belgium	NO	357	71	92	3.1%	92	∞	-265	-74%	21	30%	T2	CS,D,PS
Bulgaria	NO	NO	23	22	0.8%	22	∞	22	∞	-1	-2%	NO,T2	D,NO
Croatia	NO	NO	NO	NO	-	-	-	-	-	-	-	NA	NA
Cyprus	NE,NO	NO,NE	1	1	0.0%	1	∞	1	∞	0	1%	-	-
Czech Republic	NO	0	3	6	0.2%	6	∞	6	44162%	4	146%	T1	D
Denmark	NO	200	26	14	0.5%	14	∞	-186	-93%	-12	-47%	T2	D
Estonia	NO	18	2	2	0.1%	2	∞	-16	-88%	0	-1%	T2	CS
Finland	NO	1	6	6	0.2%	6	∞	5	982%	0	-1%	T2	D
France	NO	NO	264	288	9.7%	288	∞	288	∞	24	9%	T2	CS,D
Germany	IE	1 666	642	631	21.4%	631	∞	-1 034	-62%	-11	-2%	T2	CS
Greece	NO	NO	192	193	6.5%	193	∞	193	∞	1	1%	T3	D
Hungary	NO	NO	128	127	4.3%	127	∞	127	∞	-1	-1%	T2	CS
Ireland	NO	NO	NO	NO	-	-	-	-	-	-	-	NA	NA
Italy	NO	NO	647	650	22.0%	650	∞	650	∞	4	1%	T2	D
Latvia	NO	0	4	2	0.1%	2	∞	2	513%	-2	-44%	T1a	D,OTH
Lithuania	NO	NO	16	18	0.6%	18	∞	18	∞	2	12%	T2	D
Luxembourg	NO	13	1	1	0.0%	1	∞	-12	-89%	0	5%	T1	CS
Malta	NO	NO	3	2	0.1%	2	∞	2	∞	-1	-31%	T1	D
Netherlands	IE,NA	IE,NA	IE,NA	IE,NA	-	-	-	-	-	-	-	T2	CS
Poland	NO	NO	301	298	10.1%	298	∞	298	∞	-3	-1%	T2	D
Portugal	NA	1	44	45	1.5%	45	∞	44	5816%	0	1%	NO	NO
Romania	NO	NO	0	0	0.0%	0	∞	0	∞	0	-1%	T2	D
Slovakia	NO	NO	2	2	0.1%	2	∞	2	∞	0	-1%	T2	D
Slovenia	NO	30	2	2	0.1%	2	∞	-28	-94%	0	-5%	T2	CS,D
Spain	NO	NO	91	81	2.7%	81	∞	81	∞	-10	-11%	T2	D
Sweden	NO	NO	32	31	1.0%	31	∞	31	∞	-1	-2%	T2	PS
United Kingdom	NO	184	400	424	14.3%	424	∞	240	131%	23	6%	T2	CS
EU-28	**NE,NA,IE,NO**	**2 770**	**2 918**	**2 956**	**100%**	**2 956**	**∞**	**186**	**7%**	**38**	**1%**	**-**	**-**
Iceland	-	-	-	-	-	-	-	-	-	-	-	NA	NA
United Kingdom (KP)	NO	184	402	425	14.4%	425	∞	241	131%	23	6%	T2	CS
EU-28 + ISL	**NE,NA,IE,NO**	**2 770**	**2 920**	**2 957**	**100%**	**2 957**	**∞**	**187**	**7%**	**38**	**1%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year. Note: CY does not indicate method and EF since their emission estimates are based on a methodology currently under revision.

In 2016 HFC emissions from 2.F.2 (Table 4.46 and ***Figure 4.24***) remained stable compared to 2015 – and increased by 7% compared to 1995. This shows that the phase-out of ODS in the foam sector from the 1990s onwards resulted mainly in the introduction of alternative technologies not relying on fluorinated gases. The HFC foam blowing agents reported in 2F2 are HFC-152a, HFC-134a, HFC-227ea, HFC-245fa and HFC-365mfc. The biggest contributors to emissions from this sector are Germany (21%), Italy (22%), Poland (10%) and UK (14%), those four countries account for 68% of the share in EU-28+ISL emissions in this sector.

Figure 4.24: 2F2 Foam Blowing Agents: EU-28+ISL HFC emissions



This ***Figure 4.24*** displays that emissions from sector 2.F.2 varied noticeable until 2008 but are rather stable since then. Major foam manufacturers converted their production to non-HFC blowing agents (usually hydrocarbons) which leads to a decrease of emissions from this subcategory.

Table4.47 2F3 Fire protection: Member States' contributions to HFC emissions and information on method applied, activity data and emission factor

Member State	HFCs Emissions in kt CO2 equiv.				Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 1995-2016		Change 2015-2016		Method	Emission factor Information
	1990	1995	2015	2016		kt CO2 equiv.	%	kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	NO	NO	13	13	0.4%	13	∞	13	∞	0	0%	T2	D
Belgium	NO	1	13	13	0.4%	13	∞	12	2107%	0	-3%	T2	CS
Bulgaria	NO	NO	6	7	0.2%	7	∞	7	∞	0	6%	T2	D
Croatia	NO	0	5	5	0.1%	5	∞	5	3560%	0	1%	T2	D
Cyprus	NE,NO	0	4	4	0.1%	4	∞	4	57479%	0	1%	-	-
Czech Republic	NO	NO	23	24	0.7%	24	∞	24	∞	1	4%	D	D
Denmark	-	-	-	-	-	-	-	-	-	-	-	-	-
Estonia	NO	NO	3	3	0.1%	3	∞	3	∞	0	-2%	T2	CS
Finland	NO	NO	NA,NO,IE	NO,IE,NA	-	-	-	-	-	-	-	NA	NA
France	NO	5	105	98	2.9%	98	∞	93	2027%	-7	-7%	T1	CS
Germany	-	-	38	50	1.5%	50	∞	50	∞	11	30%	CS	CS,D
Greece	NO	NO	52	58	1.7%	58	∞	58	∞	6	11%	CS	D
Hungary	NO	NO	8	7	0.2%	7	∞	7	∞	-1	-12%	T1	D
Ireland	NO	NO	32	32	1.0%	32	∞	32	∞	0	0%	T2	CS
Italy	NO	16	1 563	1 593	47.5%	1 593	∞	1 578	10098%	30	2%	T2	CS
Latvia	NE	NE	0	0	0.0%	0	∞	0	∞	0	0%	T2	D
Lithuania	NO	NO	3	3	0.1%	3	∞	3	∞	0	2%	T1b	D
Luxembourg	-	-	-	-	-	-	-	-	-	-	-	-	-
Malta	NO	NO	0	1	0.0%	1	∞	1	∞	1	298%	CS	-
Netherlands	-	-	-	-	-	-	-	-	-	-	-	T2	CS
Poland	NO	NO	79	83	2.5%	83	∞	83	∞	4	5%	T2	D
Portugal	NA	NO	32	34	1.0%	34	∞	34	∞	2	7%	NO	NO
Romania	NO	NO	4	4	0.1%	4	∞	4	∞	0	7%	T2	D
Slovakia	NO	2	21	22	0.7%	22	∞	20	962%	2	8%	T1a	CS
Slovenia	NO	NO	1	1	0.0%	1	∞	1	∞	-1	-54%	T2	CS,D
Spain	NO	3	995	969	28.9%	969	∞	966	29122%	-25	-3%	T1a	CS,D
Sweden	NO	NO	1	1	0.0%	1	∞	1	∞	0	3%	-	CS
United Kingdom	NO	1	321	329	9.8%	329	∞	328	33985%	8	3%	T2	CS
EU-28	**NE,NA,NO**	**27**	**3 323**	**3 354**	**100%**	**3 354**	**∞**	**3 327**	**12181%**	**31**	**1%**	**-**	**-**
Iceland	NO	NO	NO	NO	-	-	-	-	-	-	-	NA	NA
United Kingdom (KP)	NO	1	323	331	9.9%	331	∞	330	34058%	8	3%	T2	CS
EU-28 + ISL	**NE,NA,NO**	**27**	**3 325**	**3 356**	**100%**	**3 356**	**∞**	**3 329**	**12186%**	**31**	**1%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year. Note: CY does not indicate method and EF since their emission estimates are based on a methodology currently under revision.

In 2016, HFC emissions from 2.F.3 (Table4.47) did hardly change compared to 2015 – but increased dramatically since 1995. This development was caused by the phase-out of halons and HCFCs as fire extinguishing agents under the Montreal Protocol and the subsequent introduction of HFCs and other ODS alternatives. The HFCs reported in this subcategory are HFC-23 (banned in new equipment since 2015), HFC-227ea and HFC-236fa. In Denmark and Luxembourg HFCs are not used as fire extinguishing agents. Instead, other chemicals or not-in-kind alternatives, e.g. water mist, fluorinated ketones etc., are applied. In the Netherlands, emissions from this subcategory are included in other reported data.

The biggest contributors to this sector are Italy (47.5%), Spain (28.9%) and UK (9.9%), those three countries account for 86% of the share in EU-28+ISL emissions in this sector. Relevant decreases of emissions from this subcategory compared to 2015 have been reported by Slovenia (-54%) and Hungary (-13%) while increases were reported by Germany (+30%). The increase of emissions in Malta (+ about 300%) relates to a small amount of fire extinguishing agents.

Figure 4.25: 2F3 Fire Protection, EU28+ISL: HFC emissions

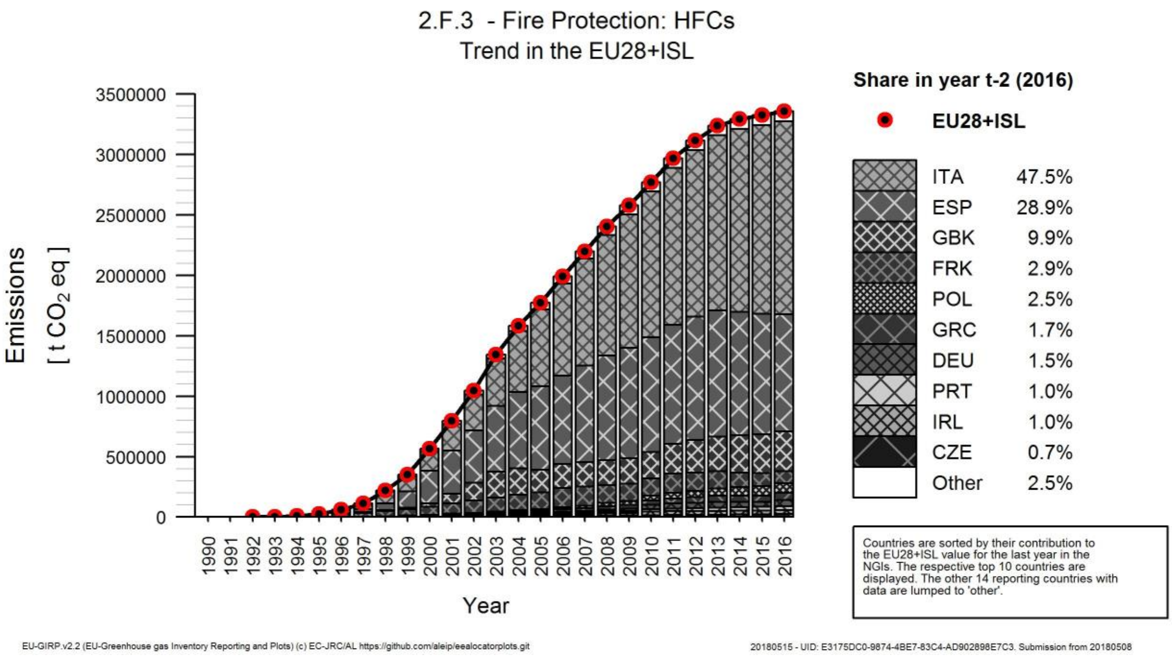


Figure 4.25 illustrates that emissions from fire protection are stabilizing since 2013.

Table.4.48 2F4 Aerosols/ Metered Dose Inhalers: Member States' contributions to HFC emissions and information on method applied, activity data and emission factor

Member State	HFCs Emissions in kt CO2 equiv.				Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 1995-2016		Change 2015-2016		Method	Emission factor Information
	1990	1995	2015	2016		kt CO2 equiv.	%	kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	NO	4	26	27	0.5%	27	∞	23	511%	1	5%	T2	D
Belgium	NO	41	90	91	1.7%	91	∞	50	121%	1	2%	T2	CS,D,PS
Bulgaria	NO	NO	11	15	0.3%	15	∞	15	∞	3	30%	T2	D
Croatia	NO	NO	12	9	0.2%	9	∞	9	∞	-3	-25%	T2	D
Cyprus	NO	0	3	3	0.1%	3	∞	3	25651%	0	1%	-	-
Czech Republic	NO	NO	7	4	0.1%	4	∞	4	∞	-3	-44%	D	D
Denmark	NO	NO	17	17	0.3%	17	∞	17	∞	0	1%	T2	D
Estonia	NO	0	3	3	0.1%	3	∞	3	5782%	0	-10%	T2	CS
Finland	NO	2	51	42	0.8%	42	∞	40	1993%	-8	-17%	T2	D
France	NO	623	1 937	1 912	34.8%	1 912	∞	1 289	207%	-25	-1%	T2	CS,PS
Germany	NO,IE	342	613	602	11.0%	602	∞	260	76%	-11	-2%	CS,T2	CS
Greece	NO	0	45	46	0.8%	46	∞	46	142888%	0	1%	T2	D
Hungary	NO	12	45	33	0.6%	33	∞	22	186%	-12	-26%	T2	CS,D
Ireland	1	25	130	134	2.4%	133	20709%	108	427%	3	3%	T1,T2	CS
Italy	NO	NO	185	164	3.0%	164	∞	164	∞	-21	-11%	T2	CS
Latvia	NO,NE	NO,NE	5	5	0.1%	5	∞	5	∞	0	0%	T1a	D
Lithuania	NO	1	6	8	0.1%	8	∞	7	798%	2	29%	T1a	D
Luxembourg	NO	2	3	3	0.1%	3	∞	1	72%	0	1%	T1,T2	CS
Malta	NO,NE	NO,NE	2	1	0.0%	1	∞	1	∞	-1	-49%	T1	CS
Netherlands	NO	NO	NO	NO	-	-	-	-	-	-	-	NA	NA
Poland	NO	18	126	127	2.3%	127	∞	110	626%	1	1%	T1a,T1b,T2	D
Portugal	NA	27	17	17	0.3%	17	∞	-10	-36%	0	0%	NO	NO
Romania	0	1	34	37	0.7%	36	20136%	36	4989%	3	8%	T2	D
Slovakia	NO	NO	10	10	0.2%	10	∞	10	∞	0	2%	T1a	D
Slovenia	NO	NO	5	5	0.1%	5	∞	5	∞	0	1%	T1	D
Spain	NO	2	342	419	7.6%	419	∞	417	17465%	77	23%	T2	CS
Sweden	1	7	33	34	0.6%	32	2269%	27	365%	1	2%	T2	D
United Kingdom	IE,NO	660	1 761	1 716	31.2%	1 716	∞	1 056	160%	-45	-3%	T2	CS
EU-28	**2**	**1 766**	**5 519**	**5 484**	**100%**	**5 482**	**243297%**	**3 718**	**210%**	**-35**	**-1%**	**-**	**-**
Iceland	1	1	1	1	0.0%	0	40%	0	34%	0	13%	T1a	D
United Kingdom (KP)	NO,IE	662	1 769	1 724	31.4%	1 724	∞	1 062	160%	-45	-3%	T2	CS
EU-28 + ISL	**3**	**1 770**	**5 529**	**5 494**	**100%**	**5 491**	**186560%**	**3 724**	**210%**	**-35**	**-1%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year. Note: CY and PT do not indicate method and EF since their emission estimates are based on a methodology currently under revision.

In 2016, HFC emissions from 2F4 more than tripled emissions from this subcategory in 1995 (Table.4.48 and ***Figure 4.25***). This partly relates to the phase-out of ODS in this subcategory but also to increased use of medical aerosols throughout Europe, especially for asthma treatment. The HFCs reported in 2F4 are HFC-134a (medical and technical aerosols), HFC-227ea (medical aerosols only) and HFC-152a (technical aerosols).

France (34.8%), Germany (11%), Spain (7.6%) and UK (31.4%) are responsible for 85% of total EU-28+ISL emissions from this source. Between 2015 and 2016 EU-28+ISL emissions hardly changed. A significant relative decrease between these years was reported by Czech Republic (-44%), Croatia (-25%) Hungary (-26%) and Malta (-49%)); the biggest increase was reported by Bulgaria (+30%), Lithuania (+29%) and Spain (+23%) (Table.4.48). It should be noted that emissions from this subcategory have been relatively stable since 2012 despite the growing number of patients in need of MDI treatment in most EU Member States. This is mainly due to increased application dry powder inhalers,

*Figure 6 4	2F4 Aerosols/Metered Dose Inhalers: EU-28+ISL HFC emissions*

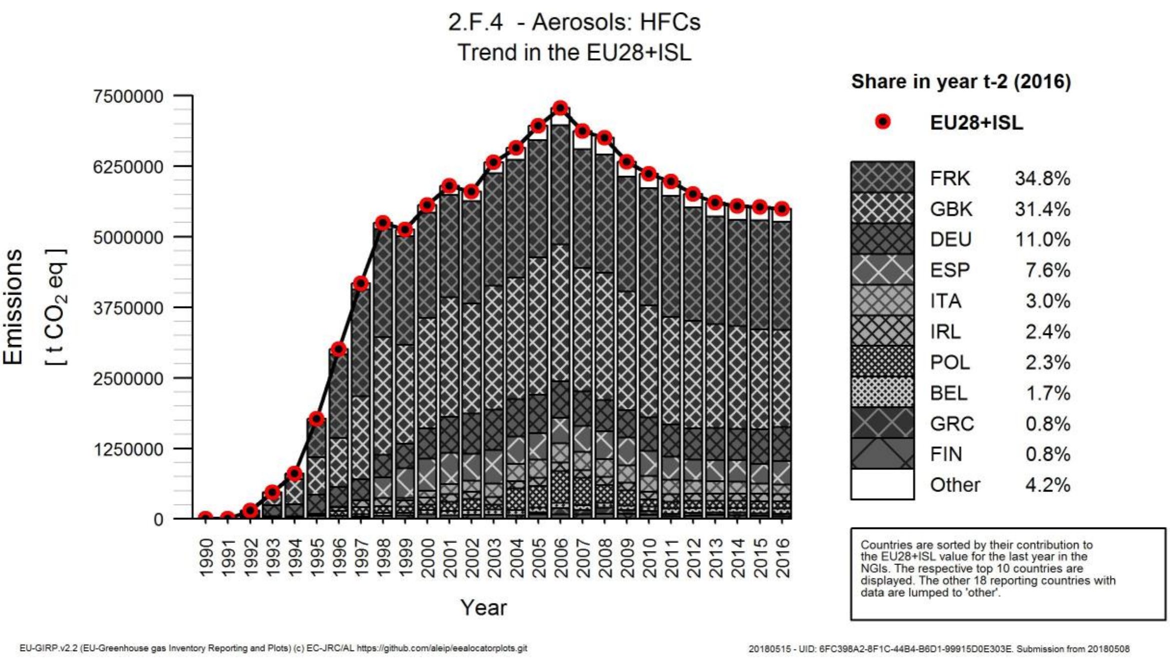


Figure 4.25 underlines the development of previous years. Emissions from sector 2.F.4 are decreasing since their peak in 2006.

The subcategories 2F5 Solvents and 2F6 Other applications are not described in detail in this submission as they account only for minor shares of emissions from 2.F (0.16% and 0.21%). Emission estimates for these subcategories are confidential in several Member States because the relevant industrial processes are only performed by very few companies. Emissions are thus reported together with other subcategories.

4.2.7 Other product manufacture and use (CRF Source Category 2G) (EU-28+ISL)

The former subcategories 2.F.8 Electrical Equipment and 2.F.9 Other sources of SF_6 are now reported under 2.G Other product manufacture and use. Primary uses of SF_6 include gas insulated switch gear for transportation and distribution of electric power (2.G.1). PFCs and SF_6 have been used for certain applications under this category for many decades.

Table.4.49 shows that all Member States report GHG emissions in 2G Other product manufacture and use for the year 2016. The major use of SF_6 is electrical switch gear and SF_6 emissions from the predominant subcategory electrical equipment (2.G.1) are reported by all Member States except the Netherlands where the share of non-F-gas alternatives is particularly high and SF_6 emission estimates are included elsewhere.

Other subcategories included in 2.G. comprise soundproof windows (SF_6), particle accelerators (SF_6), applications of adiabatic properties: Shoes and tyres (SF_6, PFCs), military applications (SF_6), Unspecified mix of PFCs, Other (SF_6; HFCs).

Table.4.49 2G Other: Overview of sources reported under this source category for 2016

Member State	2.G Other product manufacture and use	HFC emissions [kt CO_2 equivalents]	PFC emissions [kt CO_2 equivalents]	SF_6 emissions [kt CO_2 equivalents]	NF_3 emissions [kt CO_2 equivalents]	Unspecified mix of HFCs and PFCs [kt CO_2 equivalents]	Total emissions [kt CO_2 equivalents]	Share in EU-28 + ISL Total
AUT	Electrical equipment (SF_6); Soundproof windows (SF_6); Other (SF_6)	NO	NO	357			357	5.1%
BEL	Electrical equipment (SF_6); Soundproof windows (SF_6); Other (C6F14)	NO	NO	88	NO	NO	88	1.3%
BGR	Electrical equipment (SF_6)		NO	19			19	0.3%
HRV	Electrical equipment (SF_6)	NO	NO	6	NO	NO	6	0.1%
CYP	Electrical equipment (SF_6)		NO	0			0.2	0.0%
CZE	Electrical equipment (SF_6); Soundproof windows (SF_6)			75			75	1.1%
DNM	Electrical equipment (SF_6); Soundproof windows (SF_6); Other (SF_6)			92			92	1.3%
EST	Electrical equipment (SF_6); Accelerators (SF_6)	NO	NO	3	NO	NO	3	0.0%
FIN	Electrical equipment (SF_6)	NO	NO,IE	11	NO	NO	11	0.2%
FRK	Electrical equipment (SF_6); Accelerators (SF_6); Other (SF_6, Unspecified mix of PFCs)	1	457	444	NA	NA	902	12.9%
DEU	Electrical equipment (SF_6); Military applications (SF_6 => Notation Key C); Accelerators (SF_6); Soundproof windows (SF_6); Adiabatic properties: shoes and tyres (SF_6, C3F8 => Notation Key C); Other (SF_6 => partly Notation Key C), C10F18 => Notation Key C); 4. Other (HFC-134a, HFC-245fa, HFC-365mfc)	10	IE,NA	3723			3733	53.6%
GRC	Electrical equipment (SF_6)		NO	5			5	0.1%
HUN	Electrical equipment (SF_6)	NO	NO	127	NO	NO	127	1.8%
IRL	Electrical equipment (SF_6); Soundproof windows (SF_6); Adiabatic properties: shoes and tyres (SF_6); Other (SF_6)	NO	NO	22	NO	NO	22	0.3%
ITA	Electrical equipment (SF_6); Accelerators (SF_6)	NO	NO	332	NO	NO	332	4.8%
LVA	Electrical equipment (SF_6)	NO	NO	10	NO	NO	10	0.1%
LTU	Electrical equipment (SF_6); Accelerators (SF_6)	NO	NO	1	NO	NO	1	0.0%

Member State	2.G Other product manufacture and use	HFC emissions [kt CO_2 equivalents]	PFC emissions [kt CO_2 equivalents]	SF_6 emissions [kt CO_2 equivalents]	NF_3 emissions [kt CO_2 equivalents]	Unspecified mix of HFCs and PFCs [kt CO_2 equivalents]	Total emissions [kt CO_2 equivalents]	Share in EU-28 + ISL Total
LUX	Electrical equipment (SF_6); Soundproof windows (SF_6), Other (HFC-43-10mee)	2		9			11	0.2%
MLT	Electrical equipment (SF_6), Other (SF_6, C3F8)		0.00	0.05			0.05	0.001%
NLD	Other (SF_6)			134			134	1.9%
POL	Electrical equipment (SF_6)	NA	NA	74	NA	NA	74	1.1%
PRT	Electrical equipment (SF_6)	NO	NO	23	NO	NO	23	0.3%
ROU	Electrical equipment (SF_6)	NO	NO	50	NO	NO	50	0.7%
SVK	Electrical equipment (SF_6)	NO	NO	6	NO	NO	6	0.1%
SVN	Electrical equipment (SF_6)	NO	NO	17	NO	NO	17	0.3%
ESP	Electrical equipment (SF_6); Accelerators (SF_6), Other (SF_6)	NO,NA	NO,NA	230	NO,NA	NO,NA	230	3.3%
SWE	Electrical equipment (SF_6); Soundproof windows (SF_6)		NO	39			39	0.6%
GBE	Electrical equipment (SF_6); Military applications (SF_6); Accelerators (SF_6); Other (CF4, C2F6, C3F8, c-C4F8, SF_6)		168	432			600	9%
EU-28	**TOTAL**	12	625	6330	0	0	6968	
GBK	Electrical equipment (SF_6); Military applications (SF_6); Accelerators (SF_6); Other (CF4, C2F6, C3F8, c-C4F8, SF_6)		168	432			600	8.6%
ISL	Electrical equipment (SF_6)		NO	1			1	0.02%
EU-28+ISL	**TOTAL**	12	625	6331	0	0	6969	**100%**

Abbreviations explained in the Chapter 'Units and abbreviations'.

Figure 4.26 and Table 4.50 summarizes information by Member State on emissions for the key source SF_6 from 2G Other sources of SF_6. Emissions have been relatively stable since 2002. The development of emissions from this category is dominated by the emission trend in Germany (59% of SF_6 emissions from EU-28+ISL in 2016) because major manufacturers of SF_6 containing switchgear catering for the world market are located in Germany.

Table 4.50: Member States' contributions to SF_6 emissions

Member State	SF6 Emissions in kt CO2 equiv.				Share in EU-28+ISL	Change 1990-2016		Change 1995-2016		Change 2015-2016		Method	Emission factor Informa-tion
	1990	1995	2015	2016	Emissions in 2016	kt CO2 equiv.	%	kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	132	268	266	357	5.6%	225	171%	89	33%	91	34%	T2	D
Belgium	134	134	89	88	1.4%	-46	-35%	-46	-35%	-1	-1%	T1,T2	D
Bulgaria	4	5	18	19	0.3%	15	408%	14	283%	1	4%	NO,T2	D,NO
Croatia	10	11	5	6	0.1%	-4	-39%	-5	-43%	1	23%	T2	CS
Cyprus	0	0	0	0	0.0%	0	542%	0	184%	0	1%	NA	NA
Czech Republic	84	89	76	75	1.2%	-9	-11%	-14	-16%	-1	-1%	D,T1	D
Denmark	13	68	103	92	1.5%	79	619%	24	35%	-11	-11%	T2,T3	D
Estonia	NO	3	2	3	0.0%	3	∞	-1	-17%	0	13%	T3	CS
Finland	45	27	11	11	0.2%	-34	-75%	-15	-57%	1	5%	T2	CS
France	1 249	1 479	456	444	7.0%	-804	-64%	-1 035	-70%	-12	-3%	T1,T2	CS,D
Germany	4 050	6 072	3 510	3 723	58.8%	-326	-8%	-2 349	-39%	214	6%	T3	CS
Greece	3	3	5	5	0.1%	2	78%	2	52%	0	3%	CS	CS
Hungary	11	52	114	127	2.0%	116	1062%	74	143%	12	11%	T1	D
Ireland	33	38	23	22	0.4%	-11	-33%	-16	-41%	-1	-3%	T1	NA
Italy	296	552	394	332	5.2%	36	12%	-220	-40%	-62	-16%	CS,T2	CS,PS
Latvia	NO	0	10	10	0.2%	10	∞	10	5606%	0	-2%	T1	D
Lithuania	NO	0	1	1	0.0%	1	∞	1	1245%	0	-23%	T3	CS
Luxembourg	1	1	9	9	0.1%	8	954%	8	564%	0	4%	D,T3	CS,M,PS
Malta	0	1	0	0	0.0%	0	338%	-1	-97%	0	-75%	CS	CS,PS
Netherlands	207	261	139	134	2.1%	-73	-35%	-127	-49%	-5	-4%	T1,T3	CS
Poland	NA,NO	13	73	74	1.2%	74	∞	62	492%	1	2%	T1	D
Portugal	NO,NA	14	23	23	0.4%	23	∞	10	68%	0	1%	NO	NO
Romania	0	1	52	50	0.8%	49	10403%	49	5010%	-2	-5%	T2	D
Slovakia	0	10	14	6	0.1%	6	9868%	-4	-43%	-8	-59%	T3	CS
Slovenia	10	12	17	17	0.3%	8	77%	5	44%	0	0%	T2	CS
Spain	64	101	222	230	3.6%	166	261%	129	128%	8	4%	T2,T3	CS,D
Sweden	79	108	36	39	0.6%	-40	-50%	-68	-64%	3	9%	T2,T3	CS,PS
United Kingdom	892	877	378	432	6.8%	-460	-52%	-446	-51%	54	14%	OTH,T1,T2,T3	CS,D
EU-28	**7 316**	**10 202**	**6 047**	**6 330**	**100%**	**-986**	**-13%**	**-3 872**	**-38%**	**283**	**5%**	**-**	**-**
Iceland	1	1	2	1	0.0%	0	16%	0	3%	0	-17%	T2	CS
United Kingdom (KP)	892	877	378	432	6.8%	-460	-52%	-446	-51%	54	14%	OTH,T1,T2,T3	CS,D
EU-28 + ISL	**7 317**	**10 203**	**6 048**	**6 331**	**100%**	**-986**	**-13%**	**-3 872**	**-38%**	**283**	**5%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year. Note: CY and PT do not indicate method and EF since their emission estimates are based on a methodology currently under revision.

Figure 4.26: 2G - Other Product Manufacture and Use: SF_6 Trend in the EU28+ISL

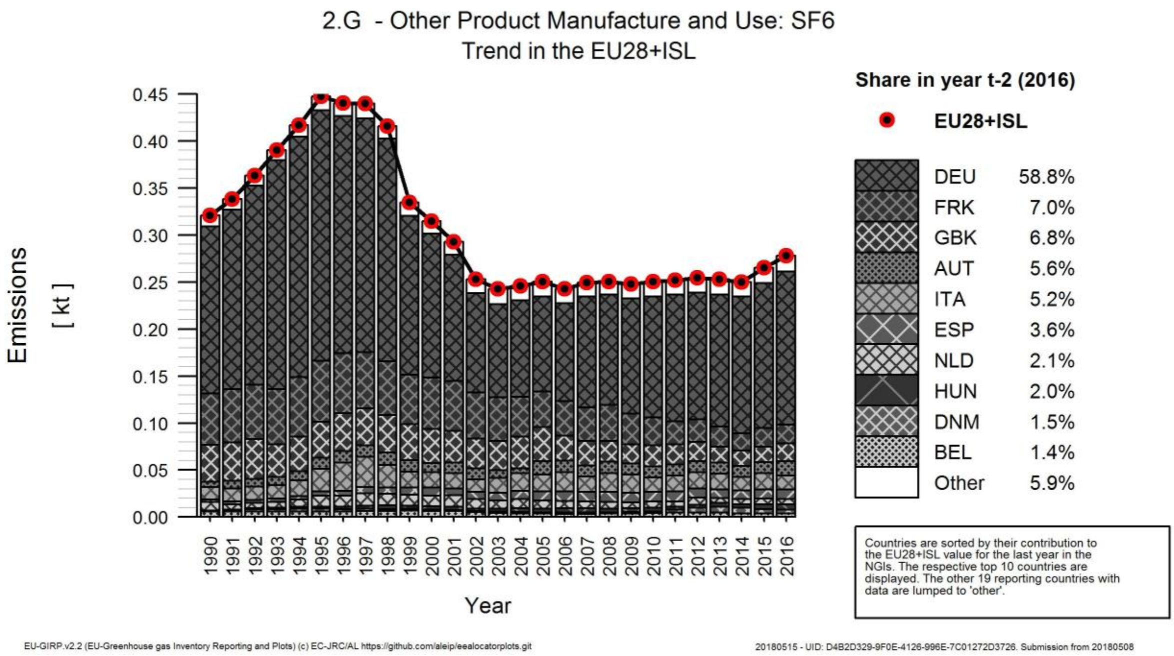


Figure 4.26 shows a stable trend for emissions from SF_6 in sector 2.G. In 2016 a minor increase took place (+5%) due to larger emissions from Austria (34%) and Germany (6%).

4.2.8 IPPU – non key categories

Table 4.51: Aggregeted GHG emission from non-key categories in the waste sector

EU-28 + ISL	Aggregated GHG emissions in kt CO_2 equ.			Share in sector 2. IPPU in 2016	Change 1990-2016		Change 2015-2016	
	1990	2015	2016		kt CO_2 equ.	%	kt CO_2 equ.	%
2.A.3 Glass production: no classification (CO_2)	4 262.4	4 221.7	4 214.6	1.12%	-48	-1%	-7	0%
2.B.1 Ammonia Production: no classification (CH_4)	2.2	3.1	2.5	0.00%	0	11%	-1	-20%
2.B.1 Ammonia Production: no classification (N_2O)	0.8	1.0	0.9	0.00%	0	14%	0	-7%
2.B.10 Other chemical industry: no classification (CH_4)	270.5	112.8	120.8	0.03%	-150	-55%	8	7%
2.B.10 Other chemical industry: no classification (HFCs)	0.0	0.0	0.0	0.00%	0	0%	0	0%
2.B.10 Other chemical industry: no classification (N_2O)	611.0	318.2	177.2	0.05%	-434	-71%	-141	-44%
2.B.10 Other chemical industry: no classification (NF3)	0.0	0.0	0.0	0.00%	0	0%	0	0%
2.B.10 Other chemical industry: no classification (PFCs)	0.0	0.0	0.0	0.00%	0	0%	0	0%
2.B.10 Other chemical industry: no classification (SF_6)	0.0	0.0	0.0	0.00%	0	0%	0	0%
2.B.10 Other chemical industry: no classification (Unspecified mix of HFCs and PFCs)	0.0	0.0	0.0	0.00%	0	0%	0	0%
2.B.3 Adipic Acid Production: no classification (CO_2)	17.7	17.4	20.2	0.01%	2	14%	3	16%

EU-28 + ISL	Aggregated GHG emissions in kt CO_2 equ.			Share in sector 2. IPPU in 2016	Change 1990-2016		Change 2015-2016	
	1990	2015	2016		kt CO_2 equ.	%	kt CO_2 equ.	%
2.B.4 Caprolactam, Glyoxal and Glyoxylic Acid Production: no classification (CO_2)	0.0	0.0	0.0	0.00%	0	0%	0	0%
2.B.4 Caprolactam, Glyoxal and Glyoxylic Acid Production: no classification (N_2O)	4 128.3	2 319.1	2 101.5	0.56%	-2 027	-49%	-218	-9%
2.B.5 Carbide Production: no classification (CH_4)	5.6	15.6	11.7	0.00%	6	111%	-4	-25%
2.B.5 Carbide Production: no classification (CO_2)	1 742.5	211.5	226.0	0.06%	-1 517	-87%	14	7%
2.B.6 Titanium Dioxide Production: no classification (CO_2)	179.0	276.7	261.0	0.07%	82	46%	-16	-6%
2.B.7 Soda Ash Production: no classification (CO_2)	2 249.3	2 125.2	2 182.0	0.58%	-67	-3%	57	3%
2.B.8 Petrochemical and Carbon Black Production: no classification (CH_4)	1 157.7	1 249.2	1 269.2	0.34%	111	10%	20	2%
2.B.9 Fluorochemical Production: no classification (NF3)	0.0	0.0	0.0	0.00%	0	0%	0	0%
2.B.9 Fluorochemical Production: no classification (PFCs)	4 331.8	2 017.8	2 357.7	0.63%	-1 974	-46%	340	17%
2.B.9 Fluorochemical Production: no classification (SF_6)	1 845.5	96.7	87.5	0.02%	-1 758	-95%	-9	-9%
2.C.1 Iron and Steel Production: no classification (CH_4)	262.6	146.7	150.1	0.04%	-113	-43%	3	2%
2.C.2 Ferroalloys Production: no classification (CH_4)	27.2	21.4	22.3	0.01%	-5	-18%	1	4%
2.C.2 Ferroalloys Production: no classification (CO_2)	4 868.5	3 279.2	3 393.5	0.90%	-1 475	-30%	114	3%
2.C.3 Aluminium Production: no classification (CO_2)	4 891.9	4 602.0	4 642.7	1.23%	-249	-5%	41	1%
2.C.3 Aluminium Production: no classification (SF_6)	25.1	15.9	13.6	0.00%	-12	-46%	-2	-14%
2.C.4 Magnesium Production: no classification (CO_2)	0.0	0.0	0.0	0.00%	0	0%	0	0%
2.C.4 Magnesium Production: no classification (HFCs)	0.0	60.5	73.6	0.02%	74	100%	13	22%
2.C.4 Magnesium Production: no classification (PFCs)	0.0	0.0	0.0	0.00%	0	0%	0	0%
2.C.4 Magnesium Production: no classification (SF_6)	836.3	113.6	132.2	0.04%	-704	-84%	19	16%
2.C.5 Lead Production: no classification (CO_2)	390.7	282.3	246.8	0.07%	-144	-37%	-35	-13%
2.C.6 Zinc Production: no classification (CO_2)	2 928.2	958.0	962.8	0.26%	-1 965	-67%	5	0%
2.C.7 Other Metal Industry: no classification (CH_4)	0.0	0.0	0.0	0.00%	0	0%	0	0%
2.C.7 Other Metal Industry: no classification (CO_2)	501.0	278.5	260.4	0.07%	-241	-48%	-18	-6%
2.C.7 Other Metal Industry: no classification (HFCs)	0.0	0.0	0.0	0.00%	0	0%	0	0%
2.C.7 Other Metal Industry: no classification (N_2O)	20.0	25.2	21.7	0.01%	2	9%	-3	-14%
2.C.7 Other Metal Industry: no classification (NF3)	0.0	0.0	0.0	0.00%	0	0%	0	0%
2.C.7 Other Metal Industry: no classification (PFCs)	0.0	0.0	0.0	0.00%	0	0%	0	0%
2.C.7 Other Metal Industry: no classification (SF_6)	781.0	37.6	60.2	0.02%	-721	-92%	23	60%
2.C.7 Other Metal Industry: no classification (Unspecified mix of HFCs and PFCs)	0.0	0.0	0.0	0.00%	0	0%	0	0%
2.D.1 Lubricant Use: no classification (CH_4)	3.3	0.3	0.3	0.00%	-3	-91%	0	-3%
2.D.1 Lubricant Use: no classification (CO_2)	4 639.3	2 900.1	2 952.7	0.78%	-1 687	-36%	53	2%

EU-28 + ISL	Aggregated GHG emissions in kt CO_2 equ.			Share in sector 2. IPPU in 2016	Change 1990-2016		Change 2015-2016	
	1990	2015	2016		kt CO_2 equ.	%	kt CO_2 equ.	%
2.D.1 Lubricant Use: no classification (N_2O)	4.5	3.2	3.3	0.00%	-1	-28%	0	4%
2.D.2 Paraffin Wax Use: no classification (CH_4)	0.2	0.4	0.4	0.00%	0	115%	0	-1%
2.D.2 Paraffin Wax Use: no classification (CO_2)	630.3	1 194.4	1 189.0	0.32%	559	89%	-5	0%
2.D.2 Paraffin Wax Use: no classification (N_2O)	0.7	1.6	1.6	0.00%	1	138%	0	-3%
2.D.3 Other non energy products: no classification (CH_4)	1.2	1.2	1.4	0.00%	0	14%	0	8%
2.D.3 Other non energy products: no classification (N_2O)	0.0	0.0	0.0	0.00%	0	0%	0	0%
2.E.1 Integrated Circuit or Semiconductor: no classification (HFCs)	86.2	52.7	55.6	0.01%	-31	-36%	3	6%
2.E.1 Integrated Circuit or Semiconductor: no classification (NF3)	23.8	64.4	55.3	0.01%	32	132%	-9	-14%
2.E.1 Integrated Circuit or Semiconductor: no classification (PFCs)	433.4	511.6	582.6	0.15%	149	34%	71	14%
2.E.1 Integrated Circuit or Semiconductor: no classification (SF_6)	237.7	142.2	137.9	0.04%	-100	-42%	-4	-3%
2.E.2 TFT Flat Panel Display: no classification (HFCs)	0.0	0.0	0.0	0.00%	0	0%	0	0%
2.E.2 TFT Flat Panel Display: no classification (PFCs)	0.0	0.0	0.0	0.00%	0	0%	0	0%
2.E.3 Photovoltaics: no classification (HFCs)	0.0	0.0	0.0	0.00%	0	0%	0	0%
2.E.3 Photovoltaics: no classification (PFCs)	0.0	0.0	0.0	0.00%	0	0%	0	0%
2.E.4 Heat Transfer Fluid: no classification (HFCs)	0.0	0.0	0.0	0.00%	0	100%	0	0%
2.E.4 Heat Transfer Fluid: no classification (PFCs)	0.2	0.0	0.0	0.00%	0	-100%	0	0%
2.E.5 Other electronics industry: no classification (HFCs)	0.0	0.0	0.0	0.00%	0	0%	0	0%
2.E.5 Other electronics industry: no classification (NF3)	0.0	0.0	0.0	0.00%	0	0%	0	0%
2.E.5 Other electronics industry: no classification (PFCs)	0.0	0.0	0.0	0.00%	0	0%	0	0%
2.E.5 Other electronics industry: no classification (SF_6)	0.0	0.0	0.0	0.00%	0	0%	0	0%
2.E.5 Other electronics industry: no classification (Unspecified mix of HFCs and PFCs)	0.0	0.0	0.0	0.00%	0	0%	0	0%
2.F.1 Refrigeration and Air conditioning: no classification (NF3)	0.0	0.0	0.0	0.00%	0	0%	0	0%
2.F.1 Refrigeration and Air conditioning: no classification (PFCs)	0.0	93.7	84.4	0.02%	84	100%	-9	-10%
2.F.1 Refrigeration and Air conditioning: no classification (SF_6)	0.0	0.0	0.0	0.00%	0	0%	0	0%
2.F.1 Refrigeration and Air conditioning: no classification (Unspecified mix of HFCs and PFCs)	0.0	482.0	556.7	0.15%	557	100%	75	16%
2.F.2 Foam Blowing Agents: no classification (NF3)	0.0	0.0	0.0	0.00%	0	0%	0	0%
2.F.2 Foam Blowing Agents: no classification (PFCs)	0.0	0.0	0.0	0.00%	0	0%	0	0%
2.F.2 Foam Blowing Agents: no classification (SF_6)	0.0	0.0	0.0	0.00%	0	0%	0	0%

EU-28 + ISL	Aggregated GHG emissions in kt CO_2 equ.			Share in sector 2. IPPU in 2016	Change 1990-2016		Change 2015-2016	
	1990	2015	2016		kt CO_2 equ.	%	kt CO_2 equ.	%
2.F.2 Foam Blowing Agents: no classification (Unspecified mix of HFCs and PFCs)	0.0	0.0	0.0	0.00%	0	0%	0	0%
2.F.3 Fire Protection: no classification (PFCs)	0.0	14.4	14.0	0.00%	14	100%	0	-3%
2.F.4 Aerosols: no classification (NF3)	0.0	0.0	0.0	0.00%	0	0%	0	0%
2.F.4 Aerosols: no classification (PFCs)	0.0	0.0	0.0	0.00%	0	0%	0	0%
2.F.4 Aerosols: no classification (SF_6)	0.0	0.0	0.0	0.00%	0	0%	0	0%
2.F.4 Aerosols: no classification (Unspecified mix of HFCs and PFCs)	0.0	0.0	0.0	0.00%	0	0%	0	0%
2.F.5 Solvents: no classification (HFCs)	0.0	287.4	174.1	0.05%	174	100%	-113	-39%
2.F.5 Solvents: no classification (PFCs)	0.0	0.0	0.0	0.00%	0	0%	0	0%
2.F.6 Other Applications: no classification (HFCs)	0.0	227.1	228.8	0.06%	229	100%	2	1%
2.F.6 Other Applications: no classification (NF3)	0.0	0.0	0.0	0.00%	0	0%	0	0%
2.F.6 Other Applications: no classification (PFCs)	0.0	0.0	0.0	0.00%	0	0%	0	0%
2.F.6 Other Applications: no classification (SF_6)	0.0	0.0	0.0	0.00%	0	0%	0	0%
2.F.6 Other Applications: no classification (Unspecified mix of HFCs and PFCs)	0.0	0.0	0.0	0.00%	0	0%	0	0%
2.G.1 Electrical Equipment: no classification (HFCs)	0.0	0.0	0.0	0.00%	0	0%	0	0%
2.G.1 Electrical Equipment: no classification (PFCs)	0.0	0.0	0.0	0.00%	0	0%	0	0%
2.G.1 Electrical Equipment: no classification (SF_6)	2 823.1	1 964.2	1 923.8	0.51%	-899	-32%	-40	-2%
2.G.2 SF_6 and PFCs from Other Product Use: no classification (PFCs)	322.1	556.6	625.4	0.17%	303	94%	69	12%
2.G.2 SF_6 and PFCs from Other Product Use: no classification (SF_6)	4 493.9	4 084.0	4 407.3	1.17%	-87	-2%	323	8%
2.G.3 N_2O from Product Uses: no classification (N_2O)	5 714.2	3 241.1	3 292.0	0.87%	-2 422	-42%	51	2%
2.G.4 Other unspecifed product manufacture and use: no classification (CH_4)	56.8	82.3	76.3	0.02%	19	34%	-6	-7%
2.G.4 Other unspecifed product manufacture and use: no classification (CO_2)	728.2	535.0	526.5	0.14%	-202	-28%	-9	-2%
2.G.4 Other unspecifed product manufacture and use: no classification (HFCs)	0.0	12.2	12.4	0.00%	12	100%	0	1%
2.G.4 Other unspecifed product manufacture and use: no classification (N_2O)	45.4	183.2	200.2	0.05%	155	341%	17	9%
2.G.4 Other unspecifed product manufacture and use: no classification (NF3)	0.0	0.0	0.0	0.00%	0	0%	0	0%
2.G.4 Other unspecifed product manufacture and use: no classification (PFCs)	0.0	0.0	0.0	0.00%	0	0%	0	0%
2.G.4 Other unspecifed product manufacture and use: no classification (SF_6)	0.0	0.0	0.0	0.00%	0	0%	0	0%

EU-28 + ISL	Aggregated GHG emissions in kt CO_2 equ.			Share in sector 2. IPPU in 2016	Change 1990-2016		Change 2015-2016	
	1990	2015	2016		kt CO_2 equ.	%	kt CO_2 equ.	%
2.G.4 Other unspecifed product manufacture and use: no classification (Unspecified mix of HFCs and PFCs)	0.0	0.0	0.0	0.00%	0	0%	0	0%
2.H Other Industrial Process and Product Use: no classification (CH_4)	37.2	5.1	13.9	0.00%	-23	-63%	9	172%
2.H Other Industrial Process and Product Use: no classification (CO_2)	117.6	104.1	103.0	0.03%	-15	-12%	-1	-1%
2.H Other Industrial Process and Product Use: no classification (HFCs)	0.0	3.2	2.8	0.00%	3	26955%	0	-13%
2.H Other Industrial Process and Product Use: no classification (N_2O)	63.8	82.4	82.2	0.02%	18	29%	0	0%
2.H Other Industrial Process and Product Use: no classification (NF3)	0.0	0.0	0.0	0.00%	0	0%	0	0%
2.H Other Industrial Process and Product Use: no classification (PFCs)	0.2	2.2	3.5	0.00%	3	1606%	1	61%
2.H Other Industrial Process and Product Use: no classification (SF_6)	7.5	26.7	36.6	0.01%	29	390%	10	37%
2.H Other Industrial Process and Product Use: no classification (Unspecified mix of HFCs and PFCs)	273.8	183.9	122.8	0.03%	-151	-55%	-61	-33%

4.3 Methodological issues and uncertainties

The previous section presented for each EU-28 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.

4.3.1 Gap filling of Activity data

It is important to explain the reasons why the EU is not always able to provide EU-level AD or IEFs but has instead opted to transparently document what the MS have reported.

Because of the differences in methodological approaches used by countries the EU NIR provides overview tables for the activity data used by Member States and the corresponding IEFs. Some of these tables do include a calculation of EU-level implied emission factors based on a number of Member States. In those cases where (a) more than 75% of the emissions are calculated on basis of consistent activity data, and (b) the IEF has a reasonable degree of consistency (i.e. standard deviation divided by mean < 50%) we gap-filled activity data in the CRF. In these cases we are confident that the IEF included in the CRF provides reliable information to reviewers and adds to the transparency of the EU inventory. In all other cases we believe that an IEF in the CRF would be misleading because it would be based on a limited number of Member States or based on very different methodological approaches which cannot be meaningfully aggregated. Due to the significant amount of time required, the CRF only includes gap filled activity data for 2016 and only for the EU key categories where the criteria above apply.

In 2018 the following categories have been gap-filled:

- Lime production in 2.A.2
- Glass production in 2.A.3
- Ammonia production in 2.B.1

The method for gap filling includes four steps:

1. Emissions have been aggregated for those MS that are using the same activity data and that are reporting activity data and emissions (i.e. not using notation keys for either activity data or emissions. Usually the geographical coverage of these MS is smaller than EU-28.
2. These emissions have been divided by the aggregated activity data of those MS in order to derive an IEF for those MS.
3. This IEF has been multiplied by the emissions of the EU-28 in order to derive a gap-filled estimate for activity data for EU-28.

Table **4.52** shows the details for the gap filling of activity data for the four categories in particular the geographical coverage of MS used as a basis for calculating the IEF.

Table 4.52 Documentation of gap filling of activity data

Category	Geographical coverage	2016			
		Activity data Description	(kt)	IEF (t/t)	Emissions (kt)
2.A.2	EU-28	Lime Production	25 369	0.74	18 695
	EU-28 excl. NLD, PRT & GBK	Lime Production	23 298	0.74	17 168
2.A.3	EU-28	Glass Production	33 769	0.12	4 215
	EU-28 excl FI, LV, NLD, BG & SK	Glass Production	32 192	0.12	4 018
2.B.1	EU-28	Ammonia Production	17 216	1.39	23 935
	EU-28 excl BG, NL, HU & RO	Ammonia Production	12 205	1.39	16 967

4.3.2 Uncertainty estimates

Table 4.53 shows the total EU-28 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 SF_6 from 2.F (101.3 %) and the lowest for SF_6 from 2.B (3 %). With regard to trend HFC from 2.H shows the highest uncertainty estimates, CO_2 from 2.A and 2.C the lowest. For a description of the Tier 1 uncertainty analysis carried out for the EU-28 see Chapter 1.6.

Table 4.53 Sector 2 Industrial processes: Uncertainty estimates for the EU-28

Source category	Gas	Emissions Base Year	Emissions 2016	Emission trends Base Year-2016	Level uncertainty estimates based on MS uncertainty estimates	Trend uncertainty estimates based on MS uncertainty estimates
2.A Mineral Industry	CO_2	148 540	105 477	-29.0%	3.2%	0.0%
2.A Mineral Industry	CH_4	31	6	-80.7%	100.0%	0.8%
2.A Mineral Industry	N_2O	0	0		0.0%	
2.B Chemical Industry	CO_2	65 267	53 223	-18.5%	4.8%	0.0%
2.B Chemical Industry	CH_4	1 392	1 240	-10.9%	33.1%	0.0%
2.B Chemical Industry	N_2O	118 196	6 318	-94.7%	8.5%	0.2%
2.B Chemical Industry	HFC	30 978	475	-98.5%	14.9%	0.1%
2.B Chemical Industry	PFC	4 428	2 358	-46.8%	46.5%	0.1%
2.B Chemical Industry	Unspecified mix of HFCs and PFCs	0	0		0.0%	0.0%
2.B Chemical Industry	SF_6	1 891	88	-95.4%	3.0%	0.2%
2.B Chemical Industry	NF3	0	0		0.0%	0.0%
2.C Metal Industry	CO_2	111 455	67 622	-39.3%	3.3%	0.0%
2.C Metal Industry	CH_4	394	342	-13.3%	10.1%	0.0%
2.C Metal Industry	N_2O	35	22	-37.0%	79.4%	0.4%
2.C Metal Industry	HFC	4 446	79	-98.2%	29.6%	0.5%
2.C Metal Industry	PFC	15 231	524	-96.6%	10.2%	0.1%
2.C Metal Industry	Unspecified mix of HFCs and PFCs	0	0		0.0%	0.0%
2.C Metal Industry	SF_6	1 908	182	-90.5%	20.5%	0.1%
2.C Metal Industry	NF3	0	0		0.0%	0.0%
2.D Non-energy products from fuels and solvent use	CO_2	13 681	9 848	-28.0%	39.2%	0.2%
2.D Non-energy products from fuels and solvent use	CH_4	5	2	-56.5%	88.1%	0.6%
2.D Non-energy products from fuels and solvent use	N_2O	5	5	-10.4%	77.2%	0.1%
2.E Electronics industry	CO_2	0	0		0.0%	
2.E Electronics industry	CH_4	0	0		0.0%	
2.E Electronics industry	N_2O	0	0		0.0%	
2.E Electronics industry	HFC	59	1 299	2115.3%	23.0%	4.8%
2.E Electronics industry	PFC	551	545	-1.2%	21.5%	0.1%
2.E Electronics industry	Unspecified mix of HFCs and PFCs	0	0		0.0%	0.0%
2.E Electronics industry	SF_6	200	121	-39.6%	14.4%	0.8%
2.E Electronics industry	NF3	99	55	-45.0%	16.2%	0.1%
2.F Product uses as substitutes for ODS	CO_2	0	1 400		51.0%	
2.F Product uses as substitutes for ODS	CH_4	0	0		0.0%	
2.F Product uses as substitutes for ODS	N_2O	0	0		0.0%	
2.F Product uses as substitutes for ODS	HFC	4 616	97 291	2007.9%	42.6%	3.2%
2.F Product uses as substitutes for ODS	PFC	21	93	343.8%	101.3%	4.0%

Source category	Gas	Emissions Base Year	Emissions 2016	Emission trends Base Year-2016	Level uncertainty estimates based on MS uncertainty estimates	Trend uncertainty estimates based on MS uncertainty estimates
2.F Product uses as substitutes for ODS	Unspecified mix of HFCs and PFCs	0	0		0.0%	0.0%
2.F Product uses as substitutes for ODS	SF_6	0	0		0.0%	0.0%
2.F Product uses as substitutes for ODS	NF3	0	0		0.0%	0.0%
2.G Other product manufacture and use	CO_2	733	613	-16.3%	13.8%	0.0%
2.G Other product manufacture and use	CH_4	64	76	19.8%	30.6%	0.1%
2.G Other product manufacture and use	N_2O	4 886	3 022	-38.1%	46.2%	0.1%
2.G Other product manufacture and use	HFC	46	114	149.3%	99.8%	1.9%
2.G Other product manufacture and use	PFC	401	664	65.4%	30.6%	0.1%
2.G Other product manufacture and use	Unspecified mix of HFCs and PFCs	0	0		0.0%	0.0%
2.G Other product manufacture and use	SF_6	3 244	2 178	-32.9%	24.9%	0.1%
2.G Other product manufacture and use	NF3	0	0		0.0%	0.0%
2.H Other	CO_2	143	129	-10.0%	19.9%	0.0%
2.H Other	CH_4	18	9	-48.7%	6.0%	0.0%
2.H Other	N_2O	1 617	1 161	-28.2%	20.6%	0.1%
2.H Other	HFC	0	3	28010.0%	17.0%	47.7%
2.H Other	PFC	0	4	1606.3%	48.4%	7.8%
2.H Other	Unspecified mix of HFCs and PFCs	0	0		0.0%	0.0%
2.H Other	SF_6	7	37	389.7%	52.4%	2.0%
2.H Other	NF3	0	0		0.0%	0.0%
2 (where no subsector data were submitted)	*all*	0	0		0.0%	0.0%
Total - 2	**all**	**534 587**	**356 624**	-33.3%	**11.8%**	**4.8%**

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*

4.4 Sector-specific quality assurance and quality control

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 were 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 were reviewed by Member States experts for all source categories in Industrial Processes. In 2012 a comprehensive review was carried out for all sectors and all EU Member States in order to fix the base year 2020 under the EU Effort Sharing Decision. (ESD review 2012). For the inventory 2005 plant-specific data was available from the EU Emission Trading Scheme (EU ETS) for the first time. This information was used by EU Member States for quality checks and as an input for calculating total CO_2 emissions for the sectors Energy and Industrial Processes in the 2005 report (see Section 1.4.2). During the ESD review 2012 consistency checks were carried out between EU ETS data and the inventory estimates.

In 2013 two workshops were organized in the context of the MS assistance project with the aim of supporting Member States in improving their inventories related to the use of EU ETS data and related to F-gases. Both workshops were very well attended.

In 2014, the initial checks for F-gases were extended: (1) the time series of HFC emissions of the EU Member States was checked at 3-digit level (2.F.1, 2.F.2,…) and at 4-digit level for 2.F.1 (i.e. 2.F.1.1, 2.F.1.2,…); (2) time series and comparability across EU Member States was checked for per capita HFC emissions of category 2-F.1 and its subcategories (2.F.1.1, 2.F.1.2, …). As a result of the checks, 74 issues were clarified with EU Member States. Furthermore, in 2014 additional quality checks of the EU NIR chapter waste were carried out in order to improve the consistency between the CRF tables and the EU NIR and consistency of tables and figures with text in the EU NIR.

After the implementation of the new IPCC guidelines in 2015 and the subsequent changes to the sector (it now comprises 2D, Non-Energy Products from Fuels and Solvent Use, 2E, Electronics Industry, 2F Product Uses as Substitutes for Ozone Depleting Substances, and 2G Other Product Manufacture and Use), chapters had to be re-written, and certain methodological changes had to be applied. NF_3 as a new gas had to be included, and new GWPs for most fluorinated gases had to be applied. In 2016 a comprehensive ESD review was performed followed by an annual ESD review in 2017.

4.5 Sector Specific Recalculations

Table 4.54 shows that in the industrial processes sector the largest recalculations in absolute terms were made for N_2O and HFCs in 1990 and 2015.

Table 4.54 Recalculations of total GHG emissions and recalculations from industrial processes and product use for 1990 and 2015 by gas (kt CO_2 equivalents) and percent of sector total)

1990	**CO_2**		**CH_4**		**N_2O**		**HFCs**		**PFCs**		**SF_6**		**Unspecified mix of HFCs and PFCs**		**NF3**	
	kt	%	kt	%	kt	%	kt	%	kt	%	kt	%	kt	%	kt	%
Total emissions and removals	-14 675	-0.3%	-7 566	-1.0%	-1 842	-0.5%	2	0.0%	0	0.0%	46	0.4%	0	0.0%	0	0.0%
Industrial Processes and Product Use	751	0.2%	7	0.4%	-241	-0.2%	2	0.0%	0	0.0%	46	0.4%	0	0.0%	0	0.0%
2015																
Total emissions and removals	-1 134	0.0%	-2 451	-0.5%	-940	-0.4%	2 323	2.2%	12	0.3%	66	1.0%	482	199.2%	-5	-6.6%
Industrial Processes and Product Use	-43	0.0%	1	0.1%	-6	-0.1%	2 323	2.2%	12	0.3%	66	1.0%	482	199.2%	-5	-6.6%

Table 4.55 provides an overview of Member States' contributions to EU-28+ISL recalculations.

Table 4.55 Sector 2 Industrial processes: Contribution of Member States to EU-28+ISL recalculations for 1990 and 2015 by gas (difference between latest submission and previous submission kt of CO_2 equivalents)

	1990								2015							
	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF3	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF3
Austria	-1	0	0	0	0	0	0	0	35	0	0	-42	0	0	0	0
Belgium	8	0	0	0	0	47	0	0	98	0	-5	47	24	0	0	0
Bulgaria	0	0	0	0	0	0	0	0	0	0	0	70	0	0	0	0
Croatia	52	0	0	0	0	0	0	0	78	0	26	0	0	0	0	0
Cyprus	7	0	0	0	0	0	0	0	5	0	0	-83	0	0	0	0
Czech Republic	33	0	0	0	0	0	0	0	122	0	-1	-529	0	-12	0	0
Denmark	0	0	0	0	0	0	0	0	1	0	0	5	0	0	0	0
Estonia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Finland	18	0	0	0	0	0	0	0	-79	0	0	-132	-4	0	0	0
France	218	6	5	0	0	-3	0	0	-690	8	9	-100	-4	-25	0	-4
Germany	751	0	-246	0	0	0	0	0	-688	0	-1	-1	-9	91	0	0
Greece	0	0	0	0	0	0	0	0	2	0	0	17	0	0	0	0
Hungary	2	0	0	0	0	0	0	0	-7	0	0	118	0	2	0	0
Ireland	37	0	0	0	0	0	0	0	15	0	0	-1	0	0	0	0
Italy	18	0	0	0	0	2	0	0	17	0	0	2 204	0	11	0	0
Latvia	15	0	0	0	0	0	0	0	7	0	0	-8	0	0	0	0
Lithuania	-21	0	0	0	0	0	0	0	25	0	0	49	0	0	0	0
Luxembourg	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Malta	0	0	0	0	0	0	0	0	0	0	0	-1	0	0	0	0
Netherlands	-2 060	0	0	0	0	0	0	0	-595	-6	0	37	0	1	0	0
Poland	0	0	0	0	0	0	0	0	-11	0	0	20	0	0	0	0
Portugal	41	0	0	0	0	0	0	0	23	0	0	230	0	-3	0	0
Romania	1 714	0	0	0	0	0	0	0	888	0	0	0	0	0	0	0
Slovakia	-30	0	0	0	0	0	0	0	-147	0	0	0	0	0	0	0
Slovenia	0	0	0	0	0	0	0	0	1	0	-41	0	0	3	0	0
Spain	-13	0	0	0	0	0	0	0	812	0	0	209	6	0	482	0
Sweden	-42	0	0	1	0	0	0	0	-32	0	3	123	-1	-1	0	0
United Kingdom	0	0	0	0	0	0	0	0	74	-2	4	113	0	0	0	0
EU28	748	6	-241	1	0	46	0	0	-46	-1	-6	2 348	12	66	482	-5
Iceland	3	1	0	0	0	0	0	0	3	2	0	-2	0	0	0	0
United Kingdom (KP)	0	0	0	0	0	0	0	0	74	-2	4	91	0	0	0	0
EU28+ISL	751	7	-241	2	0	46	0	0	-43	1	-6	2 323	12	66	482	-5

5 AGRICULTURE (CRF SECTOR 3)

Half 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 state[22].

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 Agricultural 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 links direct payments to respecting a number of statutory management requirements and to maintain all agricultural land in good agricultural and environmental conditions (EC 2003)[23].

- "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.
- 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.

In 2013, the Council of the EU Agriculture Ministers adopted four Basic Regulations for a reformed CAP following a CAP Health Check[24] in 2008 and a Commission Communication on the CAP towards 2020[25] in 2011. The four legislative texts that regulate the post-2013 CAP are (i) Rural Development:

[22] http://ec.europa.eu/agriculture/envir/index_en.htm

[23] http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:32003R1782

[24] http://ec.europa.eu/agriculture/healthcheck/index_en.htm

[25] https://ec.europa.eu/agriculture/cap-post-2013_en

Regulation 1305/2013[26]; (ii) "Horizontal" issues such as funding and controls: Regulation 1306/2013[27]; (iii) Direct payments for farmers: Regulation 1307/2013[28]; (iv) Market measures: Regulation 1308/2013[29].

With the adoption of the 2013 CAP reform, the environment concerns received an enhanced focus being materialised by explicitly linking the agricultural support to "agricultural practices beneficial to the climate and environment" (so called 'CAP greening'). Agro-environmental indicators have been identified as useful tools to perform this task, especially since they allow for the assessment of territorial impacts. The monitoring and evaluation of CAP performance is carried out through indicators (EC 2006[30], 2001[31], 2000[32]). Green direct payments account for 30% of EU countries' direct payment budgets. Farmers receiving an area-based payment have to make use of various straightforward, non-contractual practices that benefit the environment and the climate. These require action each year. They include:

- diversifying crops;
- maintaining permanent grassland; and
- dedicating 5% of arable land to ecologically beneficial elements ('ecological focus areas').

Currently, the next reform of the CAP is under discussion enabling agriculture in Europe by its modernisation and simplification to face new challenges, such related to economic prospects and care for the environment including action over climate change and maximise its contribution to the Commission's priorities and to the Sustainable Development Goals[33].

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 $NO_3^- \ l^{-1}$ and listing codes of good practice (Annex II A) to be implemented by the farmers on a voluntary basis. Nitrate vulnerable zones (NVZ) 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 fertilisers are prohibited; (ii) capacity of and facilities for storage of animal manure; and (iii) limits to the amounts of animal manure and fertilisers applied to land.

The action programmes need to be implemented by farmers within NVZs on a compulsory basis. These programmes must include measures already included in Codes of Good Agricultural Practice, which become mandatory, and other measures, such as limitation of fertiliser application (mineral and organic), taking into account crop needs and all nitrogen inputs and soil nitrogen supply, with maximum amount of livestock manure to be applied. Every four years countries are required to report on nitrates concentrations in groundwaters and surface waters; eutrophication of surface waters;

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26 http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2013:347:0487:0548:en:PDF

27 http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2013:347:0549:0607:en:PDF

28 http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2013:347:0608:0670:en:PDF

29 http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2013:347:0671:0854:en:PDF

30 EC (2006). Development of agri-environmental indicators for monitoring the integration of environmental concerns into the common agricultural policy. Communication from the Commission to the Council and the European Parliament. COM(2006) 508 final. Commission of the European Communities, Brussels.

31 EC (2001). Statistical Information needed for Indicators to monitor the Integration of Environmental concerns into the Common Agricultural Policy. Communication from the Commission to the Council and the European Parliament. COM(2001) 144 final. Commission of the European Communities.

32 EC (2000). Indicators for the Integration of Environmental Concerns into the Common Agricultural Policy. Commission of the European Communities.

33 https://ec.europa.eu/agriculture/consultations/cap-modernising/2017_en

assessment of the impact of action programme(s) on water quality and agricultural practices; revision of NVZs and action programme(s); estimation of future trends in water quality.

This has affected emissions in most countries:

- In Belgium, Manure Action Plans (MAP, based on the Nitrate Directive) in Flanders affected NH_3 volatilization from manure application. The first action plan in 1991 regulated the reduced period in which manure can be spread and foresaw low-emission techniques for the application of manure on land. The MAP2bis in 2000 focused on the reduction of the manure surplus and manure processing in order to reduce the NH_3 emissions from manure application on land. Other MAP's followed, which have had a positive effect on the NH_3 and N_2O emissions.
- In Denmark, the environmental policy has introduced a series of measures to prevent loss of nitrogen from agricultural soils 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 accounting at farm and field level with the N-excretion data from FAS (Faculty of Agricultural 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 commercial farmers to the Plant Directorate. An active environmental policy has brought about a decrease in the N-excretion and 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 since 1990.
- In the Netherlands, manure and fertiliser 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 poultry production rights (ceilings for total animal numbers) by the government and lowering the maximum nutrient application standards for manure and fertiliser. 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 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. The milk quota system ended in 2015.

Other important policies affecting greenhouse gas emissions from agriculture, particularly by addressing the abatement of air pollution through the control of NO_x and NH_3 emissions include, amongst others:

- The 1999 Gothenburg Protocol under the Convention on Long Range Transboundary Air Pollution (CLRTAP[34]) to 'Abate Acidification, Eutrophication and Ground-level Ozone', revised in 2012 setting national emission reduction commitments to be achieved by 2020 and beyond;
- The National Emission Ceilings Directive (NEC - Directive 2001/81/EC[35]) 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. It has been updated in 2016[36] setting new objectives for EU air policy for 2020 and 2030;

34 http://www.unece.org/env/lrtap/multi_h1.html

35 http://ec.europa.eu/environment/air/pollutants/ceilings.htm

36 http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32016L2284&from=EN

- The Industrial Emission Directive (IED[37][38]), which was established in 1996, and aims at minimizing pollution from point sources, i. e., intensive animal production facilities (pig and poultry farms, with more than 2000 fattening pigs (over 30 kg); more than 750 sows or more than 40,000 head of poultry). These are required under the directive to apply control techniques for preventing NH_3 emissions according to Best Available Technology (BAT).

Legislation related with animal health may also affect emissions through changes in specific parameters. That is the case of Spain, where the methane conversion factor (Ym), and therefore the implied emission factor for CH_4 emissions from enteric fermentation from swine decreased in 2006, partly due to the ban of the use of growth-promoting antibiotics in animal feeding. This resulted in a radical change in feeding conditions: raw materials with lowest digestibility were removed and replaced by carbohydrates (mainly cereals). To increase higher digestibility and quality protein supply, the soybean flour 44 was systematically replaced by soybean 47 which has higher protein content. Also, affordable synthetic amino acids and digestive enzymes were systematically introduced. In addition, during the same year, the regulation on additives used in animal feeding was published, thus forcing the withdrawal of products that were being used to date, in order to make the digestion of other diet components easier.

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 rationalizations over the past 50 years. One fifth of the Swedish arable land cultivated in the 1950s is no longer farmed. Closures have mainly affected small holdings 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 increased from 3% of the arable land area in 1995 to 17% in 2007.

In the case of Croatia, we can observe livestock population drops in 1992 due to the beginning of the Croatian War of Independence in 1991/1992, which significantly influenced animal production for most animal categories. The countries which formed part of the communist block suffered structural changes when they changed regime, mainly due to privatizations. Lithuania shows an important decrease of non-dairy cattle population in 1993-1994, after the collapse of the Soviet Union and the restoration of independence in 1990, when changes in economy and significant reforms occurred. The reform included the re-establishment of private ownership and management in agriculture sector. Legislation defined dismemberment of collective farms, but they did not definitively ensure their replacement by at least equally productive private farms and corporations. The decrease in cattle population occurred also due to high costs in production, product differences in prices and lack of market for meat and milk. Similarly, Bulgaria shows a decline in cattle numbers in 1992-1995, after the communist period, due to the reforms in agricultural holdings, together with a decrease in the quantities of inorganic fertilisers. Poland, in turn, had a significant drop in cattle population since mid-1990s up to 2002 due to intentional limitations of cattle breeding related to weakening demand for beef meat. Further increase in population could be connected with the prospect of inclusion of Poland into the EU planned for 2004 and joining the common agricultural policy, with expectations for stable agricultural production. An increase in population in 2012 was probably triggered by the improved economic situation for the agricultural markets. The economic situation seems to highly influence the use of fertilisers in the EU countries, especially for liming and urea fertilisation. In Poland,

[37] http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32010L0075

[38] http://ec.europa.eu/environment/industry/stationary/index.htm

limestone/dolomite fertiliser use dramatically decreased after 2004 as a result of a cut in their subsidies for farmers. In 2006, limestone use was lower by 40% than in previous year, despite remaining high need of soils. In Lithuania, a sharp increase of N input from application of other organic fertilisers took place in 2013, caused by changes in national circumstances when using financial resources of 2004-2006 EU ISPA/Cohesion funds Lithuania started to improve municipal solid waste management system. Also in Italy, fertiliser use was affected by the economic crisis (2009-2011), which led to a reduction in the application of all synthetic fertilisers, in particular urea. In 2012, a recovery from the sharp decline was recorded. In the same line, Slovenia reports a strong decrease in urea fertilisers in 1991 and 2008 due to the economic crisis and high prices of fertilisers.

Similarly, the area used for rice cultivation suffers large changes for both continuous flooded and intermittently flooded rice as consequences of economic and environmental pressures. For emissions at EU-level, the combination of emissions from rice from different countries and cultivation systems contributes additionally to fluctuations. Emissions from burning of agricultural residues also have fluctuating trends due to the heterogeneity of the emission source: it is a composite emission categories over countries and crops with different shares of residues burned and different shares of agricultural area and, consequently, large fluctuations are to be expected.

5.1 Overview of sector

In the year 2016, CH_4, N_2O and CO_2 emissions from CRF sector 3 Agriculture were 47.5%, 72.2%, and 0.27% of total EU28+ISL emissions, respectively. Total emissions from agriculture were 431 Mt CO_2-eq with contributions from CH_4, N_2O, and CO_2 of 238 Mt CO_2-eq, 183 Mt CO_2-eq and 10.7 Mt CO_2-eq, respectively. Thus, CH_4, N_2O, and CO_2 contributed with 5%, 3.8% and 0.22% to total EU28+ISL GHG emissions. They make 55.1%, 42.4% and 2.5% of total agricultural emissions.

Figure 5.1 shows the development of total GHG emissions from agriculture from 543 Mt CO_2-eq in 1990 to 431 Mt CO_2-eq in 2016 and the considerably decrease in EU28+ISL. The decrease was most pronounced for CO_2 with a decrease of 27.8%, followed by CH_4 with a decrease of 21.7% and N_2O with a decrease of 18.7%. The decrease was most pronounced in the first decade with a total reduction of 15.5% between 1990 and 2000, a further decrease by between 2000 and 2005, while remaining constant since 2005 (change -0.98%).

Figure 5.2 shows that largest reductions occurred in the largest key sources CH_4 from *3.A.1: Cattle* and N_2O from *3.D.1: Direct emissions from managed soils*. The main reasons for this are decreasing use of fertiliser and manure and declining cattle numbers in most Member States. Figure 5.3 shows the distribution of agricultural GHG emissions among the different source categories for the year 2016.

Figure 5.1: EU-28 GHG emissions for 1990-2016 from CRF Sector 3: 'Agriculture' in CO_2 equivalents (Mt)

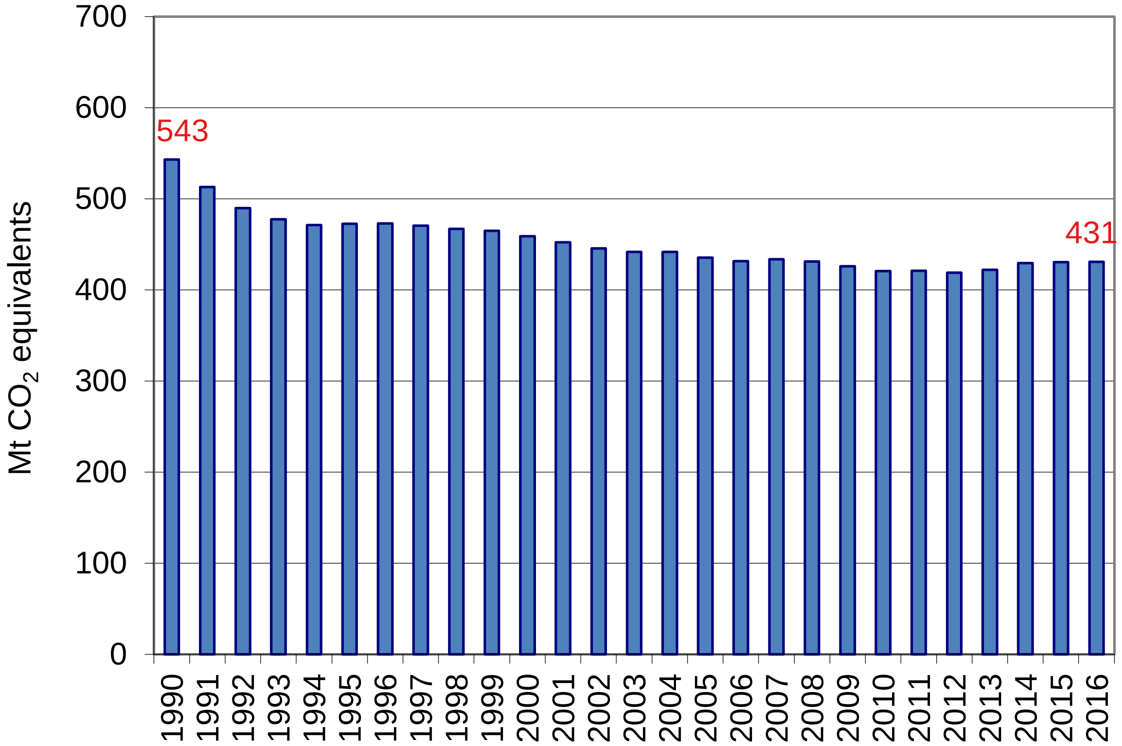


Figure 5.2: Absolute change of GHG emissions by large key source categories 1990-2016 in CO_2 equivalents (Mt) in CRF Sector 3: 'Agriculture'

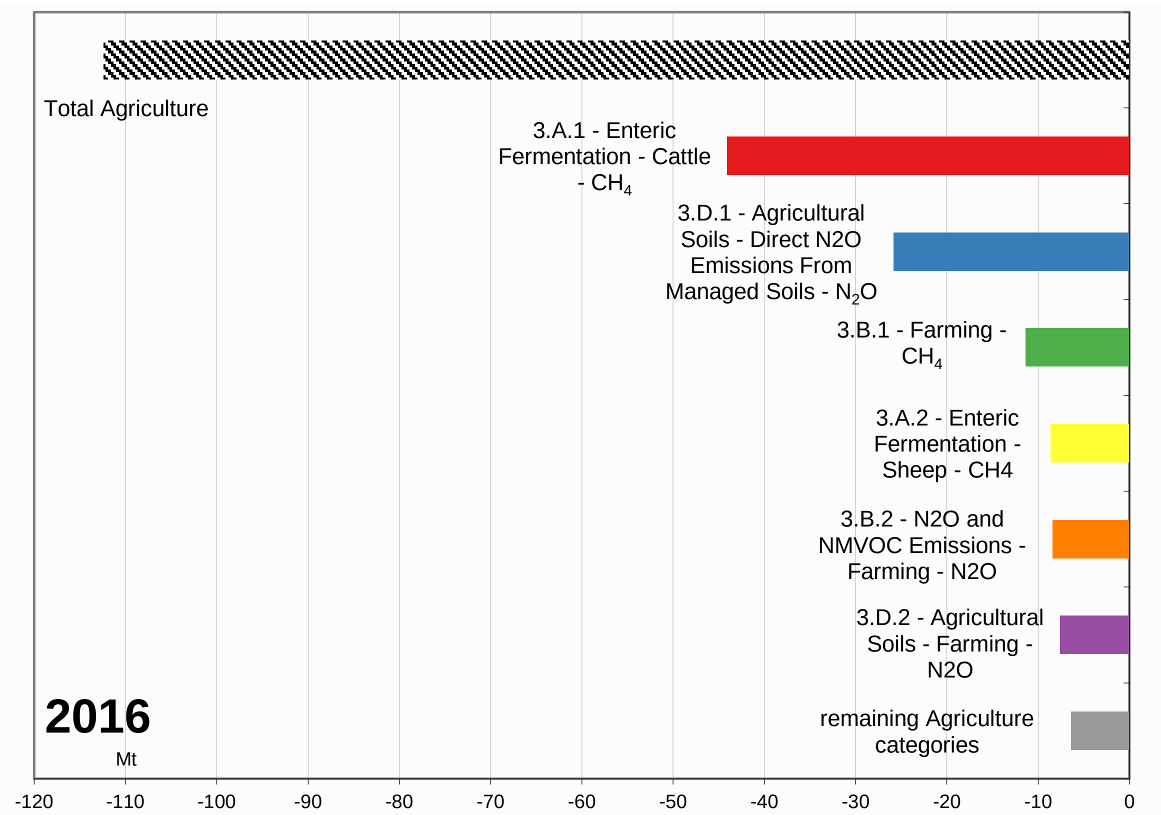
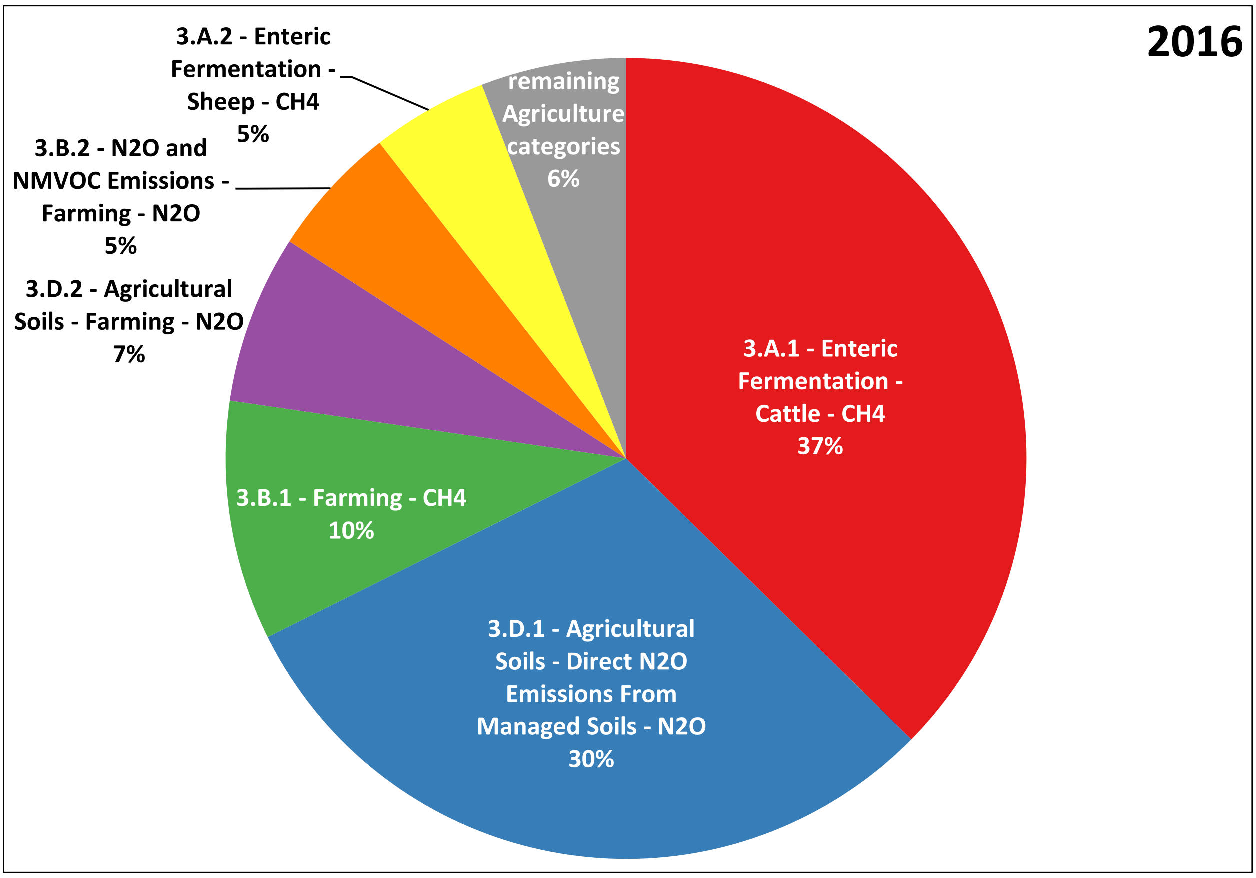


Figure 5.3: Distribution of agricultural GHG emissions among the different source categories for the year 2016



5.2 Emission trends

In this section we analyse the contribution of the different emission categories and the individual countries to the overall trend of emissions from the EU agricultural sector. Table 5.1 shows the different emission categories, their contribution to total emissions in the EU sector and their contribution to the trend 1990-2016 and 2015-2016. A negative share of the trend means that the emissions in that category are evolving in the opposite direction to those of the EU. Total emissions from agriculture have decreased by 21% compared to 1990 and nearly half of this reduction (48%) is due to sector 3.A. Another important sector in determining long-term emission trends is 3.D.1 which accounts for 23% of the total decrease in agricultural emissions, followed by 3.B.1 (10%), while all the other categories contribute less than 10% each. Only emissions from urea application follow the opposite trend, contributing to compensate the emission decrease but with a very low impact (-1% of agriculture total trend). Looking at the data, we can see that the shares of the trend 1990-2016 are close to the shares in emissions. Different figures are observed for the short-term trends, where the contribution of the emission categories is not linked to their weight in total emissions, and half of them have different sign from changes in the overall emissions of the sector. For the whole sector, there was a very slight increase of emissions between 2015 and 2016 (0.1% of total emissions), with some emission categories increasing emissions (3.A, 3.H, 3.G, 3.C) and some decreasing (3.B.1, 3.F, 3.B.2, 3.I, 3.F, 3.D.2), which nearly compensate to stabilise total emissions from agriculture. The greatest change took place in 3.A, with an increase of emissions 1.28 times the total increase in agriculture. Categories 3.H and 3.G account for 50% and 37% of total increase in the sector. The main contributor to compensate these increases is category 3.B.1 (-87% of the total), followed by 3.F and 3.B.2 (-13% and -10%, respectively). The contribution of the other categories is less than 10% of total change, in absolute terms.

Table 5.1 Contribution of the different emission categories to the total trend in emissions from the agricultural sector, compared to the share of emissions of those categories from the total of the sector

Emission category	Gas	Contribution to total agricultural emissions (2016)	Share of trend 1990-2016	Share of trend 2015-2016
3.A	CH_4	0.45	0.48	1.28
3.D.1	N_2O	0.30	0.23	0.00
3.B.1	CH_4	0.10	0.10	-0.87
3.D.2	N_2O	0.07	0.07	-0.03
3.B.2	N_2O	0.05	0.07	-0.10
3.G	CO_2	0.01	0.04	0.37
3.H	CO_2	0.01	-0.01	0.50
3.C	CH_4	0.01	0.00	0.08
3.F	CH_4	0.00	0.01	-0.13
3.I	CO_2	0.00	0.00	-0.06
3.F	N_2O	0.00	0.00	-0.05

The contribution of individual countries to the key categories will be addressed in the corresponding sections, but as a summary we can say that 2015-2016 changes in category 3.A are mainly motivated by Italy, Ireland and the Netherlands, with Germany pushing to decrease emissions. In 3.B.1, Romania and France are the main responsible for the decreasing trend, with 64 and 52% of total EU decrease. If we look at the main countries driving the EU trend in the different emission categories, we find that Germany, Italy, France and Poland are the most recurrent countries. These are also among the main contributors to total agricultural emissions, but also are the UK and Spain, which are not as important contributors to the trend, especially the UK, which does not appear among the first 4 contributors in any of the emission categories.

Table 5.2 shows the contribution of the different emission categories in the individual countries to the overall emission trend of EU agriculture (2015-2016). The greatest contributions are those of category 3.D.1 from France and Germany. Although the trend of emissions in category 3.D.1 for the whole EU is nearly stable, the variability in the different member states is high, ranging from -1730 to +903 times the change in emissions in the category for the whole EU (in absolute values, -626 to +350 CO_2-eq in 2016 compared to 2015). Other important contributors to the total trend are 3.D.1 from Spain, Poland and Italy, 3.A from Germany, Italy, Ireland and the Netherlands, and 3.G from Poland. These countries are the top 8 contributors to total EU emissions, therefore it is expectable that they highly influence the EU trends. It is also expectable that 3.A and 3.D.1 are driving overall emission trends, as they represent together 75% of total agricultural emissions in 2016. More surprising is finding 3.G among the main drivers, being only 1.4% of total emissions in the sector. Analysing the key categories of the individual countries, we found that Poland is one of the few countries where category 3G is a key category, due to its trend. In their NIR they explain that liming and, in general, fertiliser use increased in 2016 due to better meteorological conditions and related higher yields compared to 2015. This is one of the member states which has been improving agricultural production after EU accession in 2004. Similar increases in 3.G emissions are observed within member states entering the EU in the same period.

Table 5.2 This is the dummy header of Trendtable2

Country	Emission categories							Share of total EU emissions from agriculture
	3.A	3.B.1	3.B.2	3.D.1	3.D.2	3.G	3.H	
MT	0.0%	0.0%	-0.1%	-0.1%	0.0%			0.02%
IS	0.7%	0.1%	0.1%	-0.8%	-0.2%	0.0%	0.0%	0.14%
CY	4.1%	0.1%	0.5%	0.0%	0.1%		0.0%	0.17%
LU	1.5%	0.3%	0.1%	1.1%	0.4%	0.0%		0.18%
EE	-1.8%	-1.2%	-0.7%	-6.2%	-1.3%	1.1%	-0.1%	0.30%
SI	3.3%	1.1%	0.3%	-0.2%	0.1%	0.1%	0.2%	0.41%
SK	-2.1%	-1.5%	-2.3%	22.0%	5.8%	0.3%	0.5%	0.62%
LV	0.4%	0.0%	-0.5%	-2.7%	0.1%	0.6%	0.4%	0.62%
HR	-2.3%	-0.6%	-0.7%	11.1%	2.9%		1.7%	0.68%
LT	-10.8%	-4.9%	-1.5%	-14.5%	-4.3%	-1.1%	-0.2%	1.04%
BG	-3.4%	0.7%	-1.1%	53.3%	12.7%		1.0%	1.52%
FI	-2.7%	-0.4%	-0.7%	-4.0%	-1.5%	18.4%	0.1%	1.52%
PT	15.7%	3.1%	1.0%	-2.7%	-1.7%	0.0%	-0.8%	1.58%
HU	6.1%	-0.5%	-1.1%	39.0%	0.6%	-1.0%	0.2%	1.60%
SE	-2.4%	1.2%	-1.4%	6.3%	-0.5%	0.0%	0.0%	1.60%
AT	3.4%	-0.3%	0.2%	16.6%	2.5%	-0.1%	1.0%	1.70%
GR	-16.7%	1.6%	-0.9%	12.2%	3.8%	0.0%	0.6%	1.83%
CZ	13.2%	2.9%	2.6%	41.1%	11.7%	0.8%	5.1%	1.98%
BE	-0.2%	-3.1%	-0.4%	-30.5%	-6.7%	-0.3%	0.1%	2.31%
DK	9.6%	-4.8%	-2.9%	22.9%	-2.8%	9.9%	0.0%	2.45%
RO	-4.0%	-55.4%	-4.6%	13.3%	0.9%	4.5%	-0.5%	4.27%
NL	64.7%	19.9%	2.4%	-7.5%	2.0%	0.0%		4.47%
IE	69.3%	9.6%	4.5%	12.1%	4.4%	7.1%	1.6%	4.49%
PL	-30.5%	-8.8%	-10.2%	75.0%	19.5%	62.0%	3.0%	7.01%
IT	73.4%	2.3%	8.2%	70.0%	20.6%	-0.3%	21.9%	7.08%
ES	41.0%	3.3%	7.9%	-70.8%	-9.8%	0.2%	0.9%	8.02%
GB	3.4%	3.7%	4.2%	1.1%	-0.1%	2.2%	2.7%	9.72%
DE	-64.3%	-10.0%	-7.9%	-134.1%	-35.6%	-51.1%	-7.7%	14.82%
FR	-41.0%	-45.5%	-5.1%	-122.9%	-26.0%	-15.8%	18.1%	17.87%
TOTAL	**128%**	**-87%**	**-10%**	**0%**	**-3%**	**37%**	**50%**	

5.3 Source categories and methodological issues

In this section, we present the information relevant for EU28+ISL key source categories in the sector 3 Agriculture.

Key source categories identified are: 3.A.1 CH_4 emissions from enteric fermentation from dairy and non-dairy cattle, 3.A.2 CH_4 emissions form enteric fermentation from sheep, 3.A.4 CH_4 from enteric fermentation from other cattle, 3.B.1 CH_4 emissions from manure management, 3.B.2 N_2O emissions from manure management, 3.D.1 Direct N_2O emissions from agricultural soils and 3.D.2 Indirect N_2O emissions from agricultural soils. Table 5.3 shows emissions from key categories in the base year and in the last reported year, whether they are identified as key due to the level or to the trend in emissions and the share of emissions in the category which are calculated using a Tier 2 or Tier 3 method. CH_4 emissions from enteric fermentation from cattle are calculated with very sophisticated methods, with only Cyprus using partially T1. For the enteric fermentation of sheep, the situation is more divided with 13 countries use Tier 1 methods and 15 using higher tiers (including those with higher emissions). For sector 3.A.4, only three countries (Romania, France and Portugal) are using higher tiers, with all the others combining different methods. In 3.B.1 and 3.B.2 it is also more mixed, with Germany, Denmark, Finland, France, Croatia and Romania using exclusively higher tiers in both categories. For the calculation of emissions from soils, the share of high tiers is very low; only Denmark and Sweden use solely higher tiers in 3.D.2, while there are no countries using only high tiers in 3.D.1, but only some combining high with low tier methods.

Table 5.3 Key categories for the EU (Agriculture - sector excerpt)

Source category gas	kt CO_2 equ.		Trend	Level		Share of higher Tier
	1990	2016		1990	2016	
3.A.1.1 Enteric Fermentation: Dairy Cattle (CH_4)	103936	75964	0	L	L	1.00
3.A.1.2 Enteric Fermentation: Non-Dairy Cattle (CH_4)	100720	84594	0	L	L	1.00
3.A.2 Enteric Fermentation: Sheep (CH_4)	28806	20155	0	L	L	0.90
3.A.4 Enteric Fermentation: Other livestock (CH_4)	6193	6229	0	0	L	0.31
3.B.1 CH_4 Emissions: Manure Management	52893	41529	0	L	L	0.84
3.B.2 N_2O and NMVOC Emissions: manure management	31292	22891	0	L	L	0.79
3.D.1 Direct N_2O Emissions From Managed Soils	155812	129959	T	L	L	0.09
3.D.2 Indirect N_2O Emissions From Agricultural Soils	36847	29236	0	L	L	0.05

Other source categories are not identified as key source in the analysis at EU28+ISL level and are therefore not further discussed here. Emissions from source category J - other agriculture emissions are reported only from Germany (digestion of energy crops) and the UK (emissions from liming in oversee territories and crown dependencies).

For each of the above-mentioned source categories, data on the countries contributing most to EU28+ISL emissions and to EU28+ISL emissions trend are provided, as well as information on relevant activity data and IEFs and other parameters, if relevant.

Many countries recognize 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, several countries have developed comprehensive models covering consistently different source categories and different gases.

5.3.1 Enteric fermentation (CRF Source Category 3.A)

CH_4 emissions in source category *3.A - Enteric Fermentation* are 4% of total EU28+ISL GHG emissions and 38% of total EU28+ISL CH_4 emissions. They make 44.4% of total agricultural emissions and 80% of total agricultural CH_4 emissions. It is thus the largest GHG source in agriculture and the largest source of CH_4 emissions. The main sub-categories are 3.A.1.2 (Non-Dairy Cattle), 3.A.1.1 (Dairy Cattle) and 3.A.2 (Sheep) as shown in Figure 5.4. Emissions are also reported for 3.A.4 (Other Livestock) and 3.A.3 (Swine). CH_4 emissions from Enteric Fermentation for 'Other Livestock' are reported for the categories Buffalo, Deer, Goats, Horses, Mules and Asses, Poultry, and Other Other Livestock.

Regarding the origin of emissions in the different Member States, Figure 5.5 shows the distribution of CH_4 emissions from enteric fermentation by livestock category in all Member States and in the EU28+ISL. Each bar represents the total emissions of a country in the current emission category, where different shades of blue correspond to the emitting animal types.

Figure 5.4: Share of source category 3.A on total EU28+ISL agricultural emissions (left panel) and decomposition into its sub-categories (right panel). The percentages refer to the emissions in the year 2016.

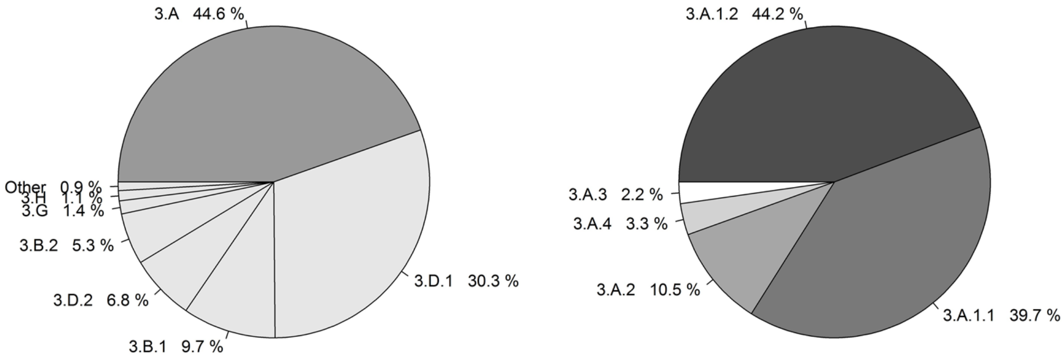
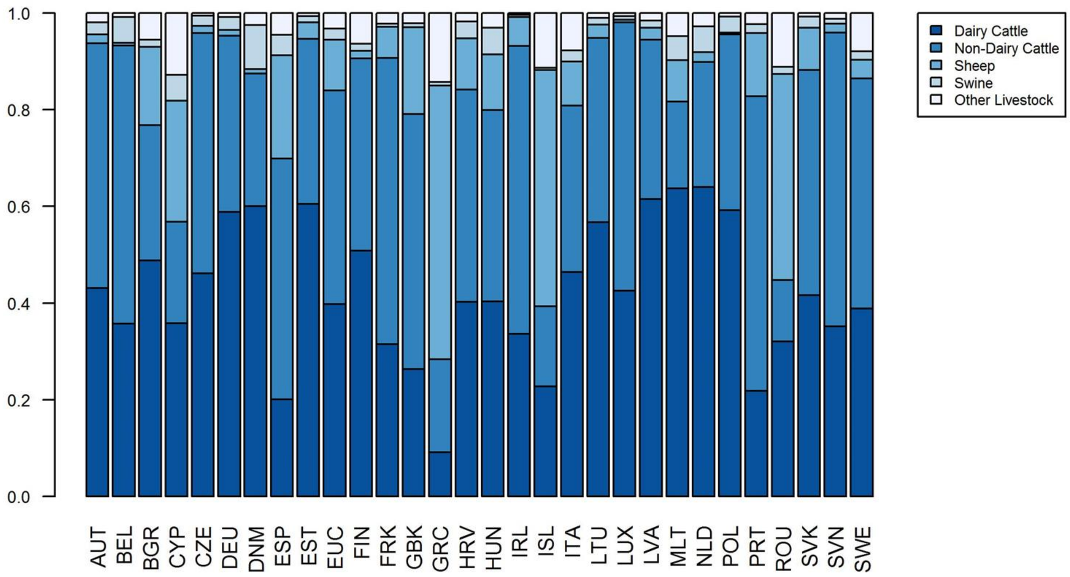


Figure 5.5: Decomposition of emissions in source category 3.A - Enteric Fermentation into its sub-categories by Member State in the year 2016.



Total GHG and CH_4 emissions by Member State from 3.A *Enteric Fermentation* are shown in Table 5.4 by Member State plus Iceland, and the total EU-28 and EU-28+ISL for the first and the last year of the inventory (1990 and 2016). Values are given in kt CO_2-eq. In this category GHG and CH_4 columns have the same values, as no other greenhouse gases are produced in the enteric fermentation process. Between 1990 and 2016, CH_4 emission in this source category decreased by 22% or 54 Mt CO_2-eq. The decrease was largest in Bulgaria in relative terms (68%) and in Germany in absolute terms (10.2 Mt CO_2-eq). From 2015 to 2016 emissions in the current category increased by 0.3%.

Table 5.4 3.A - Enteric Fermentation: Member States' contributions to total EU-GHG and CH_4 emissions

Member States	GHG emissions in 1990 (kt CO_2 equivalents)	GHG emissions in 2016 (kt CO_2 equivalents)	CH_4 emissions in 1990 (kt CO_2 equivalents)	CH_4 emissions in 2016 (kt CO_2 equivalents)
Austria	4,821	4,147	4,821	4,147
Belgium	5,410	4,591	5,410	4,591
Bulgaria	4,805	1,520	4,805	1,520
Croatia	2,172	1,176	2,172	1,176
Cyprus	197	244	197	244
Czech Republic	5,755	2,957	5,755	2,957
Denmark	4,039	3,712	4,039	3,712
Estonia	1,247	533	1,247	533
Finland	2,423	2,105	2,423	2,105
France	38,616	35,145	38,616	35,145
Germany	34,664	24,456	34,664	24,456
Greece	4,024	3,652	4,024	3,652
Hungary	3,754	2,066	3,754	2,066
Ireland	11,357	11,247	11,357	11,247
Italy	15,497	14,039	15,497	14,039
Latvia	2,222	860	2,222	860
Lithuania	4,314	1,586	4,314	1,586
Luxembourg	434	436	434	436
Malta	37	31	37	31
Netherlands	9,231	8,812	9,231	8,812
Poland	21,554	12,277	21,554	12,277
Portugal	3,521	3,555	3,521	3,555
Romania	18,745	10,664	18,745	10,664
Slovakia	2,584	976	2,584	976
Slovenia	935	951	935	951
Spain	13,313	14,237	13,313	14,237
Sweden	3,278	2,990	3,278	2,990
United Kingdom	25,993	21,936	25,993	21,936
EU-28	**244,940**	**190,899**	**244,940**	**190,899**
Iceland	314	306	314	306
EU-28 + ISL	**245,254**	**191,205**	**245,254**	**191,205**

Total GHG and CH_4 emissions by Member State from *3.A.1 - Cattle Enteric Fermentation* are shown in Table 5.5 by Member State plus Iceland, and the total EU-28 and EU-28+ISL for the first and the last year of the inventory (1990 and 2016). Values are given in kt CO_2-eq. Between 1990 and 2016, CH_4 emission in this source category decreased by 22% or 44.1 Mt CO_2-eq. The decrease was largest in Lithuania in relative terms (64%) and in Germany in absolute terms (9.9 Mt CO_2-eq). From 2015 to 2016 emissions in the current category increased by 0.4%.

Table 5.5 3.A.1 - Cattle: Member States' contributions to total EU-GHG and CH_4 emissions

Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016		Method	Emission factor Informa-tion
	1990	2015	2016		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	4 579	3 874	3 886	2.4%	-693	-15%	12	0%	T2	CS
Belgium	5 110	4 280	4 284	2.7%	-826	-16%	3	0%	T2	CS
Bulgaria	2 958	1 177	1 167	0.7%	-1 790	-61%	-9	-1%	T2	CS
Croatia	1 995	1 007	990	0.6%	-1 005	-50%	-17	-2%	T2	CS
Cyprus	101	122	138	0.1%	37	37%	17	14%	T1,T2	CS,D
Czech Republic	5 472	2 773	2 836	1.8%	-2 636	-48%	63	2%	T2	CS
Denmark	3 662	3 195	3 247	2.0%	-415	-11%	52	2%	T2	CS,D
Estonia	1 190	513	504	0.3%	-685	-58%	-8	-2%	T2	CS,D
Finland	2 226	1 919	1 907	1.2%	-320	-14%	-12	-1%	T2	CS
France	34 130	32 031	31 868	19.8%	-2 262	-7%	-163	-1%	T2,T3	CS
Germany	33 252	23 602	23 308	14.5%	-9 944	-30%	-293	-1%	T2,T3	CS,D
Greece	1 184	1 083	1 035	0.6%	-149	-13%	-48	-4%	T2	CS,D
Hungary	2 962	1 619	1 651	1.0%	-1 311	-44%	33	2%	T2	CS
Ireland	10 101	10 144	10 479	6.5%	377	4%	334	3%	CS,T2	CS
Italy	13 164	11 053	11 346	7.1%	-1 819	-14%	292	3%	T2	CS
Latvia	2 118	812	813	0.5%	-1 305	-62%	1	0%	T2	CS
Lithuania	4 170	1 558	1 504	0.9%	-2 665	-64%	-54	-3%	T2	CS
Luxembourg	428	421	428	0.3%	0	0%	7	2%	T2	CS
Malta	29	25	25	0.0%	-4	-12%	0	0%	T2	CS
Netherlands	8 195	7 601	7 920	4.9%	-275	-3%	319	4%	T2,T3	CS
Poland	19 547	11 834	11 733	7.3%	-7 814	-40%	-101	-1%	T2	CS
Portugal	2 460	2 865	2 942	1.8%	483	20%	78	3%	T2	CS
Romania	10 465	4 821	4 767	3.0%	-5 698	-54%	-55	-1%	T2	CS
Slovakia	2 328	865	861	0.5%	-1 467	-63%	-4	0%	T2	CS
Slovenia	904	897	912	0.6%	8	1%	16	2%	T2	CS
Spain	8 453	9 788	9 946	6.2%	1 492	18%	157	2%	CS,T2	CS,D
Sweden	2 885	2 589	2 585	1.6%	-299	-10%	-4	0%	CS	CS
United Kingdom	20 481	17 300	17 356	10.8%	-3 126	-15%	56	0%	T3	CS
EU-28	**204 550**	**159 766**	**160 438**	**100%**	**-44 112**	**-22%**	**672**	**0.4%**	**-**	**-**
Iceland	106	118	120	0.1%	14	14%	2	2%	T2	-
United Kingdom (KP)	20 481	17 300	17 356	10.8%	-3 126	-15%	56	0%	T3	CS
EU-28 + ISL	**204 656**	**159 885**	**160 558**	**100%**	**-44 098**	**-22%**	**674**	**0.4%**	**-**	**-**

Total GHG and CH_4 emissions by Member State from *3.A.2 - Sheep Enteric Fermentation* are shown in Table 5.6 by Member State plus Iceland, and the total EU-28 and EU-28+ISL for the first and the last year of the inventory (1990 and 2016). Values are given in kt CO_2-eq. Between 1990 and 2016, CH_4 emission in this source category decreased by 30% or 8.7 Mt CO_2-eq. The decrease was largest in Poland in relative terms (94%) and in Romania in absolute terms (2 Mt CO_2-eq). From 2015 to 2016 emissions in the current category decreased by 0.2%.

Table 5.6 3.A.2 - Sheep: Member States' contributions to total EU-GHG and CH_4 emissions

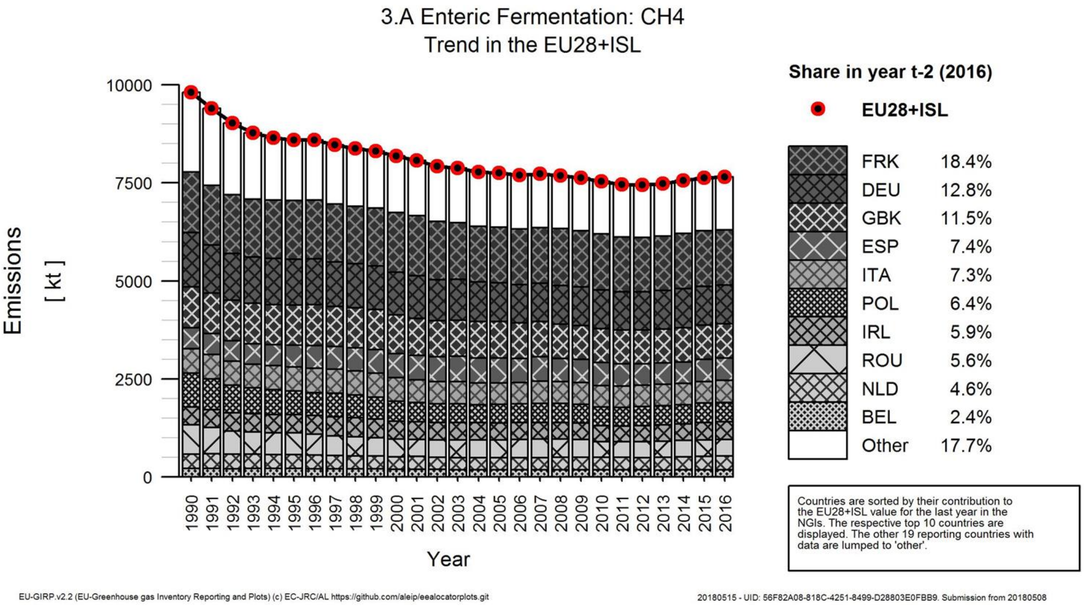
Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016		Method	Emission factor Informa-tion
	1990	2015	2016		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	62	71	76	0.4%	14	22%	5	7%	T1	D
Belgium	38	24	25	0.1%	-14	-36%	1	3%	T1	D
Bulgaria	1 454	246	246	1.2%	-1 208	-83%	0	0%	T2	CS
Croatia	94	120	124	0.6%	30	32%	4	3%	T2	CS
Cyprus	58	59	61	0.3%	3	5%	1	2%	T1	D
Czech Republic	86	46	44	0.2%	-42	-49%	-3	-6%	T1	D
Denmark	39	35	35	0.2%	-4	-10%	-1	-2%	T2	D
Estonia	32	18	18	0.1%	-13	-42%	1	4%	D,T1	D
Finland	18	33	33	0.2%	15	87%	0	1%	CS	CS
France	3 533	2 286	2 267	11.2%	-1 266	-36%	-19	-1%	T2,T3	CS
Germany	518	297	294	1.5%	-224	-43%	-3	-1%	T1	CS,D
Greece	2 054	2 070	2 068	10.3%	15	1%	-2	0%	T2	CS,D
Hungary	392	239	238	1.2%	-154	-39%	-1	0%	T1	D
Ireland	1 176	683	671	3.3%	-506	-43%	-13	-2%	T1	D
Italy	1 504	1 253	1 285	6.4%	-219	-15%	33	3%	T2	CS
Latvia	33	20	21	0.1%	-12	-35%	1	4%	T1	D
Lithuania	18	40	44	0.2%	26	141%	5	12%	T2	CS
Luxembourg	2	2	2	0.0%	0	23%	0	4%	T2	CS
Malta	3	2	3	0.0%	-1	-18%	0	10%	T2	CS
Netherlands	340	189	178	0.9%	-162	-48%	-11	-6%	T1	D
Poland	832	46	48	0.2%	-784	-94%	2	5%	T1	D
Portugal	794	468	466	2.3%	-328	-41%	-2	0%	T2	CS
Romania	6 587	4 526	4 555	22.6%	-2 032	-31%	29	1%	T2	CS
Slovakia	154	90	86	0.4%	-68	-44%	-4	-4%	T2	CS
Slovenia	3	16	18	0.1%	15	521%	2	10%	T1	D
Spain	3 791	3 067	3 050	15.1%	-741	-20%	-17	-1%	CS,T2	CS
Sweden	81	119	116	0.6%	34	42%	-3	-3%	T1	D
United Kingdom	4 936	3 974	3 936	19.5%	-1 000	-20%	-39	-1%	T3	CS
EU-28	**28 632**	**20 038**	**20 005**	**99%**	**-8 627**	**-30%**	**-32**	**-0.2%**	**-**	**-**
Iceland	174	149	150	0.7%	-24	-14%	1	1%	-	-
United Kingdom (KP)	4 936	3 974	3 936	19.5%	-1 000	-20%	-39	-1%	T3	CS
EU-28 + ISL	**28 806**	**20 187**	**20 155**	**100%**	**-8 650**	**-30%**	**-31**	**-0.2%**	**-**	**-**

5.3.1.1 Trends in Emissions and Activity Data

3.A - Enteric Fermentation - Emissions

Emissions in source category *3.A - Enteric Fermentation* decreased considerably in EU28+ISL by 22% or 54 Mt CO_2-eq in the period 1990 to 2016. Figure 5.6 shows the trend of emissions indicating the countries contributing most to EU28+ISL total. The figure represents the trend in CH_4 emissions from enteric fermentation for the different Member States along the inventory period. The ten countries with the highest emissions accounted together for 82.3% of the total. Emissions decreased in 24 countries and increased in five countries. The three countries with the largest decreases were Germany, Poland and Romania with a total absolute decrease of 27.6 Mt CO_2-eq. The largest increases occurred in Spain, with a total absolute increase of 924 kt CO_2-eq.

Figure 5.6: *3.A: Trend in emissions in the EU28+ISL and the countries contributing most to EU28+ISL values including their share to EU28+ISL emissions in 2016*



3.A.1 - Cattle - Emissions

Emissions in source category *3.A.1 - Cattle* decreased considerably in EU28+ISL by 22% or 44.1 Mt CO_2-eq in the period 1990 to 2016. The ten countries with the highest emissions accounted together for 82.8% of the total. Emissions decreased in 23 countries and increased in six countries. The three countries with the largest decreases were Germany, Poland and Romania with a total absolute decrease of 23.5 Mt CO_2-eq. The three countries with the largest increases were Ireland, Portugal and Spain, with a total absolute increase of 2.4 Mt CO_2-eq.

Emissions in source category *3.A.1 - Dairy Cattle* decreased strongly in EU28+ISL by 27% or 28 Mt CO_2-eq in the period 1990 to 2016. Figure 5.7 shows the trend of emissions indicating the countries contributing most to EU28+ISL total. The figure represents the trend in CH_4 emissions from enteric fermentation for the different Member States along the inventory period. Each bar shows the emissions in kt accumulated by the different Member States in a specific year. Every Member State is represented by a different pattern. Only the first ten Member States with the highest emission shares are shown separately, while the emissions corresponding to the remaining countries are represented under 'other' label. In red points, we see the total emissions of the category for the EU28+ISL. The legend on the right shows the Member States corresponding to each pattern and the share of their emissions over the EU-28 total. The ten countries with the highest emissions accounted together for 82.8% of the total. Emissions decreased in 24 countries and increased in five countries. The three countries with the largest decreases were Poland, Germany and Romania with a total absolute decrease of 14 Mt CO_2-eq. The largest increases occurred in Ireland and the Netherlands, with a total absolute increase of 840 kt CO_2-eq.

Emissions in source category *3.A.1 - Non-Dairy Cattle* decreased considerably in EU28+ISL by 16% or 16.1 Mt CO_2-eq in the period 1990 to 2016. Figure 5.8 shows the trend of emissions indicating the countries contributing most to EU28+ISL total. The figure represents the trend in CH_4 emissions from enteric fermentation for the different Member States along the inventory period. The ten countries with the highest emissions accounted together for 84.5% of the total. Emissions decreased in 22 countries and increased in seven countries. The largest decreases occurred in Germany and Romania with a total absolute decrease of 7.6 Mt CO_2-eq. The largest increases occurred in Portugal and Spain, with a total absolute increase of 3.2 Mt CO_2-eq.

3.A.1 - Cattle - Population

The main driver for the decrease of CH_4 emissions from enteric fermentation was the decrease in animal numbers that we can see in Figure 5.9 and Figure 5.10.

Cattle population decreased strongly in EU28+ISL by 26% or 30.9 million heads in the period 1990 to 2016. The ten countries with the highest population accounted together for 84.4% of the total. Population decreased in 24 countries and increased in five countries. The largest decreases occurred in Germany and Poland with a total absolute decrease of 11.1 million heads. The three countries with the largest increases were Portugal, Ireland and Spain, with a total absolute increase of 1.9 million heads.

Figure 5.7: 3.A.1 Dairy Cattle: Trend in emissions in the EU28+ISL and the countries contributing most to EU28+ISL values including their share to EU28+ISL emissions in 2016

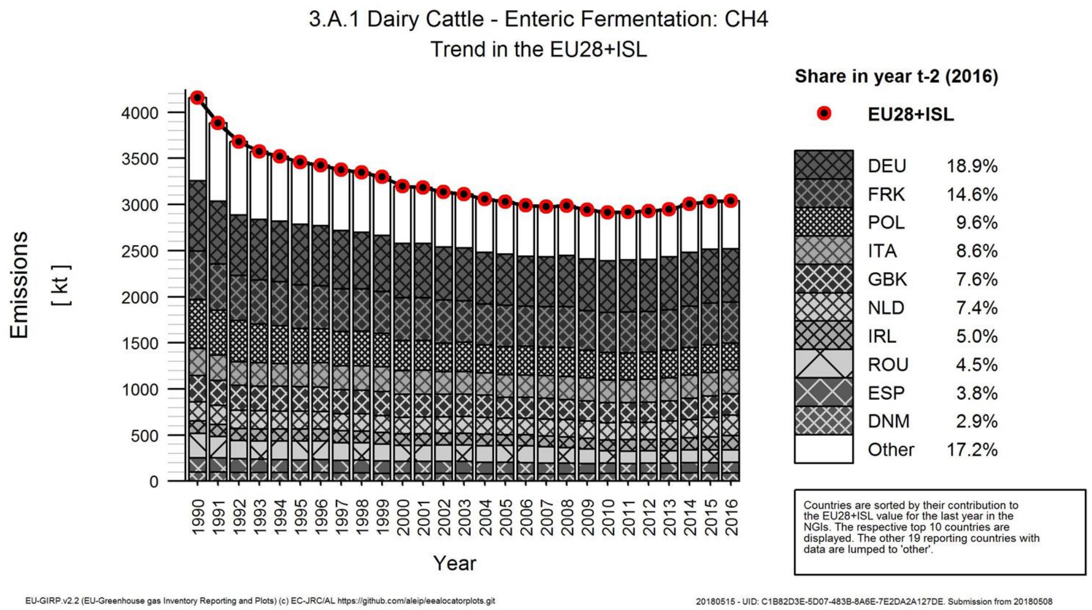


Figure 5.8: 3.A.1 Non-Dairy Cattle: Trend in emissions in the EU28+ISL and the countries contributing most to EU28+ISL values including their share to EU28+ISL emissions in 2016

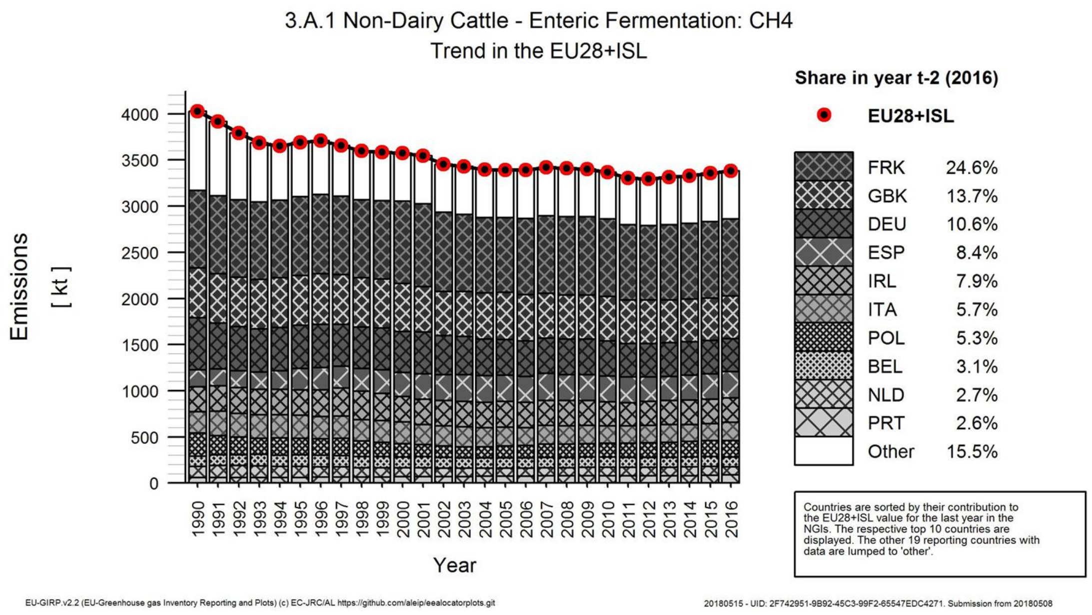


Figure 5.9: 3.A.1 Dairy Cattle: Trend in cattle population in the EU28+ISL and the countries contributing most to EU28+ISL values including their share to EU28+ISL emissions in 2016

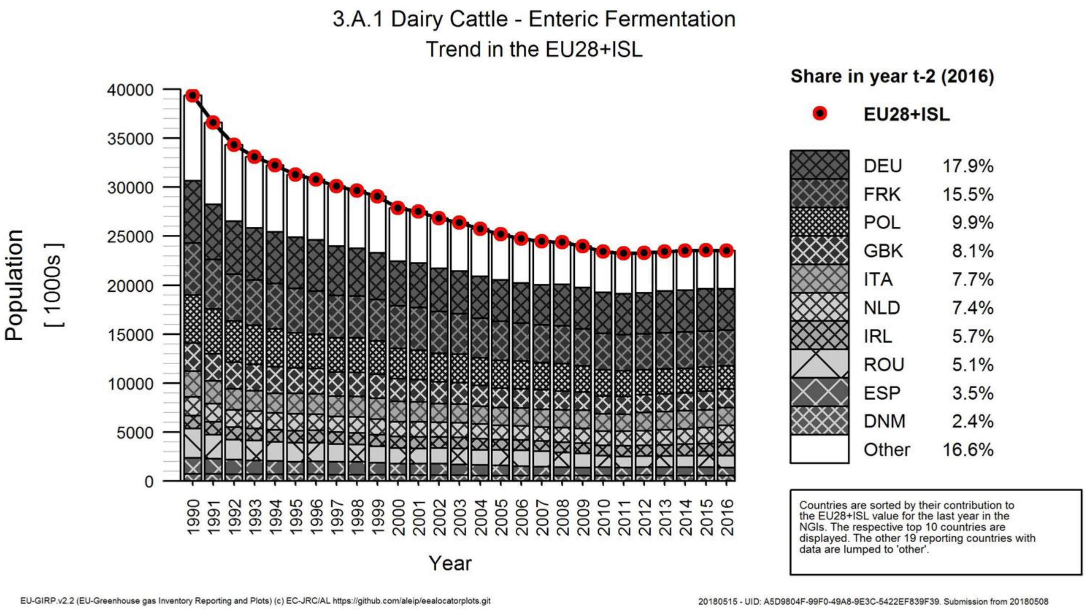
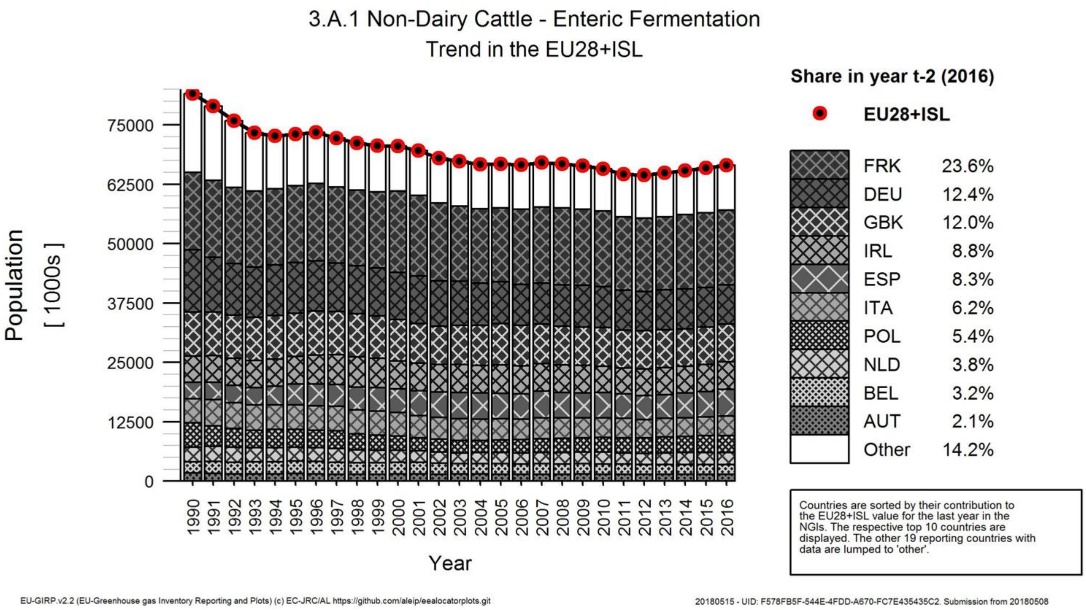


Figure 5.10: 3.A.1 Non-Dairy Cattle: Trend in cattle population in the EU28+ISL and the countries contributing most to EU28+ISL values including their share to EU28+ISL emissions in 2016



3.A.2 - Sheep - Emissions

Emissions in source category *3.A.2 - Sheep* decreased strongly in EU28+ISL by 30% or 8.7 Mt CO_2-eq in the period 1990 to 2016. Figure 5.11 shows the trend of emissions indicating the countries contributing most to EU28+ISL total. The figure represents the trend in CH_4 emissions from enteric fermentation for the different Member States along the inventory period. The ten countries with the highest emissions accounted together for 93.5% of the total. Emissions decreased in twenty countries and increased in nine countries. The four countries with the largest decreases were Romania, France, Bulgaria and the United Kingdom with a total absolute decrease of 5.5 Mt CO_2-eq. The four countries with the largest increases were Finland, Lithuania, Croatia and Sweden, with a total absolute increase of 105 kt CO_2-eq.

3.A.2 - Sheep - Population

The main driver for the decrease of CH_4 emissions from enteric fermentation for sheep was the decrease in animal numbers shown in Figure 5.12.

Sheep population decreased strongly in EU28+ISL by 32% or 47.6 million heads in the period 1990 to 2016. Figure 5.12 shows the trend of sheep population indicating the countries contributing most to EU28+ISL total. The figure represents the trend in CH_4 population for the different Member States along the inventory period. The ten countries with the highest population accounted together for 93.5% of the total. Population decreased in 21 countries and increased in eight countries. The three countries with the largest decreases were the United Kingdom, Spain and Bulgaria with a total absolute decrease of 25.9 million heads. The five countries with the largest increases were Austria, Slovenia, Greece, Lithuania and Sweden, with a total absolute increase of 494 thousand heads.

Figure 5.11: 3.A.2: Trend in emissions in the EU28+ISL and the countries contributing most to EU28+ISL values including their share to EU28+ISL emissions in 2016

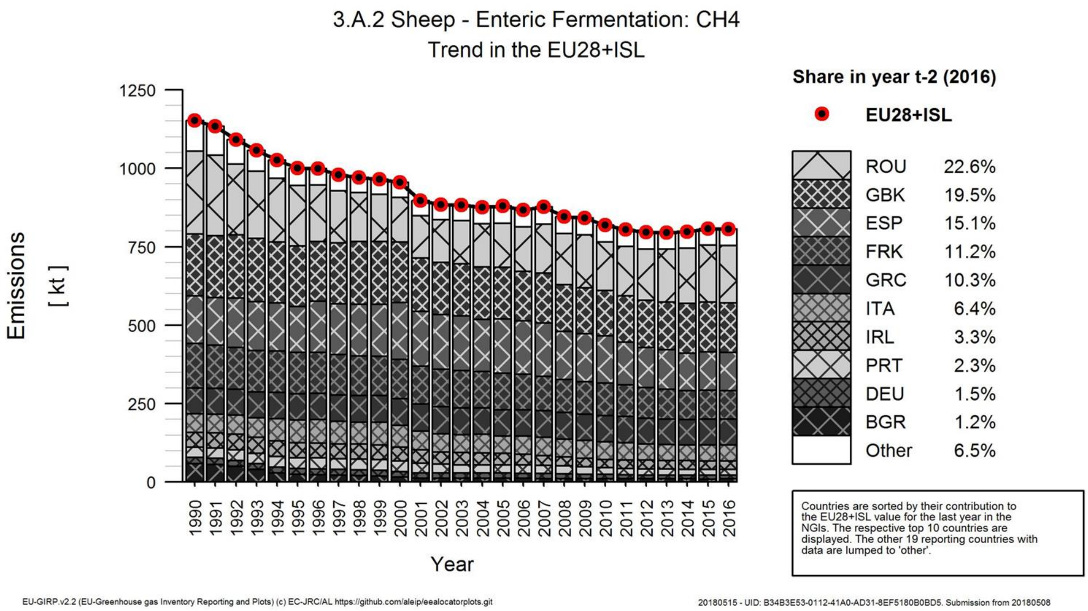
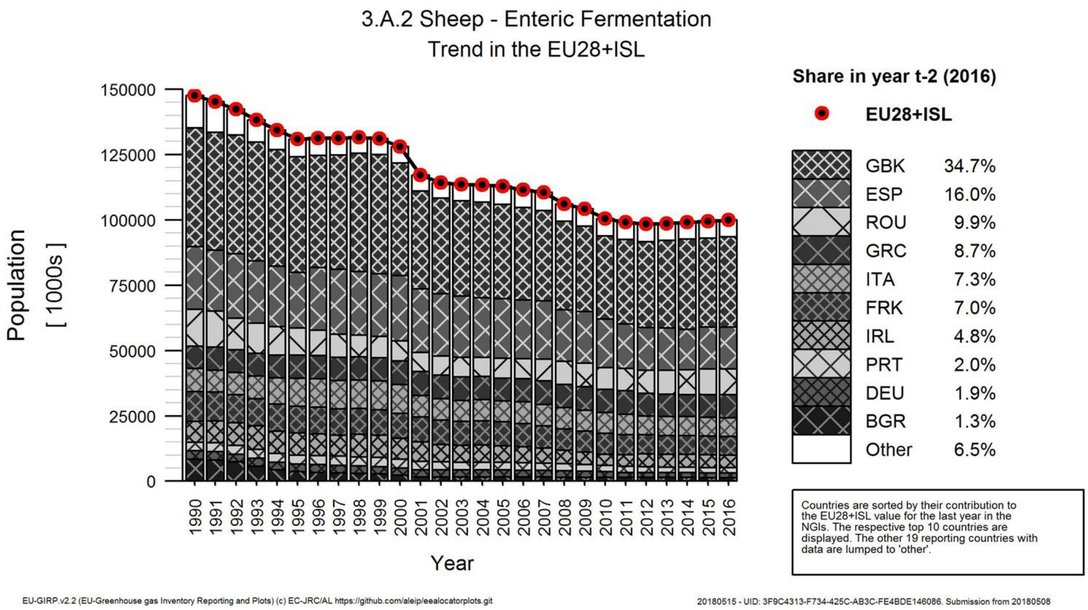


Figure 5.12: 3.A.2: Trend in sheep population in the EU28+ISL and the countries contributing most to EU28+ISL values including their share to EU28+ISL emissions in 2016



5.3.1.2 Implied EFs and Methodological Issues

Information for cattle, sheep and swine are reported using national classification of the animals. For example, it is possible to report cattle numbers using one of three options:

- Option A distinguishes 'Dairy Cattle' and 'Non-Dairy Cattle'.
- Option B distinguishes 'Mature Dairy Cattle', 'Other Mature Cattle' and 'Growing Cattle'.
- Option C allows for any national classification.

To obtain values that can be aggregated to EU28+ISL level, data reported under Option B and Option C were converted to Option A categories. 'Mature Dairy Cattle' is taken for 'Dairy Cattle' and the other two categories under Option B are used for 'Non-Dairy Cattle'. Also in Option C, dairy cattle can be identified (e.g. 'Dairy Cows', 'Other Dairy Cattle' etc.) and all other cattle categories have been grouped to the animal type 'Non-Dairy Cattle'.

In case data were aggregated, this was done on the basis of a weighted average using population data as weighting factors.

In the cases for 'Sheep' and 'Swine', all animal types reported by countries are aggregated to one single parent category using the same approach.

In this section we discuss the Implied Emission Factor for the main animal types. Furthermore, we present data on the average gross energy intake and - for dairy cattle - also the milk yield.

3.A.1 - Cattle - Implied emission factor

The implied emission factor for CH_4 emissions in source category *3.A.1 - Cattle* increased in EU28+ISL moderately between 1990 and 2016 by 5.2% or 3.54 kg/head/year. Table 5.7 shows the implied emission factor for CH_4 emissions in source category *3.A.1 - Cattle* for the years 1990 and 2016 for all Member States and EU28+ISL. The implied emission factor decreased in three countries and increased in 24 countries. Decreases occurred in Croatia, Spain and Ireland with a mean absolute value of 6 kg/head/year. The four countries with the largest increases were Latvia, Slovakia, Estonia and Czech Republic with a mean absolute value of 18 kg/head/year.

Table 5.7 3.A.1 - Cattle: Member States' and EU28+ISL implied emission factor (kg/head/year)

Member State	1990	2016	Member State	1990	2016
Austria	71	80	Ireland	59	58
Belgium	63	67	Iceland		60
Bulgaria	74	84	Italy	68	77
Cyprus	74	86	Lithuania	70	83
Czech Republic	62	80	Luxembourg	78	85
Germany	68	75	Latvia	59	79
Denmark	65	83	Malta	55	70
Spain	67	62	Netherlands	67	75
Estonia	63	81	Poland	82	83
Finland	65	84	Portugal	72	74
France	63	66	Romania	79	92
United Kingdom	68	70	Slovakia	60	77
Greece	68	75	Slovenia		75
Croatia	94	82	Sweden	67	69
Hungary	73	79	**EU28+ISL**	**68**	**72**

3.A.1 - Dairy Cattle - Implied emission factor

The implied emission factor for CH_4 emissions in source category *3.A.1 - Dairy Cattle* increased in EU28+ISL considerably between 1990 and 2016 by 22.3% or 23.6 kg/head/year. Figure 5.13 shows the trend of the implied emission factor in EU28+ISL indicating also the range of values used by the countries. Table 5.8 shows the implied emission factor for CH_4 emissions in source category *3.A.1 - Dairy Cattle* for the years 1990 and 2016 for all Member States and EU28+ISL. The reported implied emission factor increased in all reporting 29 countries. The four countries with the largest increases were Slovakia, Czech Republic, Estonia and Spain with a mean absolute value of 46 kg/head/year.

Figure 5.13: 3.A.1 - Dairy Cattle: Trend in implied emission factor in the EU28+ISL and range of values reported by countries

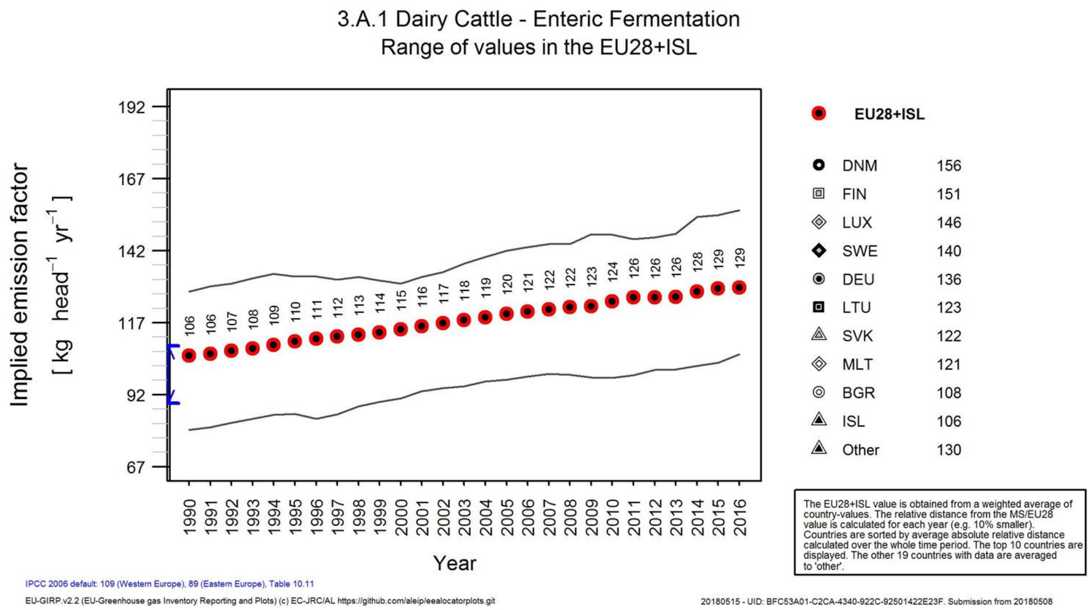


Table 5.8 3.A.1 - Dairy Cattle: Member States' and EU28+ISL implied emission factor (kg/head/year)

Member State	1990	2016		Member State	1990	2016
Austria	105	132	|	Ireland	101	112
Belgium	112	143	|	Iceland	85	106
Bulgaria	105	108	|	Italy	111	143
Cyprus	99	123	|	Lithuania	101	123
Czech Republic	97	146	|	Luxembourg	120	146
Germany	120	136	|	Latvia	103	137
Denmark	128	156	|	Malta	88	121
Spain	96	138	|	Netherlands	110	129
Estonia	101	150	|	Poland	108	125
Finland	112	151	|	Portugal	97	130
France	99	122	|	Romania	90	114
United Kingdom	98	121	|	Slovakia	80	122
Greece	93	126	|	Slovenia	92	124
Croatia	113	113	|	Sweden	112	140
Hungary	111	135	|	**EU28+ISL**	**106**	**129**

3.A.1 - Dairy Cattle - Gross energy

The gross energy, a parameter used for calculating CH_4 emissions in source category *3.A.1 - Dairy Cattle*, increased in EU28+ISL strongly between 1990 and 2016 by 26.8% or 65.4 MJ/day. Figure 5.14 shows the trend of the gross energy in EU28+ISL indicating also the range of values used by the countries. Table 5.9 shows the gross energy in source category *3.A.1 - Dairy Cattle* for the years 1990 and 2016 for all Member States and EU28+ISL. Gross energy decreased in one country and increased in 24 countries. No data were available for four countries (Bulgaria, Czech Republic, France and the Netherlands). A decrease occurred in Cyprus with an absolute value of 0.00026 MJ/day. The four countries with the largest increases were Slovakia, Estonia, Spain and Malta with a mean absolute value of 98 MJ/day.

Figure 5.14: 3.A.1 - Dairy Cattle: Trend in gross energy in the EU28+ISL and range of values reported by countries

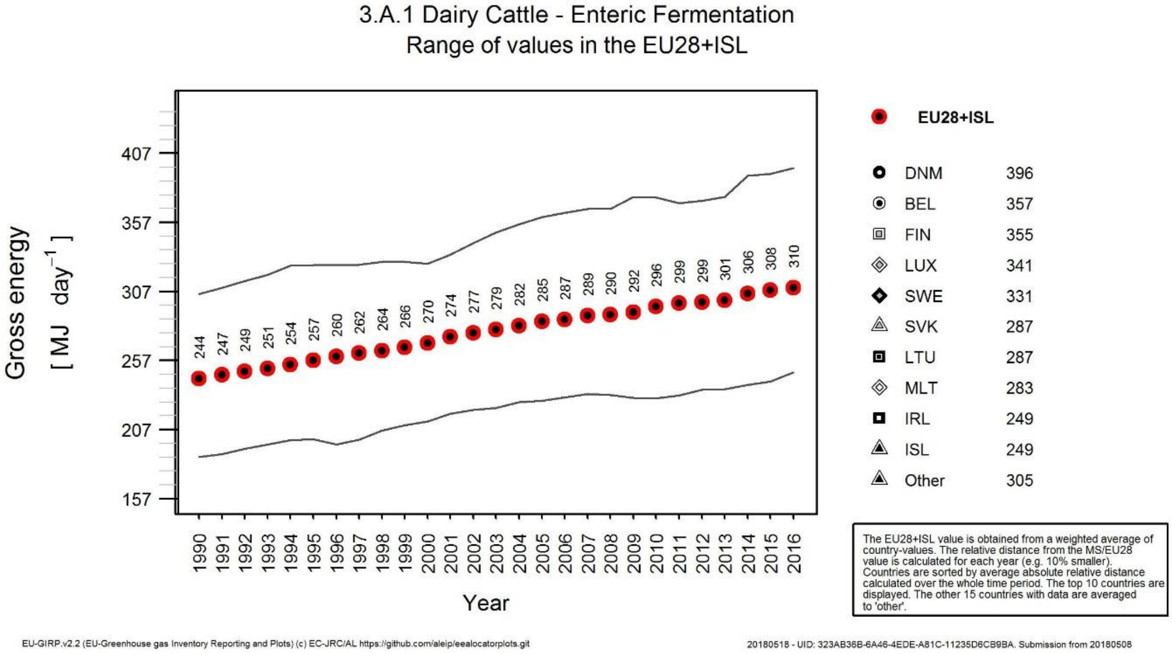


Table 5.9 3.A.1 - Dairy Cattle: Member States' and EU28+ISL gross energy (MJ/day)

Member State	1990	2016		Member State	1990	2016
Austria	246.75	310.17	|	Iceland	200.14	248.55
Belgium	279.27	357.21	|	Italy	260.66	335.42
Cyprus	231.77	287.45	|	Lithuania	233.86	287.19
Germany	259.89	330.83	|	Luxembourg	280.43	340.77
Denmark	305.08	396.35	|	Latvia	241.56	322.37
Spain	224.69	322.60	|	Malta	205.53	282.67
Estonia	236.53	351.57	|	Poland	253.73	292.38
Finland	263.54	355.14	|	Portugal	227.17	305.62
United Kingdom	211.94	282.89	|	Romania	210.06	268.54
Greece	217.06	295.83	|	Slovakia	187.08	287.32
Croatia	256.07	275.46	|	Slovenia	215.20	291.26
Hungary	254.79	309.55	|	Sweden	270.84	330.66
Ireland	221.72	248.63	|	**EU28+ISL**	**243.84**	**309.22**

3.A.1 - Dairy Cattle - Milk yield

The milk yield, a parameter used for calculating CH_4 emissions in source category *3.A.1 - Dairy Cattle*, increased in EU28+ISL very strongly between 1990 and 2016 by 70.4% or 7.87 kg/head/day. Figure 5.15 shows the trend of the milk yield in EU28+ISL indicating also the range of values used by the countries. Table 5.10 shows the milk yield in source category *3.A.1 - Dairy Cattle* for the years 1990 and 2016 for all Member States and EU28+ISL. The reported milk yield in 2016 was at the level of 1990 in one country and increased in all reporting other 26 countries. The four countries with the largest increases were Slovakia, Romania, Spain and Greece with a mean absolute value of 10 kg/head/day.

Figure 5.15: 3.A.1 - Dairy Cattle: Trend in milk yield in the EU28+ISL and range of values reported by countries

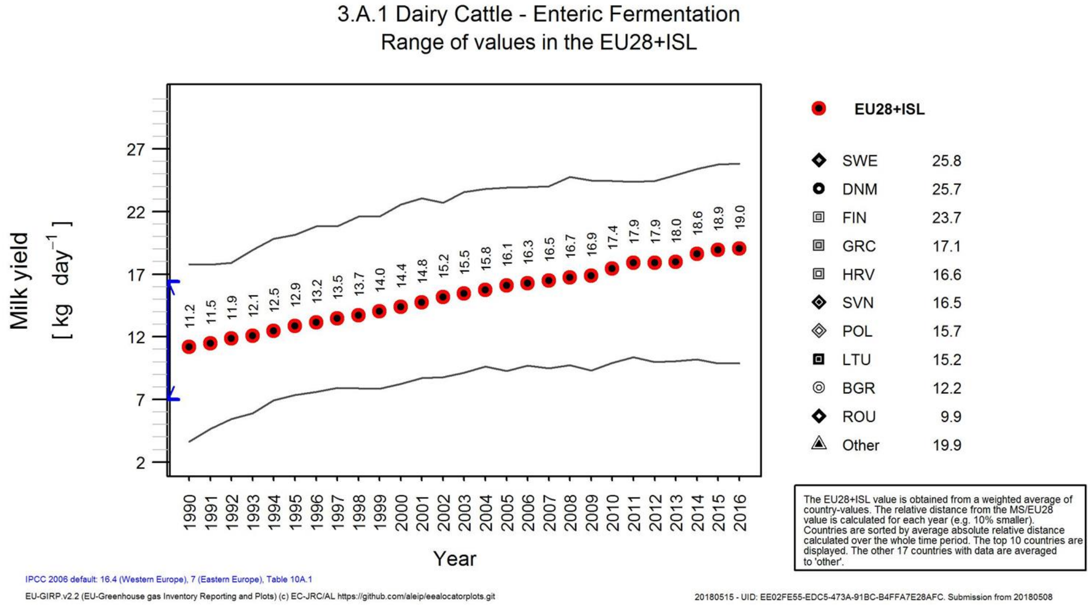


Table 5.10 3.A.1 - Dairy Cattle: Member States' and EU28+ISL milk yield (kg/head/day)

Member State	1990	2016	Member State	1990	2016
Austria	10.4	18.5	Ireland	11.5	14.6
Belgium	11.2	21.3	Iceland	11.3	16.8
Bulgaria	11.1	12.2	Italy	11.5	19.7
Cyprus	12.2	19.3	Lithuania	10.2	15.2
Czech Republic	10.7	22.0	Luxembourg		
Germany	12.9	21.2	Latvia	11.3	20.3
Denmark	16.5	25.7	Malta	14.2	14.2
Spain	9.9	23.5	Poland	8.9	15.7
Estonia	11.4	24.3	Portugal	12.2	22.0
Finland	15.7	23.7	Romania	3.6	9.9
France	13.1	19.0	Slovakia	7.0	19.4
United Kingdom	14.1	20.9	Slovenia	7.6	16.5
Greece	7.6	17.1	Sweden	17.8	25.8
Croatia	7.8	16.6	**EU28+ISL**	**11.2**	**19.0**
Hungary	13.8	21.3			

Note that the Netherlands does not report milk yield in their CRF, but such data are available in their NIR (see also Annex III).

3.A.1 - Non-Dairy Cattle - Implied emission factor

The implied emission factor for CH_4 emissions in source category *3.A.1 - Non-Dairy Cattle* increased in EU28+ISL slightly between 1990 and 2016 by 2.5% or 1.27 kg/head/year. Figure 5.16 shows the trend of the implied emission factor in EU28+ISL indicating also the range of values used by the countries. Table 5.11 shows the implied emission factor for CH_4 emissions in source category *3.A.1 - Non-Dairy Cattle* for the years 1990 and 2016 for all Member States and EU28+ISL. The implied emission factor decreased in seven countries and increased in twenty countries. The three countries with the largest decreases were the Netherlands, Ireland and Croatia with a mean absolute value of 3 kg/head/year. The three countries with the largest increases were Finland, Latvia and Czech Republic with a mean absolute value of 13 kg/head/year.

Figure 5.16: 3.A.1 - Non-Dairy Cattle: Trend in implied emission factor in the EU28+ISL and range of values reported by countries

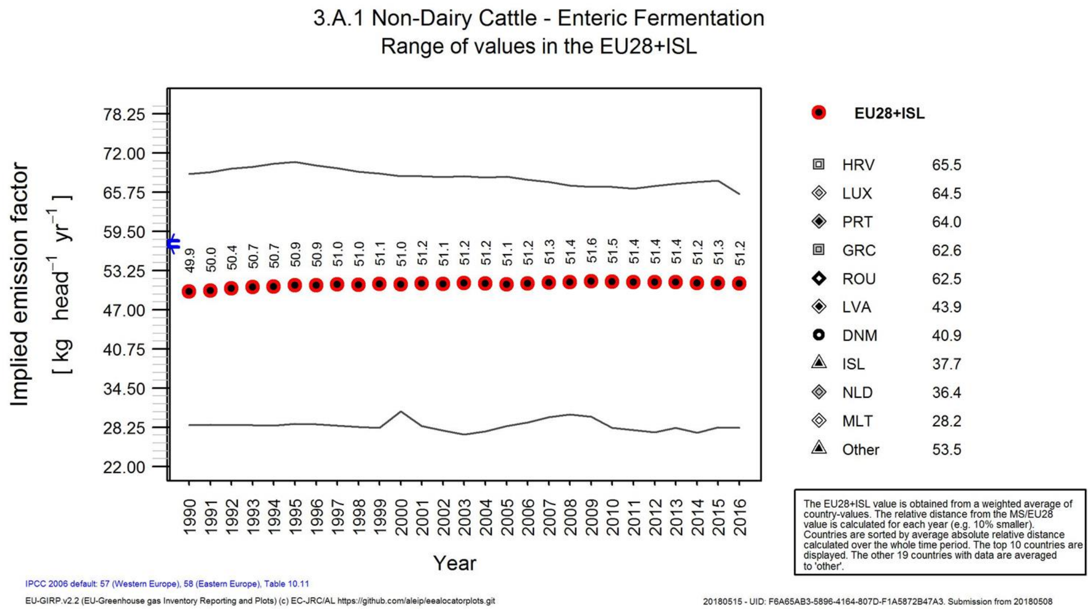


Table 5.11 3.A.1 - Non-Dairy Cattle: Member States' and EU28+ISL implied emission factor (kg/head/year)

Member State	1990	2016		Member State	1990	2016
Austria	52	59	|	Ireland	49	46
Belgium	46	50	|	Iceland		38
Bulgaria	55	61	|	Italy	46	47
Cyprus	57	57	|	Lithuania	53	56
Czech Republic	44	56	|	Luxembourg	63	64
Germany	43	43	|	Latvia	33	44
Denmark	34	41	|	Malta	29	28
Spain	53	51	|	Netherlands	40	36
Estonia	41	45	|	Poland	57	56
Finland	39	53	|	Portugal	62	64
France	52	53	|	Romania	65	63
United Kingdom	58	58	|	Slovakia	53	58
Greece	57	63	|	Slovenia		61
Croatia	69	65	|	Sweden	44	49
Hungary	53	55	|	**EU28+ISL**	**50**	**51**

3.A.1 - Non-Dairy Cattle - Average gross energy intake

The average gross energy intake, a parameter used for calculating CH_4 emissions in source category *3.A.1 - Non-Dairy Cattle*, increased in EU28+ISL slightly between 1990 and 2016 by 2% or 2.43 MJ/head/day. Figure 5.17 shows the trend of the average gross energy intake in EU28+ISL indicating also the range of values used by the countries. Table 5.12 shows the average gross energy intake in source category *3.A.1 - Non-Dairy Cattle* for the years 1990 and 2016 for all Member States and EU28+ISL. Average gross energy intake decreased in seven countries and increased in eighteen countries. It was in 2016 at the level of 1990 in one country. No data were available for Cyprus. The three countries with the largest decreases were the Netherlands, Ireland and Spain with a mean absolute value of 6 MJ/head/day. The three countries with the largest increases were Finland, Latvia and Czech Republic with a mean absolute value of 28 MJ/head/day.

Figure 5.17: 3.A.1 - Non-Dairy Cattle: Trend in average gross energy intake in the EU28+ISL and range of values reported by countries

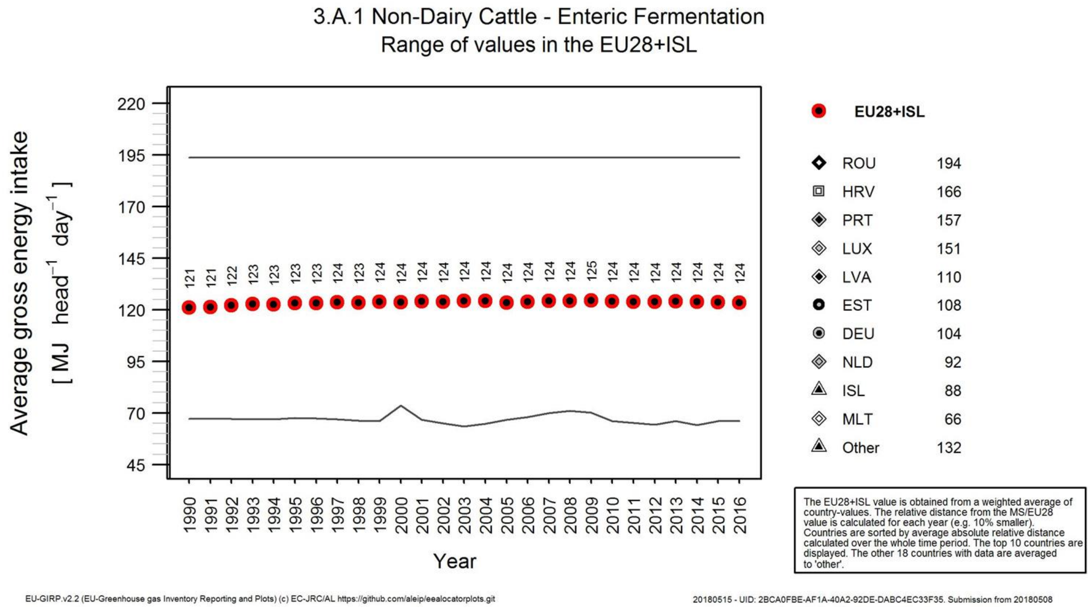


Table 5.12 3.A.1 - Non-Dairy Cattle: Member States' and EU28+ISL average gross energy intake (MJ/head/day)

Member State	1990	2016		Member State	1990	2016
Austria	123	139	|	Iceland		88
Belgium	119	131	|	Italy	141	141
Bulgaria	129	143	|	Lithuania	125	130
Czech Republic	104	132	|	Luxembourg	146	151
Germany	103	104	|	Latvia	86	110
Denmark	107	130	|	Malta	67	66
Spain	124	120	|	Netherlands	98	92
Estonia	99	108	|	Poland	133	131
Finland	92	125	|	Portugal	151	157
France	122	125	|	Romania	194	194
United Kingdom	113	113	|	Slovakia	125	139
Greece	135	147	|	Slovenia		135
Croatia	163	166	|	Sweden	129	138
Hungary	134	138	|	**EU28+ISL**	**121**	**124**
Ireland	132	125	|			

3.A.2 - Sheep - Implied emission factor

The implied emission factor for CH_4 emissions in source category *3.A.2 - Sheep* increased in EU28+ISL slightly between 1990 and 2016 by 3.3% or 0.254 kg/head/year. Figure 5.18 shows the trend of the implied emission factor in EU28+ISL indicating also the range of values used by the countries. Table 5.13 shows the implied emission factor for CH_4 emissions in source category *3.A.2 - Sheep* for the years 1990 and 2016 for all Member States and EU28+ISL. The implied emission factor decreased in seven countries and increased in fifteen countries. It was in 2016 at the level of 1990 in seven countries. The three countries with the largest decreases were Slovakia, Portugal and Ireland with a mean absolute value of 1 kg/head/year. The largest increase occurred in Croatia with an absolute value of 3 kg/head/year.

Figure 5.18: 3.A.2 - Sheep: Trend in implied emission factor in the EU28+ISL and range of values reported by countries

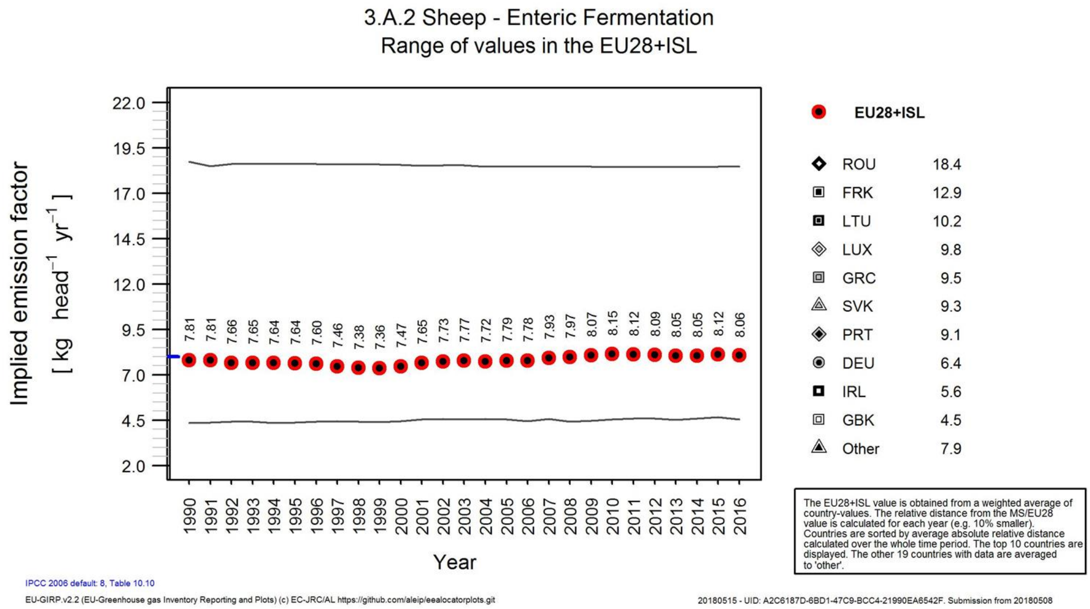


Table 5.13 3.A.2 - Sheep: Member States' and EU28+ISL implied emission factor (kg/head/year)

Member State	1990	2016		Member State	1990	2016
Austria	8.0	8.0	|	Ireland	5.9	5.6
Belgium	8.0	8.0	|	Iceland	8.1	8.1
Bulgaria	6.9	7.6	|	Italy	6.9	7.1
Cyprus	8.0	8.0	|	Lithuania	10.2	10.2
Czech Republic	8.0	8.0	|	Luxembourg	9.8	9.8
Germany	6.3	6.4	|	Latvia	8.0	8.0
Denmark	6.7	6.7	|	Malta	8.0	9.1
Spain	6.3	7.6	|	Netherlands	8.0	8.0
Estonia	8.0	8.0	|	Poland	8.0	8.0
Finland	6.8	8.4	|	Portugal	9.7	9.1
France	12.4	12.9	|	Romania	18.7	18.4
United Kingdom	4.4	4.5	|	Slovakia	10.3	9.3
Greece	9.5	9.5	|	Slovenia	8.0	8.0
Croatia	5.0	8.0	|	Sweden	8.0	8.0
Hungary	8.0	8.0	|	**EU28+ISL**	**7.8**	**8.1**

3.A.2 - Sheep - Average gross energy intake

The average gross energy intake, a parameter used for calculating CH_4 emissions in source category *3.A.2 - Sheep*, increased in EU28+ISL moderately between 1990 and 2016 by 6.8% or 1.56 MJ/head/day. Figure 5.19 shows the trend of the average gross energy intake in EU28+ISL indicating also the range of values used by the countries. Table 5.14 shows the average gross energy intake in source category *3.A.2 - Sheep* for the years 1990 and 2016 for all Member States and EU28+ISL. Average gross energy intake decreased in four countries and increased in six countries. It was in 2016 at the level of 1990 in five countries. No data were available for fourteen countries (Austria, Belgium, Cyprus, Czech Republic, Estonia, Finland, France, the United Kingdom, Croatia, Hungary, Latvia, the Netherlands, Poland and Slovenia). The three countries with the largest decreases were Slovakia, Portugal and Greece with a mean absolute value of 1 MJ/head/day. The three countries with the largest increases were Spain, Malta and Bulgaria with a mean absolute value of 2 MJ/head/day.

Figure 5.19: 3.A.2 - Sheep: Trend in average gross energy intake in the EU28+ISL and range of values reported by countries

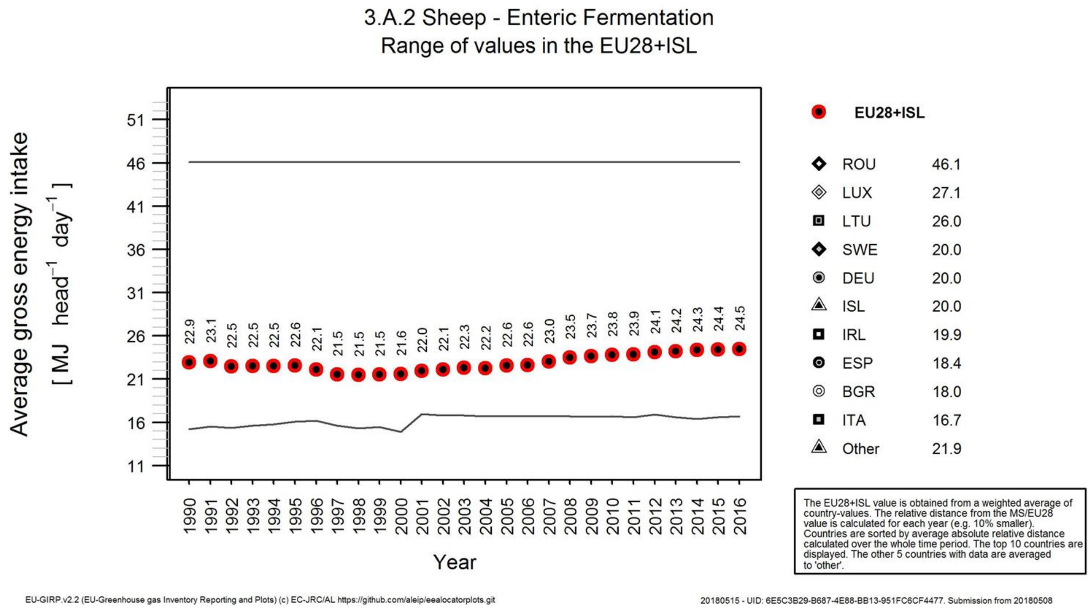


Table 5.14 3.A.2 - Sheep: Member States' and EU28+ISL average gross energy intake (MJ/head/day)

Member State	1990	2016		Member State	1990	2016
Bulgaria	17	18	|	Lithuania	26	26
Germany	20	20	|	Luxembourg	27	27
Denmark	20	20	|	Malta	20	22
Spain	15	18	|	Portugal	23	22
Greece	23	23	|	Romania	46	46
Ireland	20	20	|	Slovakia	25	22
Iceland	20	20	|	Sweden	20	20
Italy	16	17	|	**EU28+ISL**	**23**	**24**

5.3.2 Manure Management - CH_4 (CRF Source Category 3B1)

CH_4 emissions in source category *3.B.1 - Manure Management* are 0.87% of total EU28+ISL GHG emissions and 8.3% of total EU28+ISL CH_4 emissions. They make 9.6% of total agricultural emissions and 17% of total agricultural CH_4 emissions. The main sub-categories are 3.B.1.3 (Swine), 3.B.1.1.1 (Dairy Cattle) and 3.B.1.1.2 (Non-Dairy Cattle) as shown in Figure 5.20. Emissions are also reported for 3.B.1.4 (Other Livestock and 3.B.1.2 (Sheep). CH_4 emissions from Manure Management for 'Other Livestock' are reported for the categories Buffalo, Deer, Goats, Horses, Mules and Asses, Poultry, and Other Other Livestock. Regarding the origin of emissions in the different Member States, Figure 5.21 shows the distribution of CH_4 emissions from manure management by livestock category in all Member States and in the EU28+ISL. Each bar represents the total emissions of a country in the current emission category, where different shades of grey correspond to the emitting animal types.

Figure 5.20: Share of source category 3.B.1 on total EU28+ISL agricultural emissions (left panel) and decomposition into its sub-categories (right panel). The percentages refer to the emissions in the year 2016.

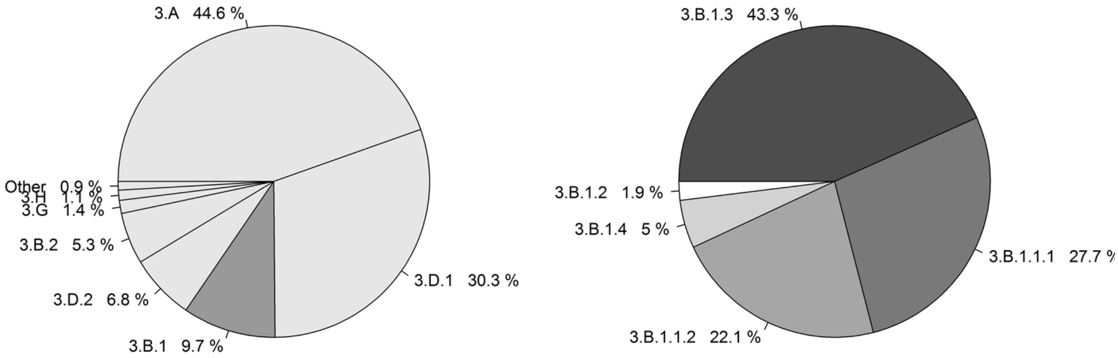
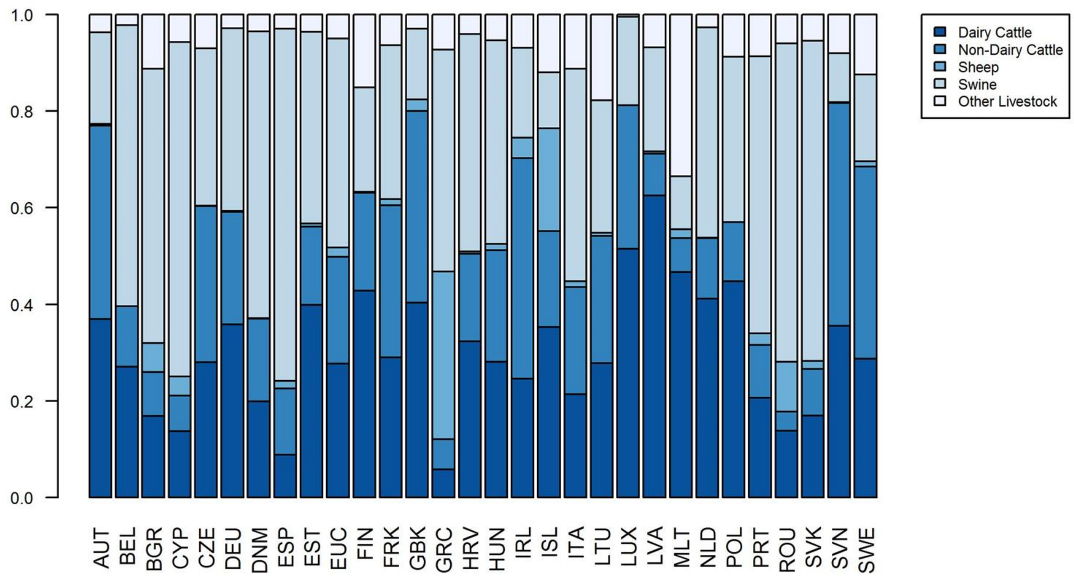


Figure 5.21: Decomposition of emissions in source category 3.B.1 - Manure Management into its sub-categories by Member State in the year 2016.



Total GHG and CH_4 emissions by Member State from 3.B.1 *Manure Management* are shown in Table 5.15 by Member State plus Iceland, and the total EU-28 and EU-28+ISL for the first and the last year of the inventory (1990 and 2016). Values are given in kt CO_2-eq. Between 1990 and 2016, CH_4 emission in this source category decreased by 21% or 11.4 Mt CO_2-eq. The decrease was largest in Bulgaria in relative terms (83%) and in Romania in absolute terms (3.2 Mt CO_2-eq). From 2015 to 2016 emissions in the current category decreased by 1%.

Table 5.15 3.B.1 - Manure Management: Member States' contributions to total EU-GHG and CH_4 emissions

Member States	GHG emissions in 1990 (kt CO_2 equivalents)	GHG emissions in 2016 (kt CO_2 equivalents)	CH_4 emissions in 1990 (kt CO_2 equivalents)	CH_4 emissions in 2016 (kt CO_2 equivalents)
Austria	587	437	587	437
Belgium	1,299	1,248	1,299	1,248
Bulgaria	715	120	715	120
Croatia	415	441	415	441
Cyprus	69	53	69	53
Czech Republic	1,695	741	1,695	741
Denmark	1,544	1,847	1,544	1,847
Estonia	147	73	147	73
Finland	370	461	370	461
France	3,623	4,075	3,623	4,075
Germany	8,073	6,143	8,073	6,143
Greece	774	647	774	647
Hungary	1,161	656	1,161	656
Ireland	1,406	1,402	1,406	1,402
Italy	3,934	3,106	3,934	3,106
Latvia	190	101	190	101
Lithuania	666	255	666	255

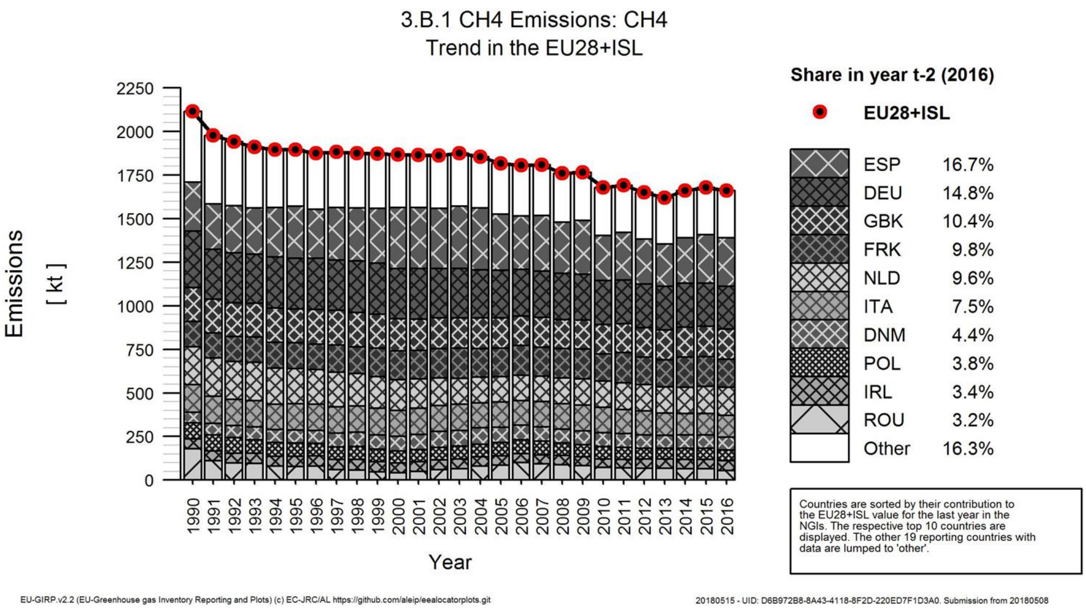
Member States	GHG emissions in 1990 (kt CO_2 equivalents)	GHG emissions in 2016 (kt CO_2 equivalents)	CH_4 emissions in 1990 (kt CO_2 equivalents)	CH_4 emissions in 2016 (kt CO_2 equivalents)
Luxembourg	52	66	52	66
Malta	5	4	5	4
Netherlands	5,443	3,994	5,443	3,994
Poland	2,274	1,578	2,274	1,578
Portugal	814	732	814	732
Romania	4,506	1,344	4,506	1,344
Slovakia	548	151	548	151
Slovenia	342	258	342	258
Spain	7,080	6,955	7,080	6,955
Sweden	245	262	245	262
United Kingdom	4,864	4,323	4,864	4,323
EU-28	**52,840**	**41,474**	**52,840**	**41,474**
Iceland	53	55	53	55
EU-28 + ISL	**52,893**	**41,529**	**52,893**	**41,529**

5.3.2.1 Trends in Emissions and Activity Data

3.B.1 - Manure Management - Emissions

Emissions in source category *3.B.1 - Manure Management* decreased considerably in EU28+ISL by 21% or 11.4 Mt CO_2-eq in the period 1990 to 2016. Figure 5.22 shows the trend of emissions indicating the countries contributing most to EU28+ISL total. The figure represents the trend in CH_4 emissions from manure management for the different Member States along the inventory period. The ten countries with the highest emissions accounted together for 83.7% of the total. Emissions decreased in 22 countries and increased in seven countries. The three countries with the largest decreases were Romania, Germany and the Netherlands with a total absolute decrease of 6.5 Mt CO_2-eq. The three countries with the largest increases were Finland, Denmark and France, with a total absolute increase of 846 kt CO_2-eq.

Figure 5.22: 3.B.1: Trend in emissions in the EU28+ISL and the countries contributing most to EU28+ISL values including their share to EU28+ISL emissions in 2016



3.B.1.1 - Cattle - Emissions

CH_4 emissions in source category *3.B.1.1 - Cattle* are 0.43% of total EU28+ISL GHG emissions and 4.1% of total EU28+ISL CH_4 emissions. They make 4.8% of total agricultural emissions and 8.7% of total agricultural CH_4 emissions.. Figure 5.23 and Figure 5.24 show the trend of emissions for Dairy and Non-Dairy Cattle indicating the countries contributing most to EU28+ISL.

Total GHG and CH_4 emissions by Member State from 3.B.1.1 *Manure Management* are shown in Table 5.16 by Member State plus Iceland, and the total EU-28 and EU-28+ISL for the first and the last year of the inventory (1990 and 2016). Values are given in kt CO_2-eq. Between 1990 and 2016, CH_4 emission in this source category decreased by 13% or 3 Mt CO_2-eq. The decrease was largest in Bulgaria in relative terms (64%) and in Germany in absolute terms (1.6 Mt CO_2-eq). From 2015 to 2016 emissions in the current category increased by 0.1%. The ten countries with the highest emissions accounted together for 85.5% of the total. Emissions decreased in sixteen countries and increased in thirteen countries. The three countries with the largest decreases were Germany, Italy and Czech Republic with a total absolute decrease of 2.6 Mt CO_2-eq. The largest increases occurred in France and the Netherlands, with a total absolute increase of 785 kt CO_2-eq.

Table 5.16 3.B.1.1 - Cattle: Member States' contributions to total EU-GHG and CH_4 emissions

Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016		Method	Emission factor Informa-tion
	1990	2015	2016		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	424	336	336	1.6%	-88	-21%	0	0%	T2	CS
Belgium	489	487	494	2.4%	5	1%	7	1%	T2	CS
Bulgaria	87	31	31	0.2%	-56	-64%	0	-1%	T2	CS
Croatia	209	224	223	1.1%	13	6%	-1	0%	T2	CS
Cyprus	10	10	11	0.1%	2	18%	1	9%	T2	D
Czech Republic	871	438	447	2.2%	-425	-49%	9	2%	T1,T2	CS
Denmark	579	658	684	3.3%	104	18%	25	4%	CS,T2	CS,D
Estonia	44	42	41	0.2%	-3	-7%	-1	-2%	T2	CS,D
Finland	234	289	290	1.4%	57	24%	1	0%	T2	CS
France	2 216	2 614	2 465	11.9%	250	11%	-148	-6%	T2	CS
Germany	5 250	3 669	3 630	17.6%	-1 619	-31%	-39	-1%	T2	CS
Greece	95	82	78	0.4%	-17	-18%	-4	-4%	T2	CS,D
Hungary	566	324	336	1.6%	-231	-41%	11	3%	T2	CS
Ireland	1 039	950	985	4.8%	-54	-5%	35	4%	T2	CS
Italy	1 947	1 329	1 352	6.5%	-595	-31%	24	2%	T2	CS
Latvia	111	71	72	0.3%	-39	-35%	1	1%	T2	CS
Lithuania	252	139	138	0.7%	-114	-45%	-1	-1%	T2	CS
Luxembourg	41	51	53	0.3%	12	30%	2	4%	T2	CS
Malta	2	2	2	0.0%	0	7%	0	1%	T2	CS
Netherlands	1 609	2 010	2 144	10.4%	535	33%	135	7%	T2	CS
Poland	1 149	914	899	4.3%	-251	-22%	-16	-2%	T2	CS
Portugal	199	228	231	1.1%	33	17%	3	1%	T2	CS
Romania	602	240	238	1.2%	-364	-60%	-2	-1%	T2	CS
Slovakia	99	41	40	0.2%	-59	-60%	-1	-1%	T2	CS
Slovenia	176	207	211	1.0%	35	20%	4	2%	T2	CS
Spain	1 691	1 593	1 570	7.6%	-121	-7%	-23	-1%	CS,T2	CS,D
Sweden	156	179	180	0.9%	24	15%	1	0%	T2	CS
United Kingdom	3 533	3 453	3 457	16.7%	-76	-2%	4	0%	T3	CS,D
EU-28	**23 679**	**20 611**	**20 639**	**100%**	**-3 040**	**-13%**	**28**	**0.1%**	**-**	**-**
Iceland	28	30	30	0.1%	2	7%	0	2%	-	-
United Kingdom (KP)	3 533	3 453	3 457	16.7%	-76	-2%	4	0%	T3	CS,D
EU-28 + ISL	**23 708**	**20 641**	**20 669**	**100%**	**-3 039**	**-13%**	**29**	**0.1%**	**-**	**-**

Figure 5.23: 3.B.1.1: Trend in emissions in the EU28+ISL and the countries contributing most to EU28+ISL values including their share to EU28+ISL emissions in 2016

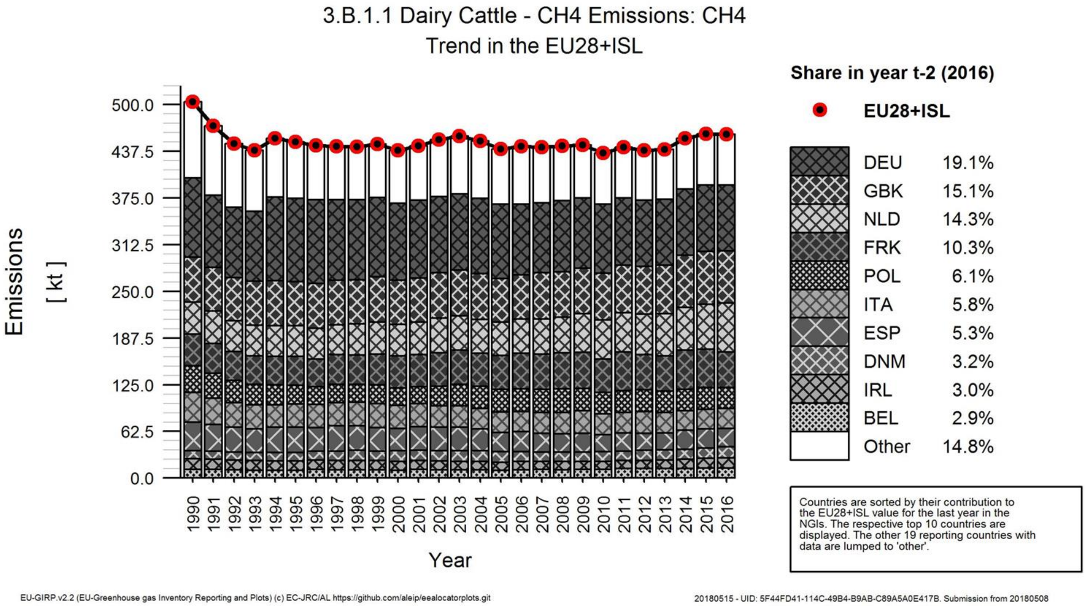
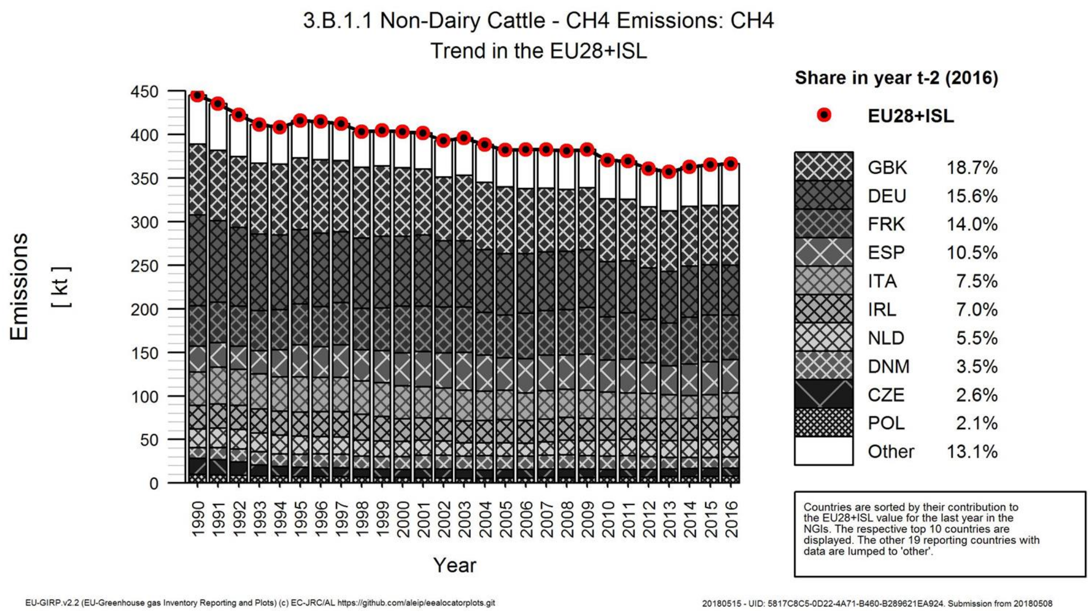


Figure 5.24: 3.B.1.1: Trend in emissions in the EU28+ISL and the countries contributing most to EU28+ISL values including their share to EU28+ISL emissions in 2016



3.B.1.1 - Cattle - Activity Data

The main activity data for CH_4 emissions from manure management - cattle are the animal numbers. Cattle numbers are already discussed under source category 3.A Enteric Fermentation and therefore not further discussed here.

Other relevant activity data are the allocation by climate region and the allocation by manure management system (MMS).

3.B.1.3 - Swine - Emissions

CH_4 emissions in source category *3.B.1.3 - Swine* are 0.38% of total EU28+ISL GHG emissions and 3.6% of total EU28+ISL CH_4 emissions. They make 4.2% of total agricultural emissions and 7.6% of total agricultural CH_4 emissions..

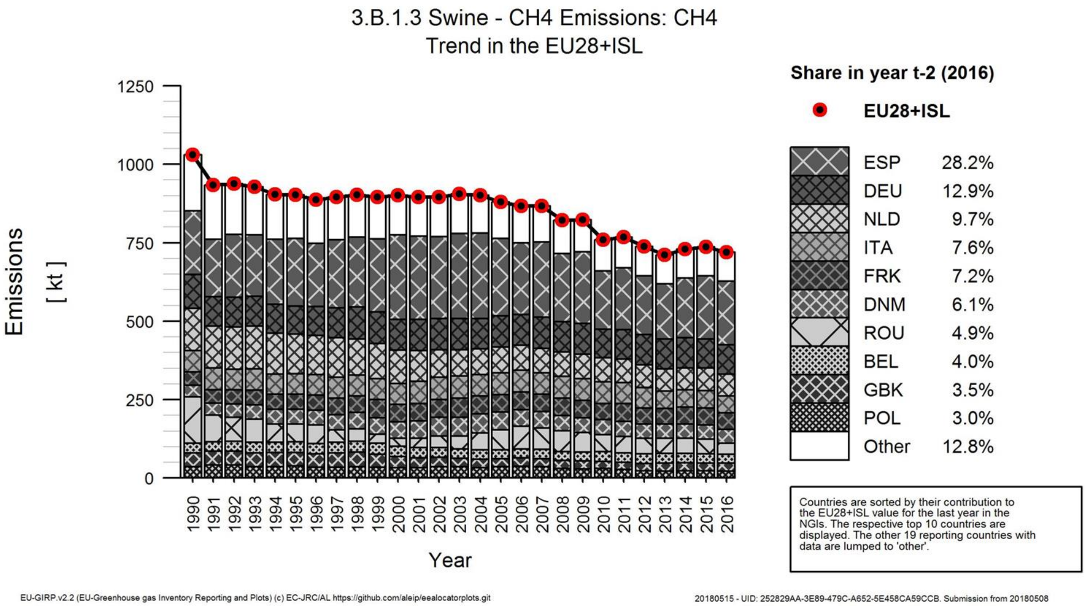
Total GHG and CH_4 emissions by Member State from 3.B.1.3 *Manure Management* are shown in Table 5.17 by Member State plus Iceland, and the total EU-28 and EU-28+ISL for the first and the last year of the inventory (1990 and 2016). Values are given in kt CO_2-eq. Between 1990 and 2016, CH_4 emission in this source category decreased by 30% or 7.8 Mt CO_2-eq. The decrease was largest in Bulgaria in relative terms (87%) and in Romania in absolute terms (2.8 Mt CO_2-eq). From 2015 to 2016 emissions in the current category decreased by 2.4%. Figure 5.25 shows the trend of emissions indicating the countries contributing most to EU28+ISL total. The figure represents the trend in CH_4 emissions for the different Member States along the inventory period. The ten countries with the highest emissions accounted together for 87.2% of the total. Emissions decreased in 22 countries and increased in seven countries. The largest decreases occurred in Romania and the Netherlands with a total absolute decrease of 4.4 Mt CO_2-eq. The three countries with the largest increases were Ireland, Denmark and France, with a total absolute increase of 462 kt CO_2-eq.

Table 5.17 3.B.1.3 - Swine: Member States' contributions to total EU-GHG and CH_4 emissions

Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016		Method	Emission factor Informa-tion
	1990	2015	2016		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	149	84	83	0.5%	-66	-44%	-2	-2%	T1	D
Belgium	793	747	726	4.0%	-67	-8%	-22	-3%	T2	CS
Bulgaria	543	64	68	0.4%	-476	-87%	4	7%	T2	CS
Croatia	170	200	199	1.1%	29	17%	-1	-1%	T2	CS
Cyprus	55	38	37	0.2%	-18	-32%	-1	-2%	T2	D
Czech Republic	718	234	241	1.3%	-477	-66%	8	3%	T1	D
Denmark	920	1 142	1 098	6.1%	178	19%	-45	-4%	CS,T2	CS,D
Estonia	94	32	29	0.2%	-65	-69%	-3	-10%	T2	CS,D
Finland	68	104	100	0.6%	32	48%	-4	-4%	T2	CS
France	1 070	1 356	1 300	7.2%	230	21%	-56	-4%	T2	CS
Germany	2 685	2 334	2 327	12.9%	-358	-13%	-7	0%	T2	CS
Greece	398	285	297	1.7%	-101	-25%	12	4%	T1	D
Hungary	500	289	276	1.5%	-223	-45%	-13	-4%	T2	CS
Ireland	206	251	260	1.4%	54	26%	10	4%	T2	CS,D
Italy	1 705	1 391	1 367	7.6%	-338	-20%	-24	-2%	T2	CS
Latvia	65	22	22	0.1%	-44	-67%	0	-1%	T2	CS
Lithuania	329	90	70	0.4%	-259	-79%	-20	-23%	T2	CS
Luxembourg	11	12	12	0.1%	1	11%	0	-3%	T2	CS
Malta	1	1	0	0.0%	-1	-60%	0	-7%	T2	CS,D
Netherlands	3 369	1 778	1 739	9.7%	-1 630	-48%	-39	-2%	T2	CS
Poland	913	579	539	3.0%	-373	-41%	-40	-7%	T1	CS
Portugal	506	412	420	2.3%	-86	-17%	8	2%	T2	CS
Romania	3 661	1 145	885	4.9%	-2 776	-76%	-259	-23%	T2	CS
Slovakia	432	106	100	0.6%	-332	-77%	-6	-6%	T1	D
Slovenia	132	27	26	0.1%	-106	-80%	-1	-3%	T1	D
Spain	5 094	5 034	5 069	28.2%	-25	0%	35	1%	CS,T2	CS,D
Sweden	59	42	47	0.3%	-12	-20%	5	11%	T2	CS
United Kingdom	1 090	617	632	3.5%	-458	-42%	15	2%	T2	D
EU-28	**25 736**	**18 417**	**17 971**	**100%**	**-7 765**	**-30%**	**-446**	**-2.4%**	**-**	**-**
Iceland	4	6	6	0.0%	2	43%	0	0%	-	-
United Kingdom (KP)	1 090	617	632	3.5%	-458	-42%	15	2%	T2	D
EU-28 + ISL	**25 740**	**18 423**	**17 977**	**100%**	**-7 763**	**-30%**	**-446**	**-2.4%**	**-**	**-**

Note that some member states are using Tier 1 and default emission factors for 3.B.1.3 category. Although this is a key category for the EU, is not a key category for all member states. For those countries using Tier 1, source category 3.B.1.3 is not a key category.

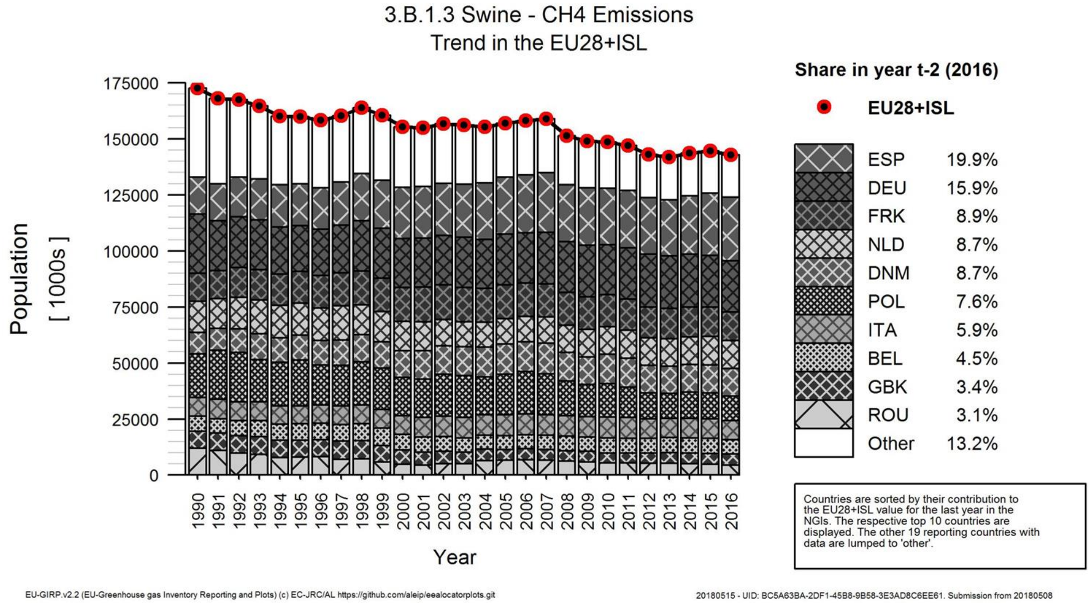
Figure 5.25: 3.B.1.3: Trend in swine emissions in the EU28+ISL and the countries contributing most to EU28+ISL values including their share to EU28+ISL emissions in 2016



3.B.1.3 - Swine - Population

The main activity data for CH_4 emissions from manure management - swine are the animal numbers. As swine are not a main animal type in the source category 3.A Enteric Fermentation its population data is discussed here. Swine population decreased considerably in EU28+ISL by 17% or 29.8 million heads in the period 1990 to 2016. Figure 5.26 shows the trend of swine population indicating the countries contributing most to EU28+ISL total. The figure represents the trend in CH_4 population for the different Member States along the inventory period. The ten countries with the highest population accounted together for 86.8% of the total. Population decreased in 21 countries and increased in eight countries. The three countries with the largest decreases were Poland, Romania and Hungary with a total absolute decrease of 21.8 million heads. The largest increases occurred in Denmark and Spain, with a total absolute increase of 14.9 million heads.

Figure 5.26: 3.B.1.3: Trend in swine population in the EU28+ISL and the countries contributing most to EU28+ISL values including their share to EU28+ISL emissions in 2016



5.3.2.2 Implied EFs and methodological issues

In this section, we discuss the implied emission factor for the category 3.B.1 for the main animal types. Furthermore, we present data on the typical animal mass as reported in CRF Tables 3B(a)s1 and average volatile solid (VS) daily excretion.

3.B.1.1 - Cattle - Implied emission factor

The implied emission factor for CH_4 emissions in source category *3.B.1.1 - Cattle* increased in EU28+ISL considerably between 1990 and 2016 by 16.9% or 1.32 kg/head/year. Table 5.18 shows the implied emission factor for CH_4 emissions in source category *3.B.1.1 - Cattle* for the years 1990 and 2016 for all Member States and EU28+ISL. The implied emission factor decreased in three countries and increased in 24 countries. The largest decrease occurred in Spain with an absolute value of 3 kg/head/year. The four countries with the largest increases were Estonia, Latvia, Croatia and Finland with a mean absolute value of 6 kg/head/year.

Table 5.18 3.B.1.1 - Cattle: Member States' and EU28+ISL implied emission factor (kg/head/year)

Member State	1990	2016		Member State	1990	2016
Austria	6.6	6.9	|	Ireland	6.1	5.5
Belgium	6.0	7.7	|	Iceland		15.2
Bulgaria	2.2	2.2	|	Italy	10.0	9.1
Cyprus	7.0	7.0	|	Lithuania	4.2	7.6
Czech Republic	9.9	12.6	|	Luxembourg	7.4	10.6
Germany	10.8	11.6	|	Latvia	3.1	7.0
Denmark	10.4	17.4	|	Malta	4.1	6.5
Spain	13.3	9.8	|	Netherlands	13.1	20.2
Estonia	2.3	6.6	|	Poland	4.6	6.1
Finland	6.9	12.8	|	Portugal	5.8	5.8
France	4.1	5.1	|	Romania	4.5	4.6
United Kingdom	11.7	14.0	|	Slovakia	2.5	3.6
Greece	5.5	5.6	|	Slovenia		17.3
Croatia	9.8	18.4	|	Sweden	3.6	4.8
Hungary	14.0	16.0	|	**EU28+ISL**	**7.8**	**9.1**

3.B.1.1 - Dairy Cattle - Implied emission factor

The implied emission factor for CH_4 emissions in source category *3.B.1.1 - Dairy Cattle* increased in EU28+ISL very strongly between 1990 and 2016 by 53% or 6.78 kg/head/year. Figure 5.27 shows the trend of the implied emission factor in EU28+ISL indicating also the range of values used by the countries. Table 5.19 shows the implied emission factor for CH_4 emissions in source category *3.B.1.1 - Dairy Cattle* for the years 1990 and 2016 for all Member States and EU28+ISL. The implied emission factor decreased in four countries and increased in 25 countries. The three countries with the largest decreases were Bulgaria, Ireland and Italy with a mean absolute value of 0.3 kg/head/year. The four countries with the largest increases were Estonia, Croatia, Latvia and Finland with a mean absolute value of 14 kg/head/year.

Figure 5.27: 3.B.1.1 - Dairy Cattle: Trend in implied emission factor in the EU28+ISL and range of values reported by countries

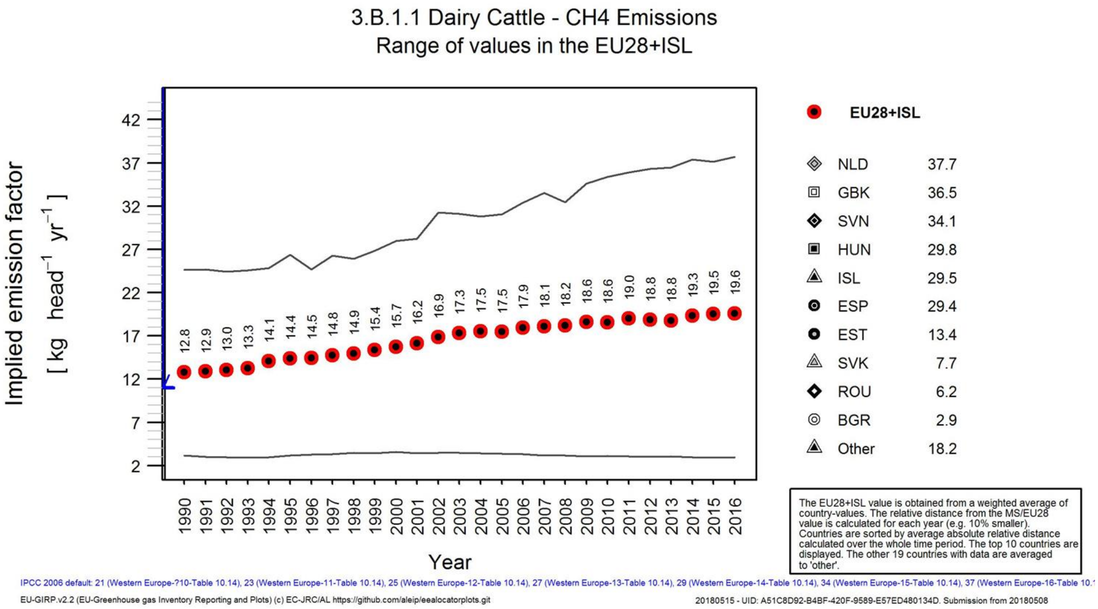


Table 5.19 3.B.1.1 - Dairy Cattle: Member States' and EU28+ISL implied emission factor (kg/head/year)

Member State	1990	2016		Member State	1990	2016
Austria	11.1	12.0	|	Ireland	10.6	10.2
Belgium	14.1	29.4	|	Iceland	24.6	29.5
Bulgaria	3.2	2.9	|	Italy	15.0	14.6
Cyprus	10.6	10.3	|	Lithuania	6.0	9.7
Czech Republic	13.9	22.3	|	Luxembourg	14.5	26.6
Germany	16.7	20.9	|	Latvia	6.4	16.4
Denmark	14.0	25.6	|	Malta	7.5	12.5
Spain	23.7	29.4	|	Netherlands	23.1	37.7
Estonia	4.0	13.4	|	Poland	7.3	12.1
Finland	12.5	27.9	|	Portugal	14.6	25.3
France	7.9	13.0	|	Romania	5.8	6.2
United Kingdom	21.0	36.5	|	Slovakia	4.8	7.7
Greece	10.4	14.1	|	Slovenia	21.0	34.1
Croatia	12.2	34.1	|	Sweden	6.6	9.1
Hungary	24.6	29.8	|	**EU28+ISL**	**12.8**	**19.6**

3.B.1.1 - Dairy Cattle - Typical animal mass

The typical animal mass, a parameter used for calculating CH_4 emissions in source category *3.B.1.1 - Dairy Cattle*, increased in EU28+ISL slightly between 1990 and 2016 by 4.3% or 25 kg. Figure 5.28 shows the trend of the typical animal mass in EU28+ISL indicating also the range of values used by the countries. Table 5.20 shows the typical animal mass in source category *3.B.1.1 - Dairy Cattle* for the years 1990 and 2016 for all Member States and EU28+ISL. Typical animal mass decreased in two countries and increased in eleven countries. It was in 2016 at the level of 1990 in fifteen countries. No data were available for the Netherlands. Decreases occurred in France and Slovakia with a mean absolute value of 4 kg. The largest increase occurred in Finland with an absolute value of 131 kg.

Figure 5.28: 3.B.1.1 - Dairy Cattle: Trend in typical animal mass in the EU28+ISL and range of values reported by countries

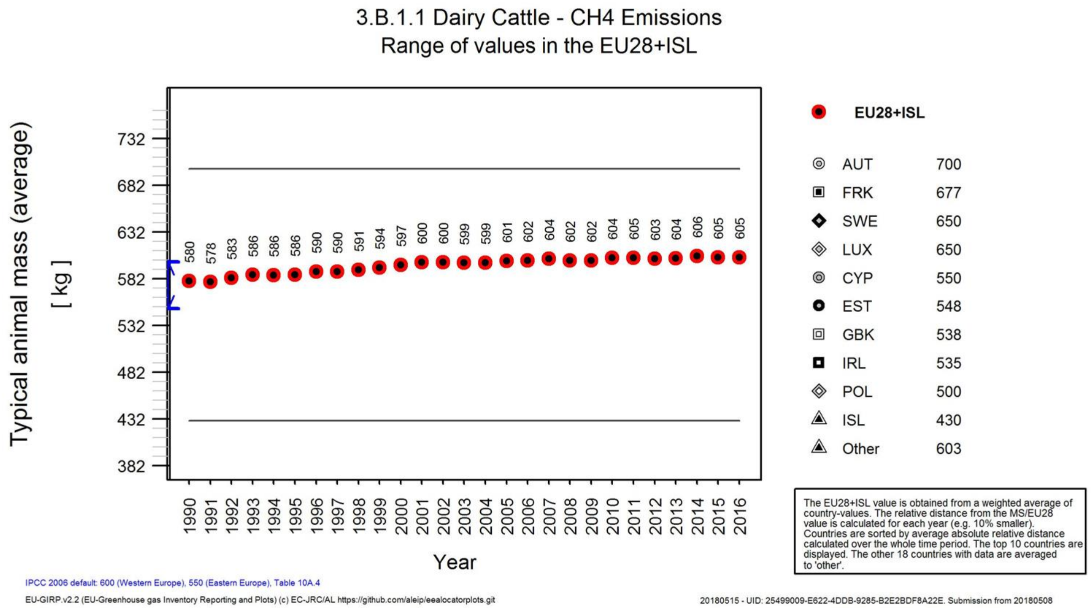


Table 5.20 3.B.1.1 - Dairy Cattle: Member States' and EU28+ISL typical animal mass (kg)

Member State	1990	2016		Member State	1990	2016
Austria	700	700	|	Ireland	535	535
Belgium	600	600	|	Iceland	430	430
Bulgaria	588	588	|	Italy	603	603
Cyprus	550	550	|	Lithuania	575	625
Czech Republic	520	620	|	Luxembourg	650	650
Germany	608	648	|	Latvia	550	565
Denmark	550	580	|	Malta	550	550
Spain	598	647	|	Poland	500	500
Estonia	545	548	|	Portugal	600	600
Finland	520	651	|	Romania	550	550
France	685	677	|	Slovakia	598	598
United Kingdom	466	538	|	Slovenia	510	619
Greece	600	600	|	Sweden	650	650
Croatia	563	563	|	**EU28+ISL**	**580**	**605**
Hungary	633	643	|			

3.B.1.1 - Dairy Cattle - VS daily excretion

The VS daily excretion, a parameter used for calculating CH_4 emissions in source category *3.B.1.1 - Dairy Cattle*, increased in EU28+ISL considerably between 1990 and 2016 by 15.2% or 0.655 kg DM/head/day. Figure 5.29 shows the trend of the VS daily excretion in EU28+ISL indicating also the range of values used by the countries. Table 5.21 shows the VS daily excretion in source category

3.B.1.1 - Dairy Cattle for the years 1990 and 2016 for all Member States and EU28+ISL. The reported vs daily excretion in 2016 was at the level of 1990 in two countries and increased in all reporting other 27 countries. The four countries with the largest increases were Malta, Slovakia, Czech Republic and Estonia with a mean absolute value of 2 kg DM/head/day.

Figure 5.29: 3.B.1.1 - Dairy Cattle: Trend in VS daily excretion in the EU28+ISL and range of values reported by countries

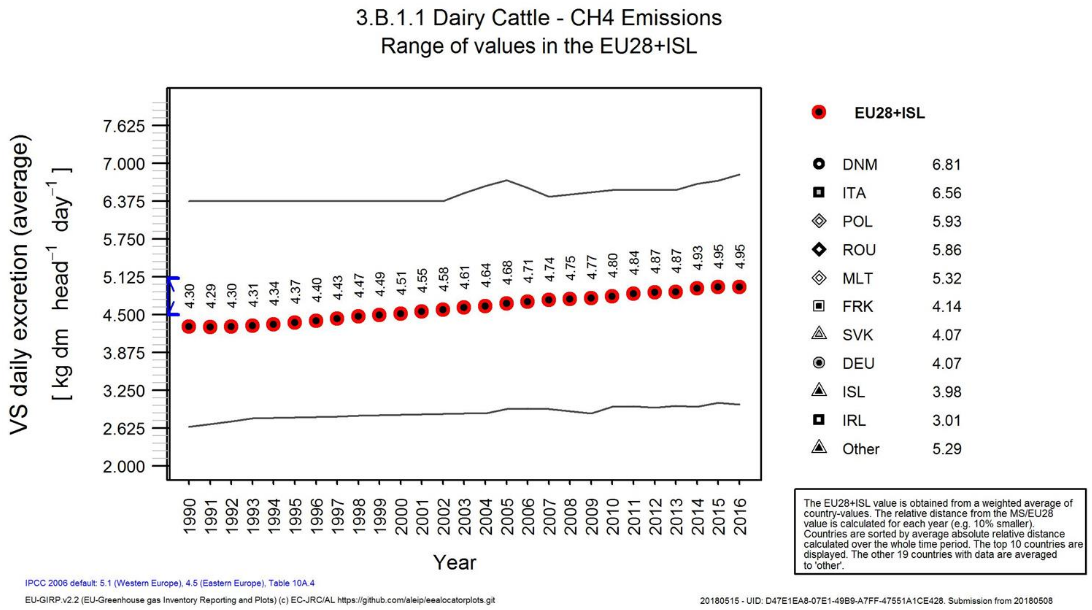


Table 5.21 3.B.1.1 - Dairy Cattle: Member States' and EU28+ISL VS daily excretion (kg DM/head/day)

Member State	1990	2016		Member State	1990	2016
Austria	4.5	5.0	|	Ireland	2.8	3.0
Belgium	4.0	5.1	|	Iceland	3.2	4.0
Bulgaria	4.0	4.2	|	Italy	6.4	6.6
Cyprus	4.5	4.5	|	Lithuania	4.5	5.6
Czech Republic	4.2	6.3	|	Luxembourg	4.8	5.8
Germany	3.5	4.1	|	Latvia	4.7	5.9
Denmark	5.7	6.8	|	Malta	3.2	5.3
Spain	3.9	5.4	|	Netherlands	3.8	4.7
Estonia	4.4	6.5	|	Poland	5.7	5.9
Finland	4.5	6.0	|	Portugal	3.5	4.7
France	3.5	4.1	|	Romania	4.6	5.9
United Kingdom	4.0	5.4	|	Slovakia	2.6	4.1
Greece	3.7	5.0	|	Slovenia	4.5	5.3
Croatia	4.5	4.5	|	Sweden	5.1	5.4
Hungary	4.4	5.3	|	**EU28+ISL**	**4.3**	**5.0**

3.B.1.1 - Non-Dairy Cattle - Implied emission factor

The implied emission factor for CH_4 emissions in source category *3.B.1.1 - Non-Dairy Cattle* increased in EU28+ISL barely between 1990 and 2016 by 0.45% or 0.0244 kg/head/year. Figure 5.30 shows the trend of the implied emission factor in EU28+ISL indicating also the range of values used by the countries. Table 5.22 shows the implied emission factor for CH_4 emissions in source category *3.B.1.1 - Non-Dairy Cattle* for the years 1990 and 2016 for all Member States and EU28+ISL. The implied emission factor decreased in nine countries and increased in eighteen countries. The three countries with the largest decreases were Spain, Romania and Germany with a mean absolute value of 1 kg/head/year. The four countries with the largest increases were Estonia, Lithuania, Sweden and Finland with a mean absolute value of 2 kg/head/year.

Figure 5.30: 3.B.1.1 - Non-Dairy Cattle: Trend in implied emission factor in the EU28+ISL and range of values reported by countries

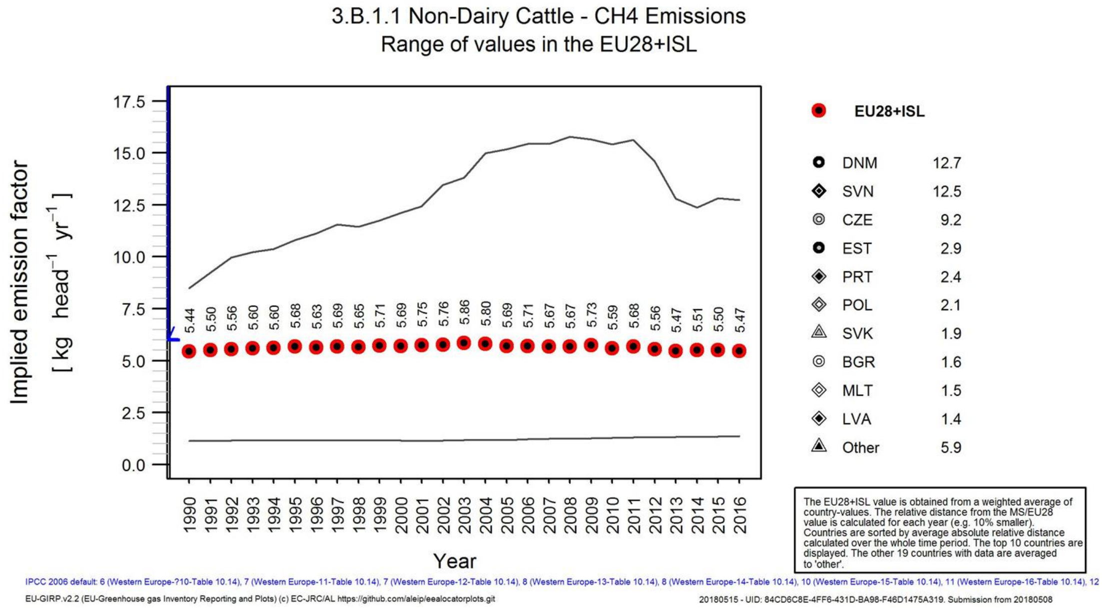


Table 5.22 3.B.1.1 - Non-Dairy Cattle: Member States' and EU28+ISL implied emission factor (kg/head/year)

Member State	1990	2016		Member State	1990	2016
Austria	4.1	4.9	|	Ireland	5.0	4.4
Belgium	3.2	3.0	|	Iceland		8.2
Bulgaria	1.6	1.6	|	Italy	7.5	6.7
Cyprus	4.5	4.4	|	Lithuania	3.3	6.2
Czech Republic	7.9	9.2	|	Luxembourg	4.9	5.2
Germany	7.9	6.9	|	Latvia	1.1	1.4
Denmark	8.5	12.7	|	Malta	1.5	1.5
Spain	8.5	6.9	|	Netherlands	6.9	8.0
Estonia	1.3	2.9	|	Poland	2.0	2.1
Finland	3.7	5.9	|	Portugal	2.2	2.4
France	2.9	3.3	|	Romania	2.9	2.4
United Kingdom	8.8	8.6	|	Slovakia	1.8	1.9
Greece	3.3	3.6	|	Slovenia		12.5
Croatia	6.7	10.1	|	Sweden	2.1	3.6
Hungary	8.3	10.2	|	**EU28+ISL**	**5.4**	**5.5**

3.B.1.1 - Non-Dairy Cattle - Typical animal mass

The typical animal mass, a parameter used for calculating CH_4 emissions in source category *3.B.1.1 - Non-Dairy Cattle*, increased in EU28+ISL moderately between 1990 and 2016 by 6.3% or 23.7 kg. Figure 5.31 shows the trend of the typical animal mass in EU28+ISL indicating also the range of values used by the countries. Table 5.23 shows the typical animal mass in source category *3.B.1.1 - Non-Dairy Cattle* for the years 1990 and 2016 for all Member States and EU28+ISL. Typical animal mass decreased in two countries and increased in 21 countries. It was in 2016 at the level of 1990 in two countries. No data were available for the Netherlands and Sweden. Decreases occurred in Malta and Ireland with a mean absolute value of 15 kg. The three countries with the largest increases were Finland, Bulgaria and Estonia with a mean absolute value of 90 kg.

Figure 5.31: 3.B.1.1 - Non-Dairy Cattle: Trend in typical animal mass in the EU28+ISL and range of values reported by countries

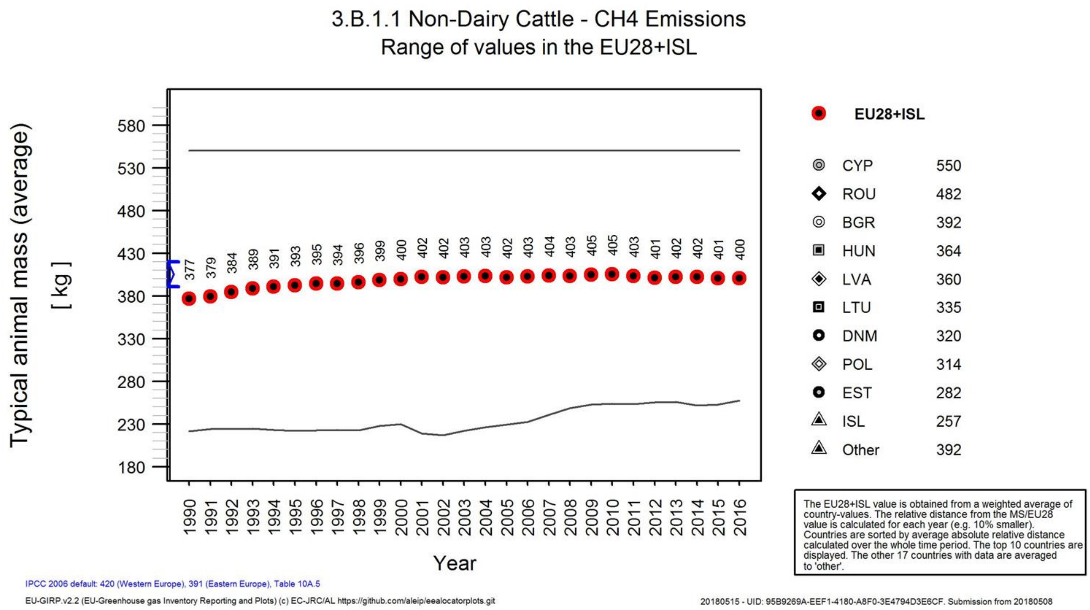


Table 5.23 3.B.1.1 - Non-Dairy Cattle: Member States' and EU28+ISL typical animal mass (kg)

Member State	1990	2016		Member State	1990	2016
Austria	364	415	|	Hungary	327	364
Belgium	381	405	|	Ireland	362	350
Bulgaria	298	392	|	Iceland		257
Cyprus	550	550	|	Italy	376	382
Czech Republic	326	402	|	Lithuania	327	335
Germany	339	371	|	Luxembourg	405	412
Denmark	290	320	|	Latvia	298	360
Spain	395	427	|	Malta	344	327
Estonia	222	282	|	Poland	311	314
Finland	278	393	|	Portugal	399	416
France	431	439	|	Romania	482	482
United Kingdom	426	429	|	Slovakia	331	368
Greece	375	428	|	Slovenia		351
Croatia	331	354	|	**EU28+ISL**	**377**	**400**

3.B.1.1 - Non-Dairy Cattle - VS daily excretion

The VS daily excretion, a parameter used for calculating CH_4 emissions in source category *3.B.1.1 - Non-Dairy Cattle*, decreased in EU28+ISL barely between 1990 and 2016 by 0.76% or 0.0151 kg DM/head/day. Figure 5.32 shows the trend of the VS daily excretion in EU28+ISL indicating also the range of values used by the countries. Table 5.24 shows the VS daily excretion in source category *3.B.1.1 - Non-Dairy Cattle* for the years 1990 and 2016 for all Member States and EU28+ISL. VS daily excretion decreased in six countries and increased in nineteen countries. It was in 2016 at the level of 1990 in three countries. The three countries with the largest decreases were Spain, Ireland and the Netherlands with a mean absolute value of 0.2 kg DM/head/day. The four countries with the largest increases were Finland, Denmark, Latvia and Czech Republic with a mean absolute value of 1 kg DM/head/day.

Figure 5.32: 3.B.1.1 - Non-Dairy Cattle: Trend in VS daily excretion in the EU28+ISL and range of values reported by countries

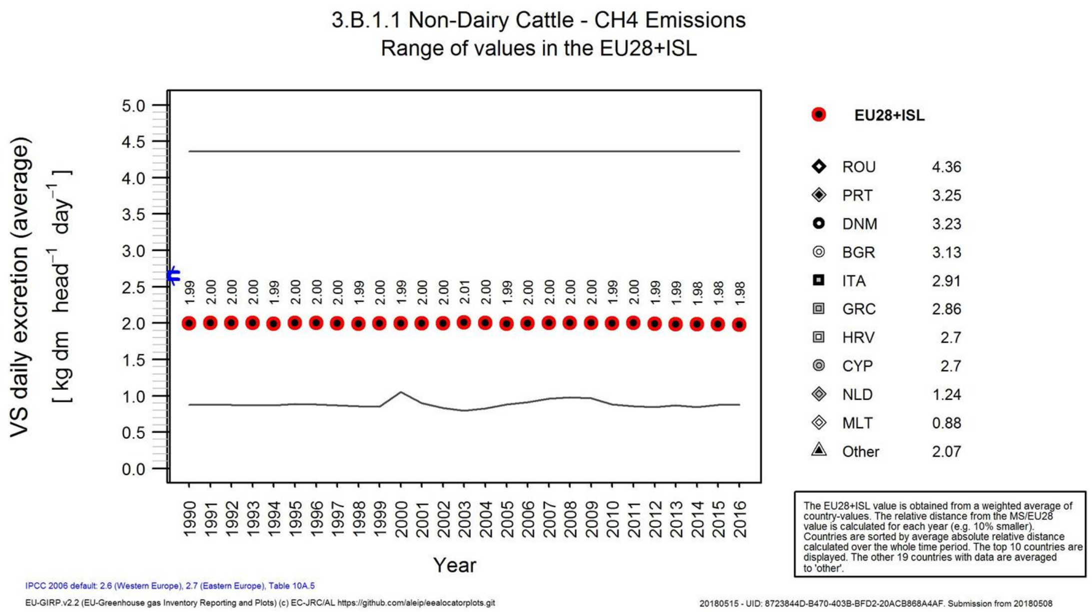


Table 5.24 3.B.1.1 - Non-Dairy Cattle: Member States' and EU28+ISL VS daily excretion (kg DM/head/day)

Member State	1990	2016		Member State	1990	2016
Austria	1.78	2.15	|	Ireland	1.43	1.29
Belgium	1.51	1.61	|	Iceland	1.29	1.35
Bulgaria	2.82	3.13	|	Italy	2.80	2.91
Cyprus	2.70	2.70	|	Lithuania	2.44	2.52
Czech Republic	2.26	2.87	|	Luxembourg	2.48	2.56
Germany	1.37	1.37	|	Latvia	1.68	2.14
Denmark	2.37	3.23	|	Malta	0.87	0.88
Spain	2.35	2.03	|	Netherlands	1.37	1.24
Estonia	2.04	2.24	|	Poland	2.04	1.88
Finland	1.55	2.18	|	Portugal	3.15	3.25
France	1.88	1.90	|	Romania	4.36	4.36
United Kingdom	2.17	2.15	|	Slovakia	1.86	2.14
Greece	2.62	2.86	|	Slovenia		2.57

Croatia	2.70	2.70	|	Sweden	1.60	1.73
Hungary	2.54	2.64	|	**EU28+ISL**	**1.99**	**1.98**

3.B.1.3 - Swine - Implied emission factor

The implied emission factor for CH_4 emissions in source category *3.B.1.3 - Swine* decreased in EU28+ISL considerably between 1990 and 2016 by 15.6% or 0.93 kg/head/year. Figure 5.33 shows the trend of the implied emission factor in EU28+ISL indicating also the range of values used by the countries. Table 5.25 shows the implied emission factor for CH_4 emissions in source category *3.B.1.3 - Swine* for the years 1990 and 2016 for all Member States and EU28+ISL. The implied emission factor decreased in nineteen countries and increased in eight countries. It was in 2016 at the level of 1990 in two countries. The four countries with the largest decreases were Finland, Hungary and Croatia with a mean absolute value of 2 kg/head/year. The four countries with the largest increases were Finland, Hungary, Croatia and Latvia with a mean absolute value of 1 kg/head/year.

Figure 5.33: 3.B.1.3 - Swine: Trend in implied emission factor in the EU28+ISL and range of values reported by countries

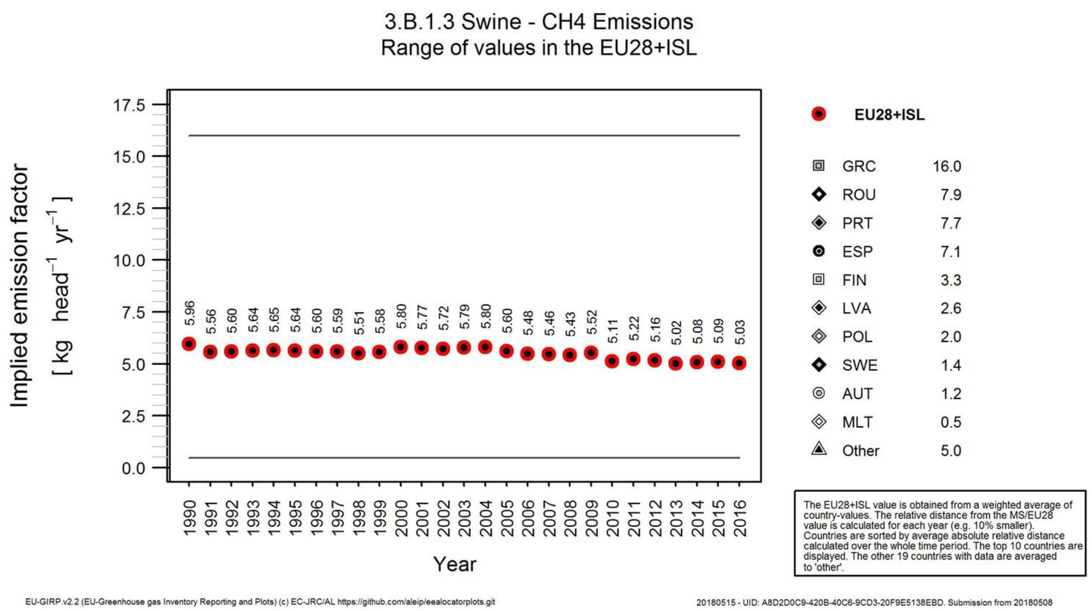


Table 5.25 3.B.1.3 - Swine: Member States' and EU28+ISL implied emission factor (kg/head/year)

Member State	1990	2016		Member State	1990	2016
Austria	1.62	1.19	|	Ireland	6.76	6.67
Belgium	4.73	4.47	|	Iceland	6.00	6.00
Bulgaria	5.15	4.47	|	Italy	8.11	6.45
Cyprus	7.85	4.21	|	Lithuania	5.11	4.14
Czech Republic	6.00	6.00	|	Luxembourg	5.76	5.21
Germany	4.05	4.09	|	Latvia	1.87	2.58
Denmark	3.87	3.55	|	Malta	0.47	0.47
Spain	12.43	7.14	|	Netherlands	9.68	5.57
Estonia	4.37	4.33	|	Poland	1.88	1.99
Finland	2.02	3.34	|	Portugal	7.98	7.73

Member State	1990	2016		Member State	1990	2016
France	3.44	4.08	|	Romania	12.20	7.89
United Kingdom	5.78	5.20	|	Slovakia	6.86	6.85
Greece	16.00	16.00	|	Slovenia	9.00	3.93
Croatia	4.32	6.66	|	Sweden	1.05	1.39
Hungary	2.29	3.66	|	**EU28+ISL**	**5.96**	**5.03**

3.B.1.3 - Swine - Typical animal mass

The typical animal mass, a parameter used for calculating CH_4 emissions in source category *3.B.1.3 - Swine*, decreased in EU28+ISL slightly between 1990 and 2016 by 3.7% or 2.79 kg. Figure 5.34 shows the trend of the typical animal mass in EU28+ISL indicating also the range of values used by the countries. Table 5.26 shows the typical animal mass in source category *3.B.1.3 - Swine* for the years 1990 and 2016 for all Member States and EU28+ISL. Typical animal mass decreased in twelve countries and increased in six countries. It was in 2016 at the level of 1990 in two countries. No data were available for nine countries (Austria, Cyprus, Finland, the United Kingdom, the Netherlands, Poland, Slovakia, Slovenia and Sweden). The three countries with the largest decreases were Latvia, Ireland and Luxembourg with a mean absolute value of 8 kg. The three countries with the largest increases were Denmark, Estonia and Hungary with a mean absolute value of 6 kg.

Figure 5.34: 3.B.1.3 - Swine: Trend in typical animal mass in the EU28+ISL and range of values reported by countries

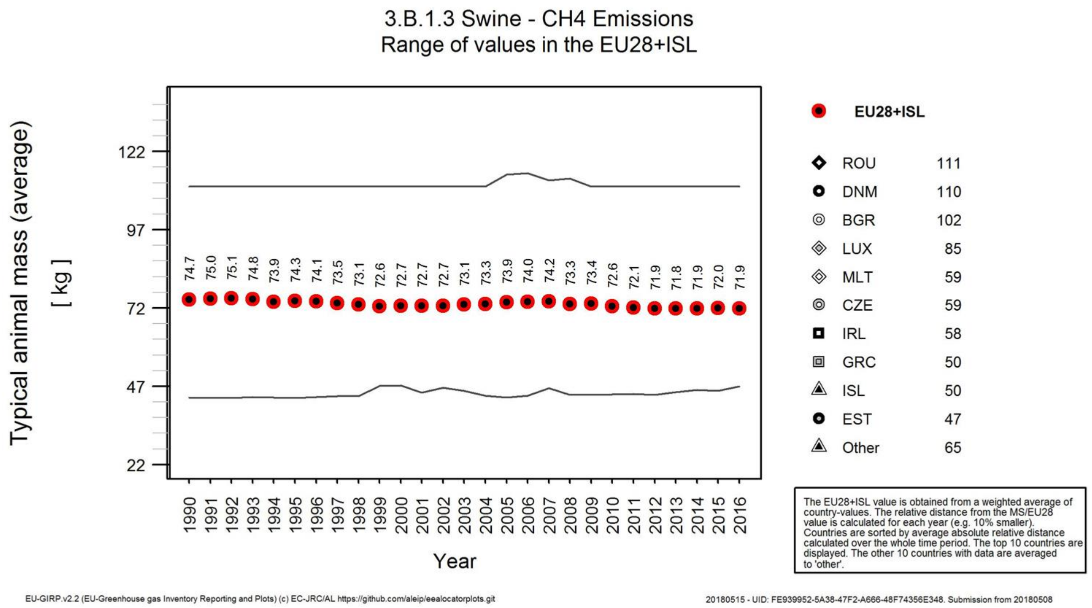


Table 5.26 3.B.1.3 - Swine: Member States' and EU28+ISL typical animal mass (kg)

Member State	1990	2016		Member State	1990	2016
Belgium	69	64	|	Ireland	63	58
Bulgaria	109	102	|	Iceland	52	50
Czech Republic	62	59	|	Italy	79	82
Germany	67	63	|	Lithuania	65	61
Denmark	98	110	|	Luxembourg	92	85

Member State	1990	2016		Member State	1990	2016
Spain	64	62	|	Latvia	75	64
Estonia	43	47	|	Malta	59	59
France	64	65	|	Portugal	62	57
Greece	50	50	|	Romania	111	111
Croatia	69	67	|	**EU28+ISL**	**75**	**72**
Hungary	63	66	|			

3.B.1.3 - Swine - VS daily excretion

The VS daily excretion, a parameter used for calculating CH_4 emissions in source category *3.B.1.3 - Swine*, decreased in EU28+ISL moderately between 1990 and 2016 by 7.1% or 0.0228 kg DM/head/day. Figure 5.35 shows the trend of the VS daily excretion in EU28+ISL indicating also the range of values used by the countries. Table 5.27 shows the VS daily excretion in source category *3.B.1.3 - Swine* for the years 1990 and 2016 for all Member States and EU28+ISL. VS daily excretion decreased in sixteen countries and increased in four countries. It was in 2016 at the level of 1990 in four countries. No data were available for five countries (Czech Republic, the United Kingdom, Greece, Iceland and Slovakia). The largest decreases occurred in the Netherlands and Denmark with a mean absolute value of 0.1 kg DM/head/day. The three countries with the largest increases were Germany, France and Sweden with a mean absolute value of 0.028 kg DM/head/day.

Figure 5.35: 3.B.1.3 - Swine: Trend in VS daily excretion in the EU28+ISL and range of values reported by countries

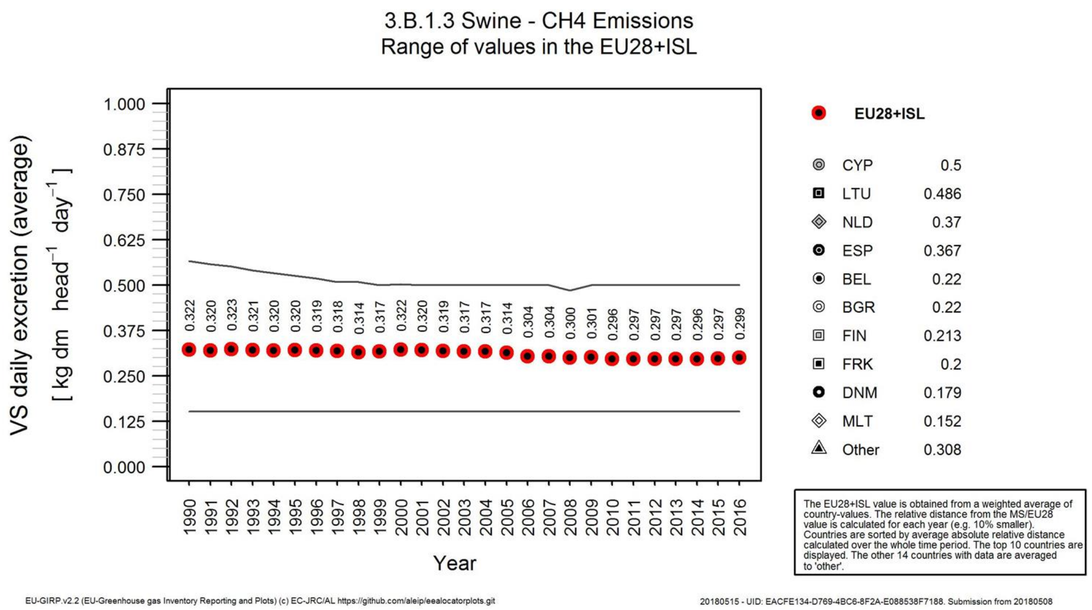


Table 5.27 3.B.1.3 - Swine: Member States' and EU28+ISL VS daily excretion (kg DM/head/day)

Member State	1990	2016		Member State	1990	2016
Austria	0.27	0.27	|	Italy	0.37	0.34
Belgium	0.23	0.22	|	Lithuania	0.50	0.49
Bulgaria	0.25	0.22	|	Luxembourg	0.32	0.31
Cyprus	0.50	0.50	|	Latvia	0.40	0.34

Germany	0.26	0.30	|	Malta	0.15	0.15
Denmark	0.24	0.18	|	Netherlands	0.57	0.37
Spain	0.44	0.37	|	Poland	0.32	0.32
Estonia	0.26	0.28	|	Portugal	0.28	0.26
Finland	0.22	0.21	|	Romania	0.28	0.28
France	0.18	0.20	|	Slovenia	0.32	0.31
Croatia	0.33	0.33	|	Sweden	0.29	0.31
Hungary	0.30	0.30	|	**EU28+ISL**	**0.32**	**0.30**
Ireland	0.36	0.36	|			

5.3.3 Manure Management - N_2O (CRF Source Category 3B2)

N_2O the emissions in source category *3.B.2 - Manure Management* are 0.48% of total EU28+ISL GHG emissions and 9% of total EU28+ISL N_2O emissions. They make 5.3% of total agricultural emissions and 13% of total agricultural N_2O emissions.. The main sub-categories are 3.B.2.5 (Indirect Emissions), 3.B.2.1.2 (Non-Dairy Cattle) and 3.B.2.1.1 (Dairy Cattle) as shown in Figure 5.36, but substantial emissions are also reported for Swine, and Poultry.

Regarding the origin of emissions in the different Member States, Figure 5.37 shows the distribution of N_2O emissions from manure management by livestock category in all Member States and in the EU28+ISL. Each bar represents the total emissions of a country in the current emission category, where different shades of grey correspond to the emitting animal types.

Regarding the handling of manure in the different Member States, Figure 5.38 shows the distribution of total manure nitrogen by manure system in all Member States and in the EU28. Each bar represents the total manure nitrogen handled in the current system for the country, where different shades of grey correspond to the emitting manure systems.

Figure 5.36: Share of source category 3.B.2 on total EU28+ISL agricultural emissions (left panel) and decomposition into its sub-categories (right panel). The percentages refer to the emissions in the year 2016.3.B.2.1-3.B.3.4: emissions by animal types (cattle, sheep, swine, other livestock); 3.B.2.5:Indirect emissions from manure management.

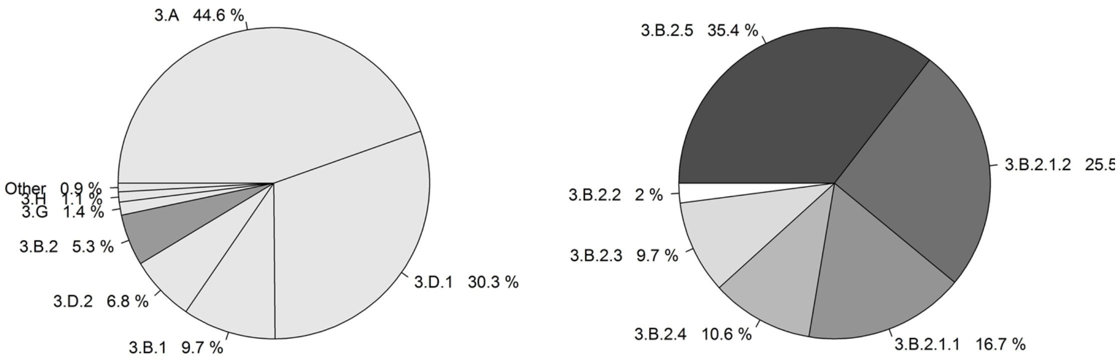


Figure 5.37: Decomposition of emissions in source category 3.B.2 - Manure Management into its sub-categories by Member State in the year 2016.

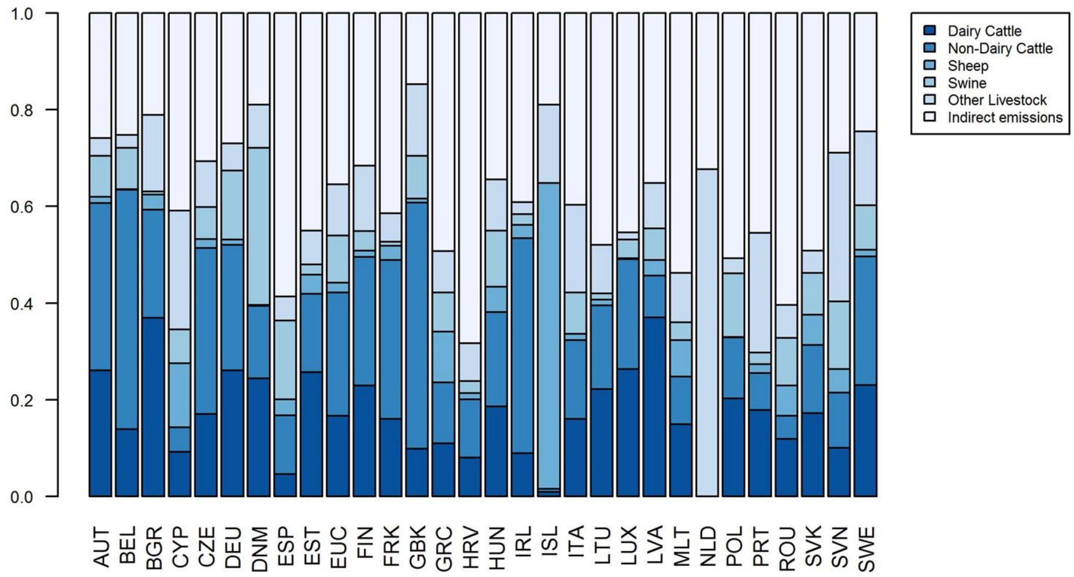
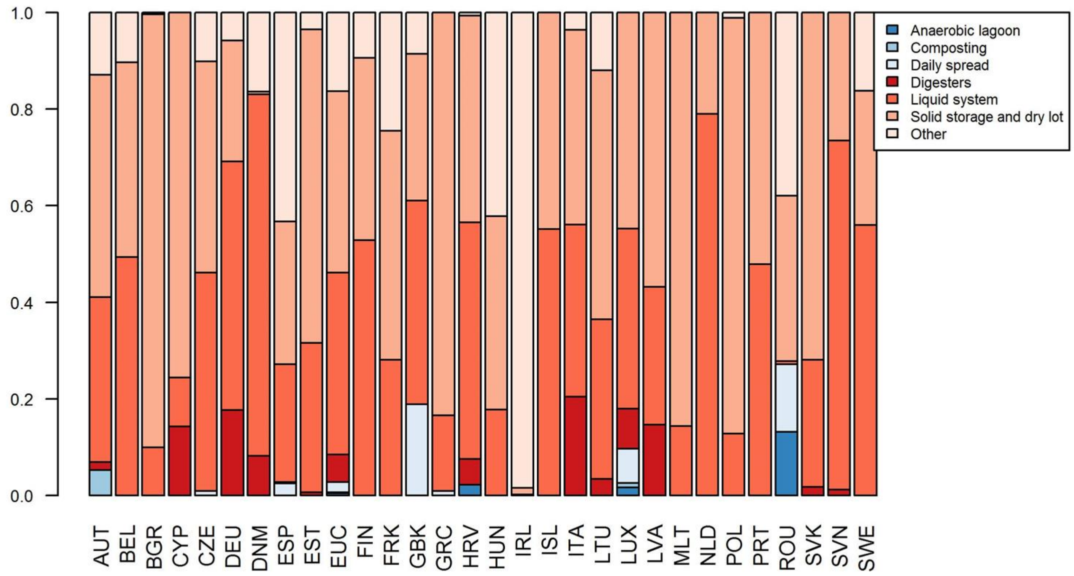


Figure 5.38: Decomposition of manure nitrogen handled in source category 3.B.2 - Manure Management into the different manure management systems by Member State in the year 2016.



Total GHG and N_2O emissions by Member State from 3.B.2 *Manure Management* are shown in Table 5.28 by Member State plus Iceland, and the total EU-28 and EU-28+ISL for the first and the last year of the inventory (1990 and 2016). Values are given in kt CO_2-eq. Between 1990 and 2016, N_2O emission in this source category decreased by 27% or 8.4 Mt CO_2-eq. The decrease was largest in Latvia in relative terms (70%) and in Germany in absolute terms (1.3 Mt CO_2-eq). From 2015 to 2016 emissions in the current category decreased by 0.2%.

Table 5.28 3.B.2 - Manure Management: Member States' contributions to total EU-GHG and N_2O emissions

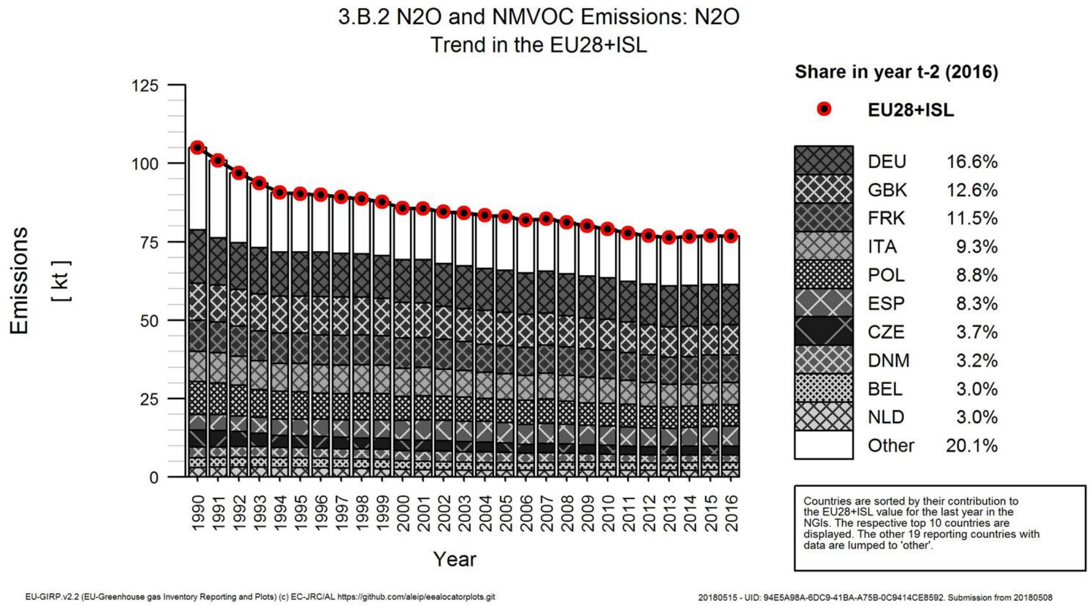
Member States	GHG emissions in 1990 (kt CO_2 equivalents)	GHG emissions in 2016 (kt CO_2 equivalents)	N_2O emissions in 1990 (kt CO_2 equivalents)	N_2O emissions in 2016 (kt CO_2 equivalents)
Austria	438	439	438	439
Belgium	932	691	932	691
Bulgaria	1,260	485	1,260	485
Croatia	362	164	362	164
Cyprus	72	67	72	67
Czech Republic	1,620	839	1,620	839
Denmark	979	725	979	725
Estonia	134	58	134	58
Finland	285	285	285	285
France	2,958	2,623	2,958	2,623
Germany	5,084	3,794	5,084	3,794
Greece	333	291	333	291
Hungary	908	476	908	476
Ireland	498	541	498	541
Italy	2,889	2,122	2,889	2,122
Latvia	295	88	295	88
Lithuania	601	196	601	196
Luxembourg	45	39	45	39
Malta	13	11	13	11
Netherlands	922	687	922	687
Poland	3,096	2,007	3,096	2,007
Portugal	276	180	276	180
Romania	1,204	637	1,204	637
Slovakia	507	163	507	163
Slovenia	156	102	156	102
Spain	1,493	1,907	1,493	1,907
Sweden	364	338	364	338
United Kingdom	3,508	2,887	3,508	2,887
EU-28	**31,233**	**22,841**	**31,233**	**22,841**
Iceland	59	51	59	51
EU-28 + ISL	**31,292**	**22,891**	**31,292**	**22,891**

5.3.3.1 Trends in Emissions and Activity Data

3.B.2 - Manure Management - Emissions

Emissions in source category *3.B.2 - Manure Management* decreased strongly in EU28+ISL by 27% or 8.4 Mt CO_2-eq in the period 1990 to 2016. Figure 5.39 shows the trend of emissions indicating the countries contributing most to EU28+ISL total. The figure represents the trend in N_2O emissions from manure management for the different Member States along the inventory period. The ten countries with the highest emissions accounted together for 79.9% of the total. Emissions decreased in 26 countries and increased in three countries. The largest decreases occurred in Germany and Poland with a total absolute decrease of 2.4 Mt CO_2-eq. The largest increases occurred in Spain, with a total absolute increase of 414 kt CO_2-eq.

Figure 5.39: 3.B.2 Manure Management: Trend in emissions in the EU28+ISL and the countries contributing most to EU28+ISL values including their share to EU28+ISL emissions in 2016



3.B.2.1 - Cattle - Emissions

N_2O emissions in source category *3.B.2.1 - Cattle* are 0.2% of total EU28+ISL GHG emissions and 3.8% of total EU28+ISL N_2O emissions. They make 2.2% of total agricultural emissions and 5.3% of total agricultural N_2O emissions.. Figure 5.40 and Figure 5.41 show the trend of emissions indicating the countries contributing most to the EU28+ISL total. The figures represent the trend in N_2O emissions from manure management for the different Member States along the inventory period.

Total GHG and N_2O emissions by Member State from 3.B.2.1 *Manure Management* are shown in Table 5.29 by Member State plus Iceland, and the total EU-28 and EU-28+ISL for the first and the last year of the inventory (1990 and 2016). Values are given in kt CO_2-eq. Between 1990 and 2016, N_2O emission in this source category decreased by 28% or 3.8 Mt CO_2-eq. The decrease was largest in Slovakia in relative terms (72%) and in Germany in absolute terms (1 Mt CO_2-eq). From 2015 to 2016 emissions in the current category increased by 0.1%. The ten countries with the highest emissions accounted together for 84% of the total. Emissions decreased in 22 countries and increased in six countries. The three countries with the largest decreases were Germany, Italy and the United Kingdom with a total absolute decrease of 2 Mt CO_2-eq. The three countries with the largest increases were Finland, Ireland and Spain, with a total absolute increase of 109 kt CO_2-eq.

Table 5.29 3.B.2.1 - Cattle: Member States' contributions to total EU-GHG and N_2O emissions

Member State	N2O Emissions in kt CO2 equiv.			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016		Method	Emission factor Informa-tion
	1990	2015	2016		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	258	265	266	2.8%	8	3%	1	0%	T2	CS
Belgium	622	438	438	4.5%	-183	-29%	0	0%	T2	D
Bulgaria	585	289	287	3.0%	-298	-51%	-1	0%	T2	D
Croatia	92	34	33	0.3%	-59	-64%	-1	-2%	T2	CS,D
Cyprus	8	9	9	0.1%	1	15%	1	9%	T1	D
Czech Republic	710	420	431	4.5%	-279	-39%	11	3%	T2	CS
Denmark	326	282	286	3.0%	-40	-12%	4	1%	T2	D
Estonia	51	25	24	0.3%	-27	-53%	-1	-2%	T2	CS,D
Finland	128	144	141	1.5%	13	10%	-3	-2%	T2	D
France	1 419	1 289	1 281	13.3%	-138	-10%	-8	-1%	T2	CS,D
Germany	3 022	1 994	1 973	20.4%	-1 049	-35%	-22	-1%	T2	CS,D
Greece	84	72	68	0.7%	-16	-18%	-3	-4%	D	D
Hungary	281	177	182	1.9%	-99	-35%	5	3%	T2	CS
Ireland	264	277	289	3.0%	25	10%	12	4%	T2	CS,D
Italy	1 267	670	685	7.1%	-582	-46%	15	2%	T2	CS,D
Latvia	121	41	40	0.4%	-81	-67%	-1	-3%	T2	D
Lithuania	206	80	77	0.8%	-129	-63%	-2	-3%	T2	D
Luxembourg	23	19	19	0.2%	-4	-16%	0	2%	T2	D
Malta	3	3	3	0.0%	-1	-21%	0	-2%	T1,T2	CS,D
Netherlands	IE	IE	IE	-	-	-	-	-	NA	NA
Poland	918	674	659	6.8%	-259	-28%	-15	-2%	T2	CS
Portugal	78	45	46	0.5%	-32	-41%	1	2%	T2	CS,D
Romania	214	105	106	1.1%	-108	-50%	0	0%	T2	D
Slovakia	181	53	51	0.5%	-129	-72%	-2	-4%	T1	CS
Slovenia	37	22	22	0.2%	-15	-41%	0	0%	T1,T2	CS,D
Spain	248	312	319	3.3%	71	29%	7	2%	CS,T2	D
Sweden	176	171	168	1.7%	-8	-5%	-3	-2%	T2	CS,D
United Kingdom	2 164	1 739	1 753	18.2%	-411	-19%	14	1%	T2	CS,D
EU-28	**13 486**	**9 647**	**9 657**	**100%**	**-3 828**	**-28%**	**10**	**0.1%**	-	-
Iceland	1	1	1	0.0%	0	12%	0	0%	-	-
United Kingdom (KP)	2 164	1 739	1 753	18.2%	-411	-19%	14	1%	T2	CS,D
EU-28 + ISL	**13 486**	**9 647**	**9 658**	**100%**	**-3 828**	**-28%**	**10**	**0.1%**	-	-

Figure 5.40: 3.B.2.1 - Dairy cattle: Trend in emissions in the EU28+ISL and the countries contributing most to EU28+ISL values including their share to EU28+ISL emissions in 2016

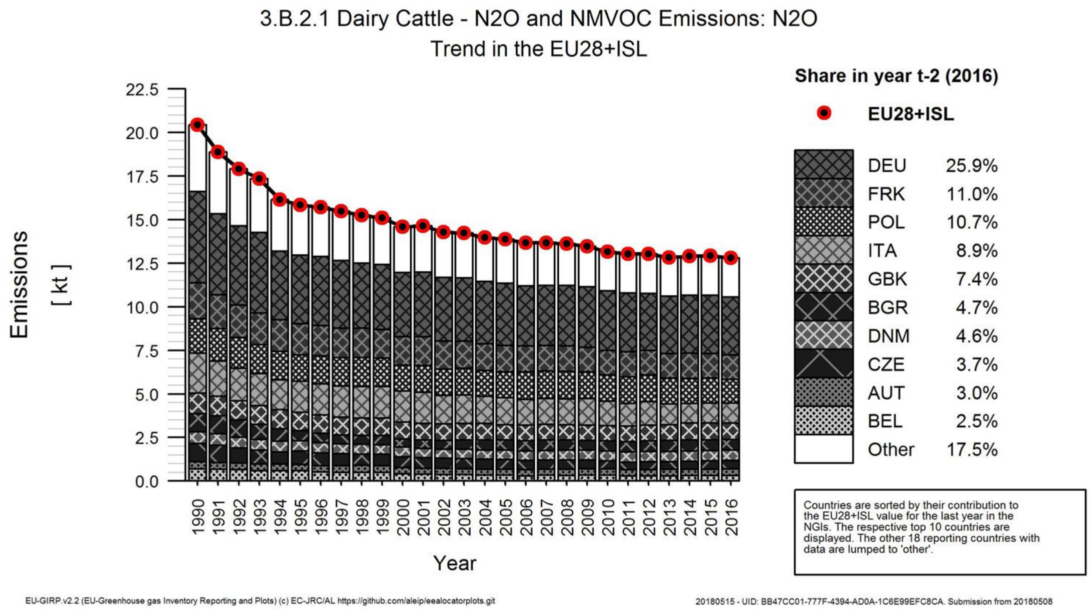
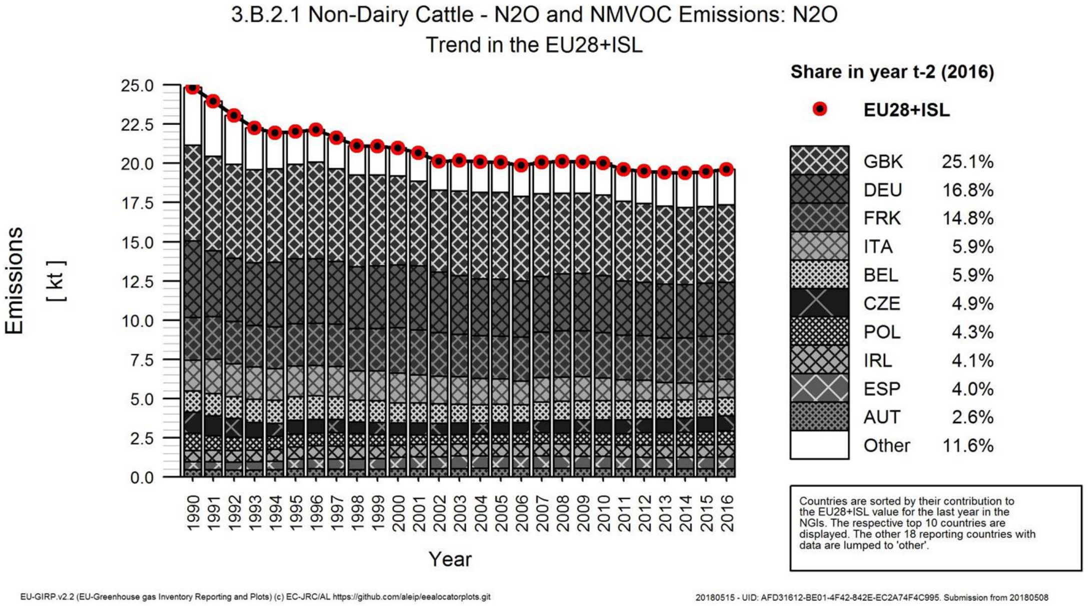


Figure 5.41: 3.B.2.1 - Non-dairy cattle: Trend in emissions in the EU28+ISL and the countries contributing most to EU28+ISL values including their share to EU28+ISL emissions in 2016



3.B.2.1 - Cattle - population

One of the main activity data for N_2O emissions from manure management - cattle is the animal numbers. Cattle numbers are already discussed under source category 3.A Enteric Fermentation and therefore not further discussed here.

Other activity data is:

- N-allocation by MMS.

3.B.2.3 - Swine - Emissions

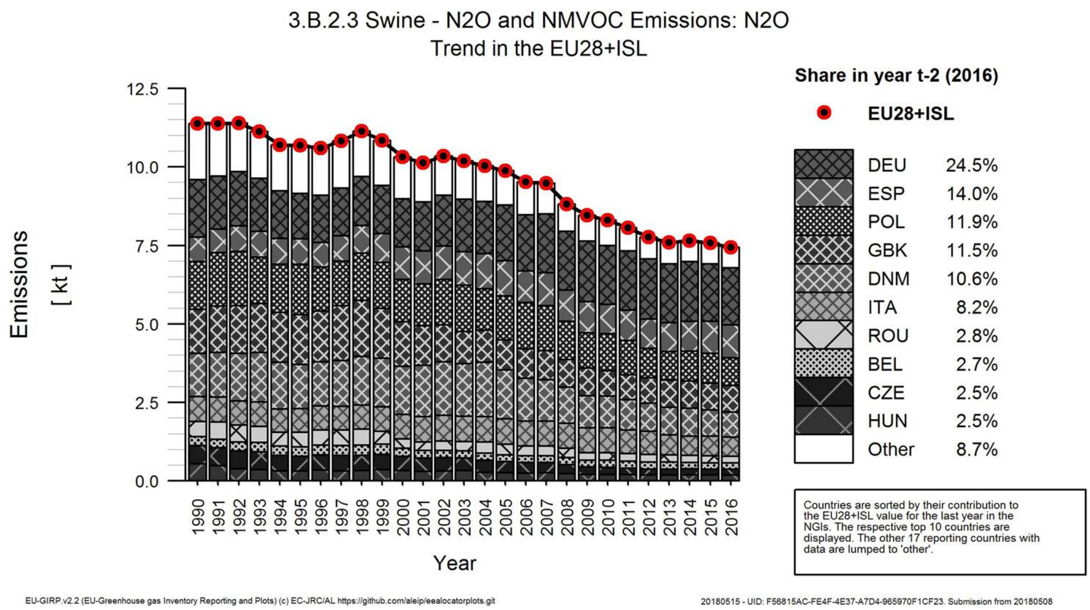
N_2O emissions in source category *3.B.2.3 - Swine* are 0.046% of total EU28+ISL GHG emissions and 0.88% of total EU28+ISL N_2O emissions. They make 0.51% of total agricultural emissions and 1.2% of total agricultural N_2O emissions.. Figure 5.43 shows the trend of emissions indicating the countries contributing most to the EU28+ISL total. The figure represents the trend in N_2O emissions from manure management for the different Member States along the inventory period.

Total GHG and N_2O emissions by Member State from 3.B.2.3 *Manure Management* are shown in Table 5.30 by Member State plus Iceland, and the total EU-28 and EU-28+ISL for the first and the last year of the inventory (1990 and 2016). Values are given in kt CO_2-eq. Between 1990 and 2016, N_2O emission in this source category decreased by 35% or 1.2 Mt CO_2-eq. The decrease was largest in Lithuania in relative terms (98%) and in Poland in absolute terms (192 kt CO_2-eq). From 2015 to 2016 emissions in the current category decreased by 1.8%. The ten countries with the highest emissions accounted together for 91.3% of the total. Emissions decreased in 25 countries and increased in two countries. The three countries with the largest decreases were Poland, Denmark and the United Kingdom with a total absolute decrease of 528 kt CO_2-eq. The largest increases occurred in Spain, with a total absolute increase of 82 kt CO_2-eq.

Table 5.30 3.B.2.3 - Swine: Member States' contributions to total EU-GHG and N_2O emissions

Member State	N2O Emissions in kt CO2 equiv.			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016		Method	Emission factor Informa-tion
	1990	2015	2016		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	59	38	37	1.7%	-22	-37%	-1	-2%	T2	CS
Belgium	85	62	60	2.7%	-25	-30%	-2	-3%	T2	D
Bulgaria	10	3	3	0.1%	-7	-70%	0	7%	T2	D
Croatia	26	4	4	0.18%	-22	-84%	0	-4%	T2	CS
Cyprus	8	5	5	0.2%	-3	-40%	0	-1%	T1	D
Czech Republic	174	54	56	2.5%	-119	-68%	2	3%	T2	CS
Denmark	407	251	236	10.6%	-172	-42%	-16	-6%	T2	D
Estonia	2	1	1	0.1%	-1	-47%	0	-10%	T2	CS,D
Finland	26	12	11	0.5%	-15	-56%	0	-3%	T2	D
France	46	21	21	1.0%	-25	-54%	0	1%	T2	CS,D
Germany	549	546	543	24.5%	-6	-1%	-3	-1%	T2	CS,D
Greece	31	23	24	1.1%	-8	-25%	1	4%	D	D
Hungary	162	57	55	2.5%	-107	-66%	-2	-3%	T2	CS
Ireland	10	12	12	0.6%	2	22%	0	4%	T2	CS,D
Italy	236	185	182	8.2%	-54	-23%	-3	-2%	T2	CS,D
Latvia	40	6	6	0.3%	-35	-86%	0	-3%	T2	D
Lithuania	110	3	3	0.1%	-108	-98%	0	-8%	T1	D
Luxembourg	1.6	1.6	1.5	0.0686%	-0.06	-4%	-0.05	-3%	T2	D
Malta	1	0	0	0.0%	-1	-60%	0	-8%	T1	D
Netherlands	IE	IE	IE	-	-	-	-	-	NA	NA
Poland	455	284	263	11.9%	-192	-42%	-21	-7%	T2	CS
Portugal	11	4	4	0.2%	-7	-61%	0	2%	T2	CS,D
Romania	144	66	62	2.8%	-81	-57%	-4	-6%	T2	D
Slovakia	66	17	14	0.6%	-52	-78%	-3	-16%	T1	CS
Slovenia	39	14	14	0.6%	-24	-63%	0	0%	T1	D
Spain	229	304	311	14.0%	82	36%	7	2%	CS,T2	D
Sweden	42	30	31	1.4%	-11	-26%	1	3%	NA,T2	D,NA
United Kingdom	420	252	255	11.5%	-165	-39%	3	1%	T2	CS,D
EU-28	**3 390**	**2 256**	**2 216**	**100%**	**-1 174**	**-35%**	**-40**	**-2%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	420	252	255	11.5%	-165	-39%	3	1%	T2	CS,D
EU-28 + ISL	**3 390**	**2 256**	**2 216**	**100%**	**-1 174**	**-35%**	**-40**	**-2%**	**-**	**-**

Figure 5.42: 3.B.2.3 - Swine: Trend in emissions in the EU28+ISL and the countries contributing most to EU28+ISL values including their share to EU28+ISL emissions in 2016



3.B.2.4 - Other Livestock - Emissions

N_2O emissions in source category *3.B.2.4 - Other Livestock* are 0.051% of total EU28+ISL GHG emissions and 0.96% of total EU28+ISL N_2O emissions. They make 0.57% of total agricultural emissions and 1.3% of total agricultural N_2O emissions..

Total GHG and N_2O emissions by Member State from 3.B.2.4 *Manure Management* are shown in Table 5.31 by Member State plus Iceland, and the total EU-28 and EU-28+ISL for the first and the last year of the inventory (1990 and 2016). Values are given in kt CO_2-eq. Between 1990 and 2016, N_2O emission in this source category decreased by 7% or 178 kt CO_2-eq. The decrease was largest in Estonia in relative terms (66%) and in Bulgaria in absolute terms (125 kt CO_2-eq). From 2015 to 2016 emissions in the current category increased by 0.4%. Figure 5.44 shows the trend of emissions indicating the countries contributing most to EU28+ISL total. The figure represents the trend in N_2O emissions from manure management for the different Member States along the inventory period. The ten countries with the highest emissions accounted together for 83.1% of the total. Emissions decreased in sixteen countries and increased in thirteen countries. The three countries with the largest decreases were Bulgaria, Poland and the Netherlands with a total absolute decrease of 286 kt CO_2-eq. The largest increases occurred in the United Kingdom and Italy, with a total absolute increase of 153 kt CO_2-eq.

Table 5.31 3.B.2.4 - Other Livestock: Member States' contributions to total EU-GHG and N_2O emissions

Member State	N2O Emissions in kt CO2 equiv.			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016		Method	Emission factor Informa-tion
	1990	2015	2016		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	9	16	16	0.7%	7	78%	0	1%	T2	CS
Belgium	10	18	18	0.8%	8	81%	1	4%	T2	D
Bulgaria	201	80	77	3.1%	-125	-62%	-4	-4%	T1,T2	D
Croatia	25	13	13	0.5%	-13	-50%	0	-3%	T2	CS
Cyprus	17	16	16	0.7%	-1	-5%	0	3%	T1	D
Czech Republic	113	84	80	3.3%	-33	-29%	-4	-5%	T2	CS,D
Denmark	46	65	64	2.6%	19	42%	-1	-2%	T2	D
Estonia	12	5	4	0.2%	-8	-66%	-1	-24%	T1	D
Finland	29	38	39	1.6%	10	34%	1	1%	T2	D
France	148	159	155	6.4%	6	4%	-4	-3%	T2	CS,D
Germany	198	215	213	8.8%	15	8%	-2	-1%	T2	CS,D
Greece	30	26	25	1.0%	-5	-16%	-1	-3%	D	D
Hungary	83	56	51	2.1%	-32	-39%	-6	-10%	T1,T2	CS,D
Ireland	11	13	13	0.5%	2	17%	0	0%	T2	CS,D
Italy	292	374	386	15.8%	94	32%	11	3%	T2	CS,D
Latvia	20	9	8	0.3%	-12	-59%	0	-5%	T1,T2	D
Lithuania	16	19	20	0.8%	4	23%	0	1%	T1	D
Luxembourg	0	1	1	0.0%	0	71%	0	-2%	T2	D
Malta	1	1	1	0.0%	0	-5%	0	-7%	T1,T2	CS,D
Netherlands	533	452	465	19.1%	-68	-13%	13	3%	CS	CS
Poland	157	62	63	2.6%	-93	-60%	1	2%	T1,T2	CS,D
Portugal	60	43	45	1.8%	-15	-26%	2	5%	T2	CS,D
Romania	67	45	44	1.8%	-23	-35%	-1	-2%	T2	D
Slovakia	10	8	8	0.3%	-3	-27%	0	-4%	T1	CS
Slovenia	37	31	31	1.3%	-6	-15%	1	2%	T1	D
Spain	70	90	94	3.8%	24	35%	4	5%	T1,T2	D
Sweden	40	52	52	2.1%	11	28%	0	-1%	T2	D
United Kingdom	368	427	428	17.6%	60	16%	1	0%	T2	CS,D
EU-28	**2 604**	**2 418**	**2 428**	**100%**	**-176**	**-7%**	**10**	**0.4%**	**-**	**-**
Iceland	10	8	8	0.3%	-2	-20%	0	-1%	-	-
United Kingdom (KP)	368	427	428	17.6%	60	16%	1	0%	T2	CS,D
EU-28 + ISL	**2 614**	**2 426**	**2 436**	**100%**	**-178**	**-7%**	**10**	**0.4%**	**-**	**-**

3.B.2.4.7 - Poultry - Emissions

Largest contribution to other livestock emissions comes from sub-category poultry with 43% of total N_2O emissions. Other animal types with high emissions are 'other' animals in this sub-category with a share of 26% and Horses with a share of 21%. Here only the most important animal type Poultry is discussed.

Emissions in source category *3.B.2.4.7 - Poultry* decreased clearly in EU28+ISL by 12% or 145 kt CO_2-eq in the period 1990 to 2016. Figure 5.45 shows the trend of emissions indicating the countries contributing most to EU28+ISL total. The figure represents the trend in N_2O emissions from manure management for the different Member States along the inventory period. The ten countries with the highest emissions accounted together for 86.2% of the total. Emissions decreased in nineteen countries and increased in nine countries. The largest decreases occurred in Bulgaria and Czech Republic with a total absolute decrease of 148 kt CO_2-eq. The three countries with the largest increases were Sweden, Germany and Italy, with a total absolute increase of 70 kt CO_2-eq.

3.A.4.7 - Poultry - Population

As population data for poultry have not yet been discussed, this will be done here. Poultry population increased slightly in EU28+ISL by 4.1% or 66.5 million heads in the period 1990 to 2016. Figure 5.46 shows the trend of poultry population indicating the countries contributing most to EU28+ISL total. The figure represents the trend in CH_4 population for the different Member States along the inventory period. The ten countries with the highest population accounted together for 85.7% of the total. Population decreased in thirteen countries and increased in sixteen countries. The four countries with the largest decreases were Romania, Poland, Hungary and Bulgaria with a total absolute decrease of 128 million heads. The four countries with the largest increases were Italy, the United Kingdom, France and Germany, with a total absolute increase of 165 million heads.

Other activity data related to this emission category are:

- Nitrogen managed on each manure management system

Figure 5.44: 3.B.2.4 - Other Livestock: Trend in emissions in the EU28+ISL and the countries contributing most to EU28+ISL values including their share to EU28+ISL emissions in 2016

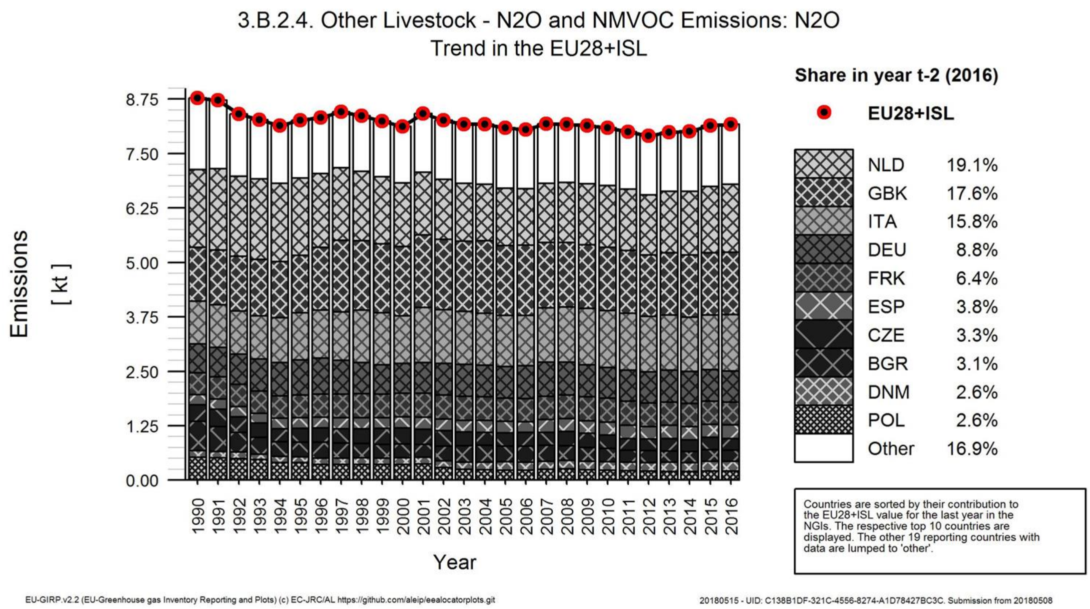


Figure 5.45: 3.B.2.4.7 - Poultry: Trend in emissions in the EU28+ISL and the countries contributing most to EU28+ISL values including their share to EU28+ISL emissions in 2016

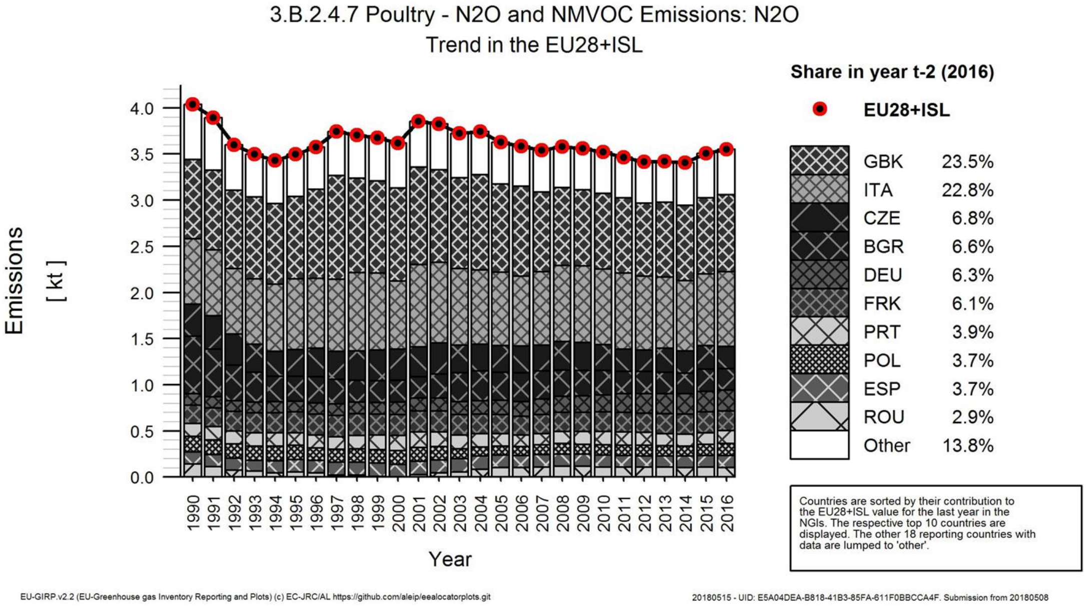
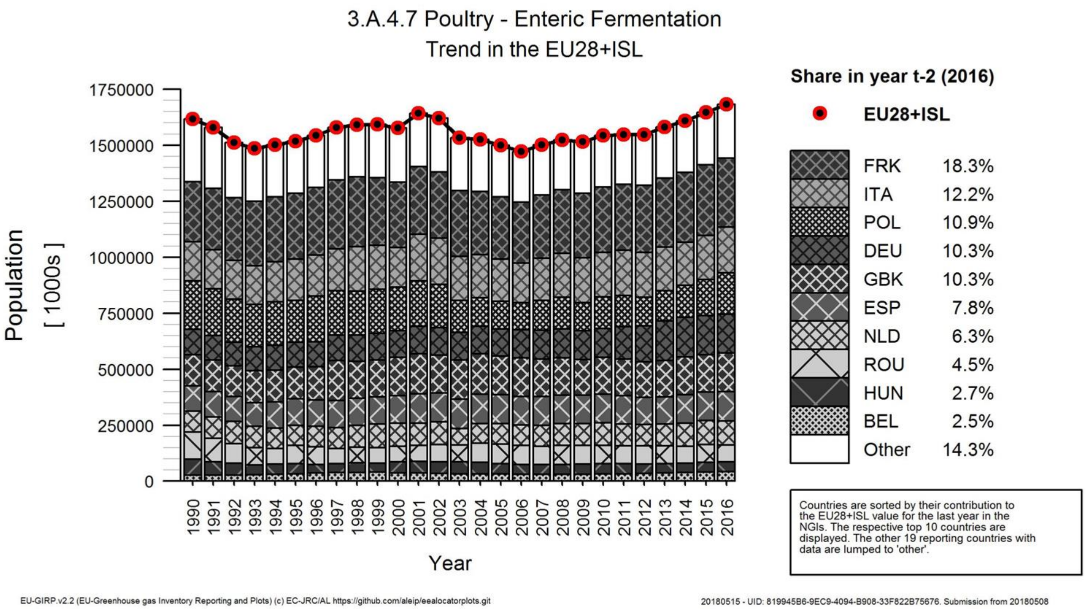


Figure 5.46: 3.A.4.7 - Poultry: Trend in population in the EU28+ISL and the countries contributing most to EU28+ISL values including their share to EU28+ISL emissions in 2016



5.3.3.2 Implied EFs and Methodological Issues

In this section, we discuss the implied emission factor for the main animal types. Furthermore, we present data on the nitrogen excretion rate for the different animal types.

3.B.2.5 - Manure Management - Indirect Emissions - Emissions

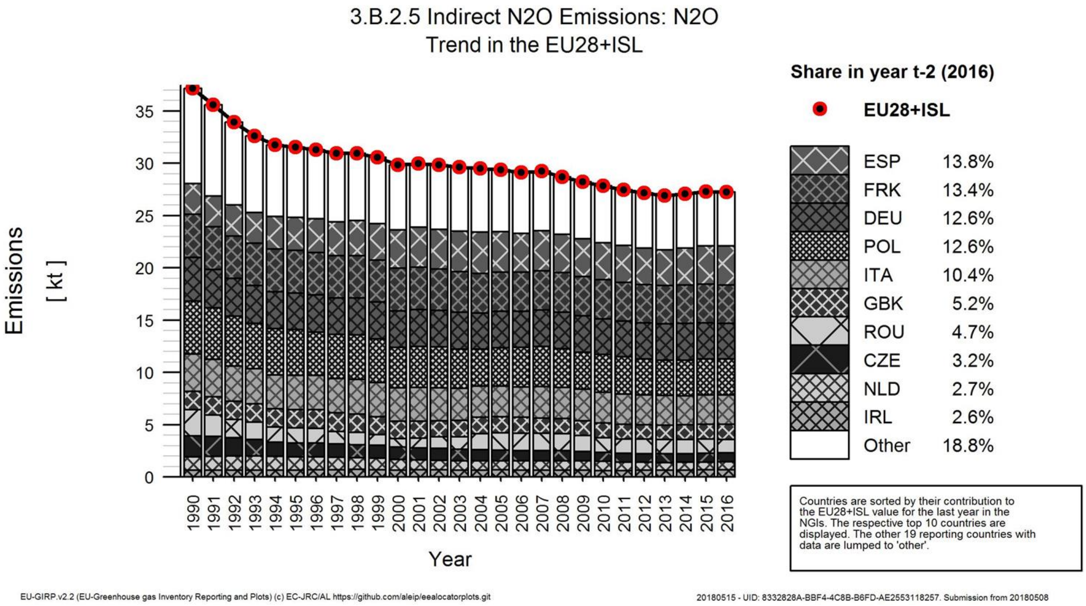
N_2O emissions in source category *3.B.2.5 - Manure Management - Indirect Emissions - Indirect N_2O emissions* are 0.17% of total EU28+ISL GHG emissions and 3.2% of total EU28+ISL N_2O emissions. They make 1.9% of total agricultural emissions and 4.4% of total agricultural N_2O emissions.

Total GHG and N_2O emissions by Member State from 3.B.2.5 *Manure Management - Indirect Emissions* are shown in Table 5.32 by Member State plus Iceland, and the total EU-28 and EU-28+ISL for the first and the last year of the inventory (1990 and 2016). Values are given in kt CO_2-eq. Between 1990 and 2016, N_2O emission in this source category decreased by 27% or 3 Mt CO_2-eq. The decrease was largest in Bulgaria in relative terms (72%) and in Poland in absolute terms (493 kt CO_2-eq). From 2015 to 2016 emissions in the current category decreased by 0.2%. Figure 5.47 shows the trend of emissions indicating the countries contributing most to EU28+ISL total. The figure represents the trend in N_2O emissions from manure management - indirect emissions for the different Member States along the inventory period. The ten countries with the highest emissions accounted together for 81.2% of the total. Emissions decreased in 26 countries and increased in three countries. The three countries with the largest decreases were Poland, Romania and Czech Republic with a total absolute decrease of 1.2 Mt CO_2-eq. The largest increases occurred in Spain, with a total absolute increase of 245 kt CO_2-eq.

Table 5.32 3.B.2.5 - Manure Management - Indirect Emissions: Member States' contributions to total EU-GHG and N_2O emissions

Member State	N2O Emissions in kt CO2 equiv.			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016	
	1990	2015	2016		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	107	114	114	1.4%	7	6%	0	0%
Belgium	215	175	174	2.1%	-40	-19%	-1	0%
Bulgaria	367	103	102	1.3%	-265	-72%	-1	-1%
Croatia	216	114	112	1.4%	-104	-48%	-2	-2%
Cyprus	30	26	27	0.3%	-3	-10%	1	3%
Czech Republic	592	253	257	3.2%	-335	-57%	4	2%
Denmark	198	138	138	1.7%	-60	-30%	-1	0%
Estonia	65	28	26	0.3%	-38	-60%	-1	-5%
Finland	99	91	90	1.1%	-9	-9%	-1	-1%
France	1 227	1 099	1 088	13.4%	-139	-11%	-11	-1%
Germany	1 242	1 033	1 023	12.6%	-219	-18%	-10	-1%
Greece	157	145	143	1.8%	-14	-9%	-1	-1%
Hungary	350	166	164	2.0%	-186	-53%	-2	-1%
Ireland	191	204	212	2.6%	21	11%	8	4%
Italy	1 061	827	841	10.4%	-220	-21%	14	2%
Latvia	109	32	31	0.4%	-78	-72%	-1	-2%
Lithuania	268	99	94	1.2%	-174	-65%	-5	-5%
Luxembourg	20	17	18	0.2%	-3	-14%	0	1%
Malta	7	6	6	0.1%	-1	-16%	0	-4%
Netherlands	389	223	222	2.7%	-168	-43%	-1	-1%
Poland	1 512	1 031	1 018	12.6%	-493	-33%	-13	-1%
Portugal	115	80	82	1.0%	-33	-29%	2	3%
Romania	746	402	385	4.7%	-361	-48%	-18	-4%
Slovakia	233	85	80	1.0%	-153	-66%	-5	-6%
Slovenia	43	29	29	0.4%	-13	-31%	1	2%
Spain	875	1 095	1 119	13.8%	245	28%	24	2%
Sweden	103	86	83	1.0%	-20	-19%	-4	-4%
United Kingdom	522	424	425	5.2%	-97	-19%	1	0%
EU-28	**11 059**	**8 124**	**8 104**	**100%**	**-2 956**	**-27%**	**-20**	**-0.2%**
Iceland	10	10	10	0.1%	-1	-6%	0	1%
United Kingdom (KP)	522	424	425	5.2%	-97	-19%	1	0%
EU-28 + ISL	**11 070**	**8 133**	**8 113**	**100%**	**-2 956**	**-27%**	**-20**	**-0.2%**

Figure 5.47: 3.B.2.5 - Manure Management - Indirect Emissions: Trend in emissions in the EU28+ISL and the countries contributing most to EU28+ISL values including their share to EU28+ISL emissions in 2016



3.B.2.1 - Cattle - Implied emission factor

The implied emission factor for N_2O emissions in source category *3.B.2.1 - Cattle* decreased in EU28+ISL slightly between 1990 and 2016 by 3% or 0.0117 kg/head/year. Table 5.33 shows the implied emission factor for N_2O emissions in source category *3.B.2.1 - Cattle* for the years 1990 and 2016 for all Member States and EU28+ISL. The implied emission factor decreased in eight countries and increased in eighteen countries. No data were available for the Netherlands. The three countries with the largest decreases were Portugal, Croatia and Italy with a mean absolute value of 0.1 kg/head/year. The four countries with the largest increases were Finland, Czech Republic, Estonia and Bulgaria with a mean absolute value of 0.3 kg/head/year.

Table 5.33 3.B.2.1 - Cattle: Member States' and EU28+ISL implied emission factor (kg/head/year)

Member State	1990	2016		Member State	1990	2016
Austria	0.34	0.457	|	Ireland	0.13	0.135
Belgium	0.64	0.575	|	Iceland		0.032
Bulgaria	1.23	1.741	|	Italy	0.55	0.388
Cyprus	0.51	0.494	|	Lithuania	0.29	0.358
Czech Republic	0.68	1.022	|	Luxembourg	0.34	0.317
Germany	0.52	0.531	|	Latvia	0.28	0.326
Denmark	0.49	0.611	|	Malta	0.53	0.619
Spain	0.16	0.168	|	Poland	0.31	0.372
Estonia	0.23	0.328	|	Portugal	0.19	0.097
Finland	0.32	0.521	|	Romania	0.14	0.172
France	0.22	0.222	|	Slovakia	0.39	0.384
United Kingdom	0.60	0.595	|	Slovenia		0.150
Greece	0.40	0.415	|	Sweden	0.34	0.378
Croatia	0.36	0.229	|	**EU28+ISL**	**0.39**	**0.379**
Hungary	0.58	0.726	|			

3.B.2.1 - Dairy Cattle - Implied emission factor

The implied emission factor for N_2O emissions in source category *3.B.2.1 - Dairy Cattle* increased in EU28+ISL moderately between 1990 and 2016 by 7.8% or 0.0425 kg/head/year. Figure 5.48 shows the trend of the implied emission factor in EU28+ISL indicating also the range of values used by the countries. Table 5.34 shows the implied emission factor for N_2O emissions in source category *3.B.2.1 - Dairy Cattle* for the years 1990 and 2016 for all Member States and EU28+ISL. The implied emission factor decreased in ten countries and increased in eighteen countries. No data were available for the Netherlands. The largest decreases occurred in Croatia and Italy with a mean absolute value of 0.2 kg/head/year. The four countries with the largest increases were Spain, Austria, Finland and Estonia with a mean absolute value of 0.2 kg/head/year.

Figure 5.48: 3.B.2.1 - Dairy Cattle: Trend in implied emission factor in the EU28+ISL and range of values reported by countries

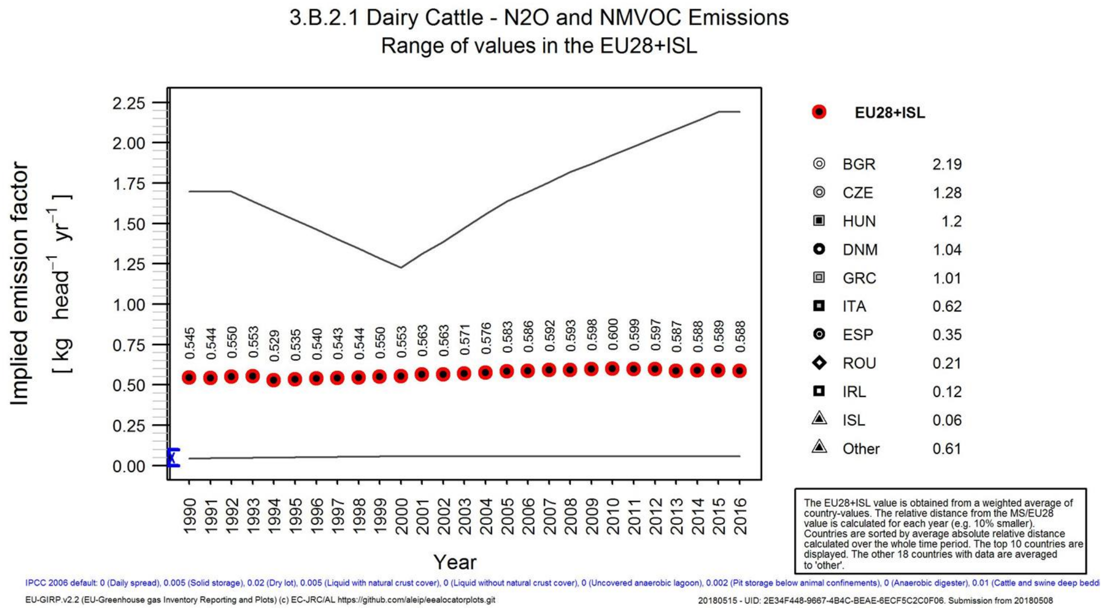


Table 5.34 3.B.2.1 - Dairy Cattle: Member States' and EU28+ISL implied emission factor (kg/head/year)

Member State	1990	2016	Member State	1990	2016
Austria	0.444	0.712	Ireland	0.128	0.120
Belgium	0.845	0.703	Iceland	0.044	0.056
Bulgaria	1.696	2.192	Italy	0.866	0.624
Cyprus	0.759	0.719	Lithuania	0.377	0.498
Czech Republic	0.873	1.283	Luxembourg	0.689	0.673
Germany	0.827	0.787	Latvia	0.596	0.707
Denmark	0.876	1.037	Malta	0.608	0.823
Spain	0.206	0.351	Poland	0.402	0.585
Estonia	0.374	0.580	Portugal	0.472	0.452
Finland	0.484	0.776	Romania	0.169	0.211
France	0.386	0.387	Slovakia	0.752	0.713
United Kingdom	0.412	0.498	Slovenia	0.319	0.317
Greece	0.784	1.007	Sweden	0.609	0.789
Croatia	0.392	0.263	**EU28+ISL**	**0.545**	**0.588**
Hungary	0.883	1.203			

3.B.2.1 - Dairy Cattle - Nitrogen excretion rate

The nitrogen excretion rate, a parameter used for calculating N_2O emissions in source category *3.B.2.1 - Dairy Cattle*, increased in EU28+ISL considerably between 1990 and 2016 by 20.7% or 19 kg/head/year. Figure 5.49 shows the trend of the nitrogen excretion rate in EU28+ISL indicating also the range of values used by the countries. Table 5.35 shows the nitrogen excretion rate in source category *3.B.2.1 - Dairy Cattle* for the years 1990 and 2016 for all Member States and EU28+ISL. Nitrogen excretion rate decreased in two countries and increased in 23 countries. It was in 2016 at the level of 1990 in four countries. Decreases occurred in the Netherlands and Slovakia with a mean absolute value of 9 kg/head/year. The four countries with the largest increases were Spain, Hungary, Estonia and Finland with a mean absolute value of 41 kg/head/year.

Figure 5.49: 3.B.2.1 - Dairy Cattle: Trend in nitrogen excretion rate in the EU28+ISL and range of values reported by countries

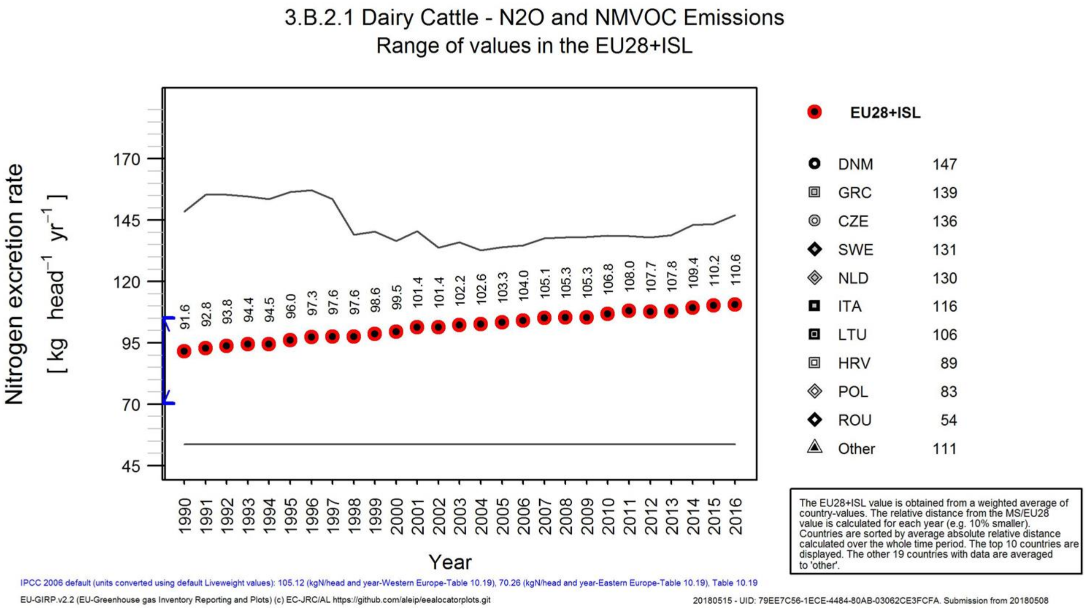


Table 5.35 3.B.2.1 - Dairy Cattle: Member States' and EU28+ISL nitrogen excretion rate (kg/head/year)

Member State	1990	2016		Member State	1990	2016
Austria	77	103	|	Ireland	96	101
Belgium	114	119	|	Iceland	72	95
Bulgaria	98	98	|	Italy	116	116
Cyprus	96	96	|	Lithuania	80	106
Czech Republic	98	136	|	Luxembourg	85	102
Germany	98	122	|	Latvia	86	112
Denmark	129	147	|	Malta	77	105
Spain	69	118	|	Netherlands	148	130
Estonia	85	122	|	Poland	65	83
Finland	91	131	|	Portugal	86	117
France	102	114	|	Romania	54	54
United Kingdom	87	108	|	Slovakia	105	105
Greece	108	139	|	Slovenia	82	116
Croatia	70	89	|	Sweden	102	131
Hungary	83	120	|	**EU28+ISL**	**92**	**111**

3.B.2.1 - Non-Dairy Cattle - Implied emission factor

The implied emission factor for N_2O emissions in source category *3.B.2.1 - Non-Dairy Cattle* decreased in EU28+ISL slightly between 1990 and 2016 by 2.8% or 0.00898 kg/head/year. Figure 5.50 shows the trend of the implied emission factor in EU28+ISL indicating also the range of values used by the countries. Table 5.36 shows the implied emission factor for N_2O emissions in source category *3.B.2.1 - Non-Dairy Cattle* for the years 1990 and 2016 for all Member States and EU28+ISL. The implied emission factor decreased in ten countries and increased in sixteen countries. No data were available for the Netherlands. The three countries with the largest decreases were Portugal, Croatia and Italy with a mean absolute value of 0.1 kg/head/year. The four countries with the largest increases were Finland, Czech Republic, Bulgaria and Estonia with a mean absolute value of 0.2 kg/head/year.

Figure 5.50: 3.B.2.1 - Non-Dairy Cattle: Trend in implied emission factor in the EU28+ISL and range of values reported by countries

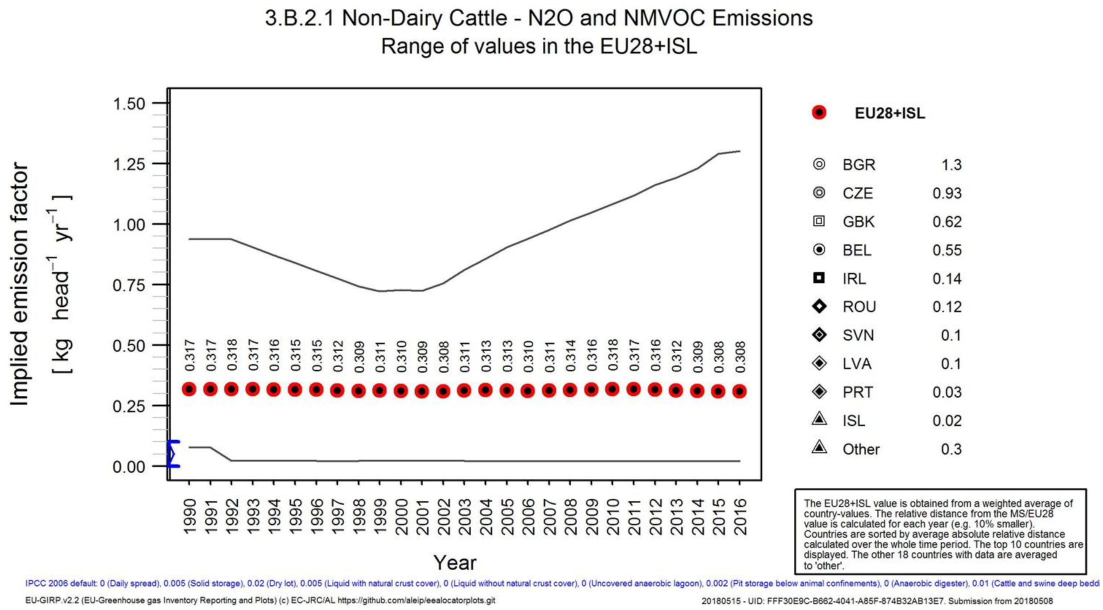


Table 5.36 3.B.2.1 - Non-Dairy Cattle: Member States' and EU28+ISL implied emission factor (kg/head/year)

Member State	1990	2016	Member State	1990	2016
Austria	0.277	0.360	Ireland	0.130	0.139
Belgium	0.572	0.547	Iceland		0.021
Bulgaria	0.936	1.300	Italy	0.384	0.283
Cyprus	0.332	0.315	Lithuania	0.242	0.263
Czech Republic	0.579	0.928	Luxembourg	0.218	0.197
Germany	0.372	0.400	Latvia	0.095	0.099
Denmark	0.292	0.367	Malta	0.474	0.449
Spain	0.144	0.140	Poland	0.215	0.235
Estonia	0.143	0.194	Portugal	0.078	0.034
Finland	0.223	0.406	Romania	0.092	0.119
France	0.167	0.184	Slovakia	0.262	0.245
United Kingdom	0.657	0.618	Slovenia		0.103
Greece	0.241	0.275	Sweden	0.209	0.260
Croatia	0.323	0.210	**EU28+ISL**	**0.317**	**0.308**
Hungary	0.422	0.527			

3.B.2.1 - Non-Dairy Cattle - Nitrogen excretion rate

The nitrogen excretion rate, a parameter used for calculating N_2O emissions in source category *3.B.2.1 - Non-Dairy Cattle*, increased in EU28+ISL slightly between 1990 and 2016 by 4.3% or 2.03 kg/head/year. Figure 5.51 shows the trend of the nitrogen excretion rate in EU28+ISL indicating also the range of values used by the countries. Table 5.37 shows the nitrogen excretion rate in source category *3.B.2.1 - Non-Dairy Cattle* for the years 1990 and 2016 for all Member States and EU28+ISL. Nitrogen excretion rate decreased in six countries and increased in nineteen countries. It was in 2016 at the level of 1990 in two countries. The largest decrease occurred in the Netherlands with an absolute value of 17 kg/head/year. The largest increases occurred in Finland and Latvia with a mean absolute value of 13 kg/head/year.

Figure 5.51: 3.B.2.1 - Non-Dairy Cattle: Trend in nitrogen excretion rate in the EU28+ISL and range of values reported by countries

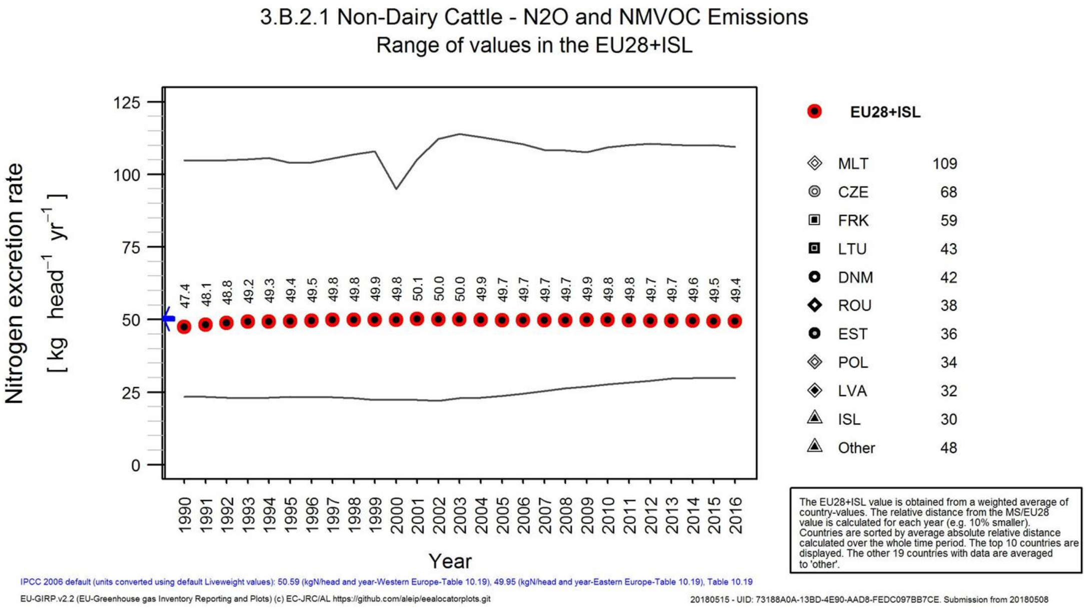


Table 5.37 3.B.2.1 - Non-Dairy Cattle: Member States' and EU28+ISL nitrogen excretion rate (kg/head/year)

Member State	1990	2016		Member State	1990	2016
Austria	40	46	|	Ireland	55	55
Belgium	54	53	|	Iceland		30
Bulgaria	54	58	|	Italy	50	51
Cyprus	42	42	|	Lithuania	41	43
Czech Republic	55	68	|	Luxembourg	45	45
Germany	41	42	|	Latvia	23	32
Denmark	36	42	|	Malta	105	109
Spain	43	41	|	Netherlands	57	40
Estonia	32	36	|	Poland	33	34
Finland	34	51	|	Portugal	44	50
France	57	59	|	Romania	38	38
United Kingdom	48	48	|	Slovakia	40	42
Greece	48	55	|	Slovenia		42
Croatia	55	50	|	Sweden	39	42
Hungary	44	52	|	**EU28+ISL**	**47**	**49**

3.B.2.3 - Swine - Implied emission factor

The implied emission factor for N_2O emissions in source category *3.B.2.3 - Swine* decreased in EU28+ISL considerably between 1990 and 2016 by 20.4% or 0.0146 kg/head/year. Figure 5.52 shows the trend of the implied emission factor in EU28+ISL indicating also the range of values used by the countries. Table 5.38 shows the implied emission factor for N_2O emissions in source category *3.B.2.3 - Swine* for the years 1990 and 2016 for all Member States and EU28+ISL. The implied emission factor decreased in nineteen countries and increased in seven countries. It was in 2016 at the level of 1990 in one country. No data were available for Iceland and the Netherlands. The four countries with the largest decreases were Bulgaria, Estonia and Sweden with a mean absolute value of 0.0097 kg/head/year. The largest increases occurred in Bulgaria and Estonia with a mean absolute value of 0.0073 kg/head/year.

Figure 5.52: 3.B.2.3 - Swine: Trend in implied emission factor in the EU28+ISL and range of values reported by countries

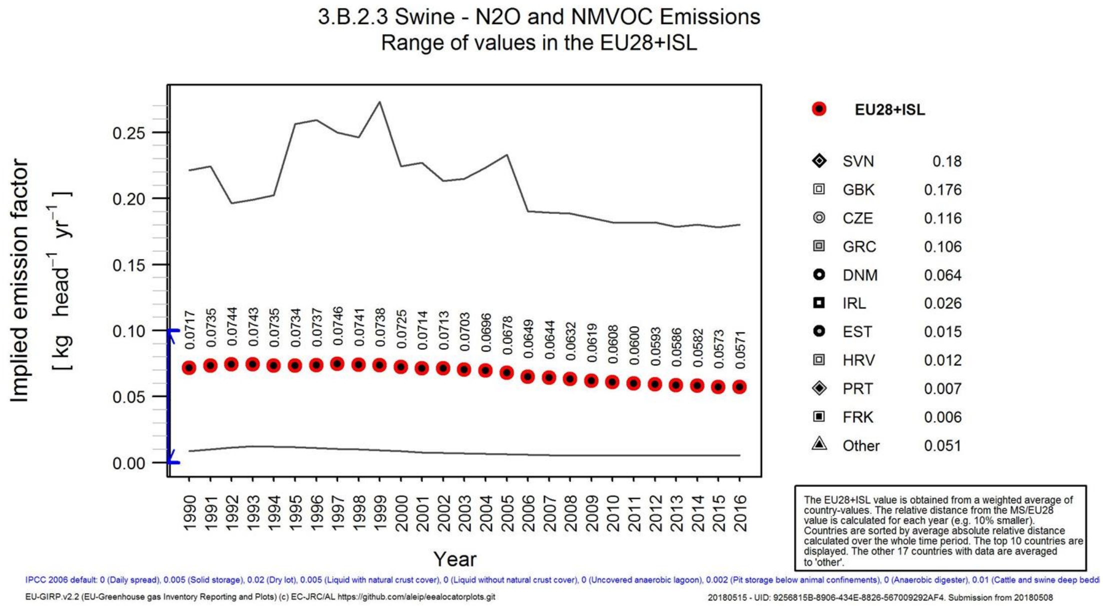


Table 5.38 3.B.2.3 - Swine: Member States' and EU28+ISL implied emission factor (kg/head/year)

Member State	1990	2016		Member State	1990	2016
Austria	0.0541	0.0449	|	Hungary	0.0623	0.0613
Belgium	0.0425	0.0308	|	Ireland	0.0277	0.0263
Bulgaria	0.0079	0.0163	|	Italy	0.0944	0.0721
Cyprus	0.0935	0.0443	|	Lithuania	0.1437	0.0131
Czech Republic	0.1221	0.1162	|	Luxembourg	0.0702	0.0553
Germany	0.0695	0.0801	|	Latvia	0.0964	0.0572
Denmark	0.1440	0.0639	|	Malta	0.0326	0.0329
Spain	0.0469	0.0368	|	Poland	0.0784	0.0812
Estonia	0.0088	0.0150	|	Portugal	0.0145	0.0066
Finland	0.0652	0.0320	|	Romania	0.0402	0.0467
France	0.0124	0.0055	|	Slovakia	0.0881	0.0817
United Kingdom	0.1867	0.1760	|	Slovenia	0.2212	0.1800
Greece	0.1061	0.1061	|	Sweden	0.0626	0.0772
Croatia	0.0549	0.0115	|	**EU28+ISL**	**0.0717**	**0.0571**

3.B.2.3 - Swine - Nitrogen excretion rate

The nitrogen excretion rate, a parameter used for calculating N_2O emissions in source category *3.B.2.3 - Swine*, decreased in EU28+ISL clearly between 1990 and 2016 by 11.9% or 1.41 kg/head/year. Figure 5.53 shows the trend of the nitrogen excretion rate in EU28+ISL indicating also the range of values used by the countries. Table 5.39 shows the nitrogen excretion rate in source category *3.B.2.3 - Swine* for the years 1990 and 2016 for all Member States and EU28+ISL. Nitrogen excretion rate decreased in nineteen countries and increased in six countries. It was in 2016 at the level of 1990 in two countries. No data were available for the United Kingdom and Slovakia. The three countries with the largest decreases were the Netherlands, Denmark and Belgium with a mean absolute value of 4 kg/head/year. The three countries with the largest increases were Sweden, Estonia and Germany with a mean absolute value of 1 kg/head/year.

Sweden explains the large increase by an update of nitrogen production data for sows and pigs in 2002, due to more intense swine production. The time trend also shows steps because surveys are only done biannually and small percentage differences in the survey have a significant effect on emissions, as emission factors are differing considerably between the different systems.

Figure 5.53: 3.B.2.3 - Swine: Trend in nitrogen excretion rate in the EU28+ISL and range of values reported by countries

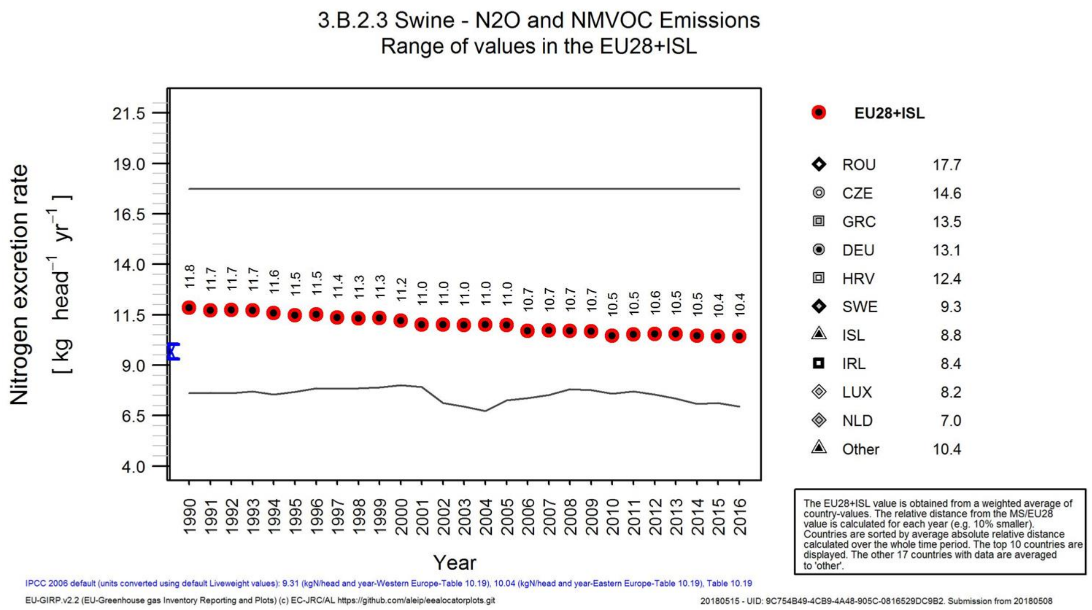


Table 5.39 3.B.2.3 - Swine: Member States' and EU28+ISL nitrogen excretion rate (kg/head/year)

Member State	1990	2016	Member State	1990	2016
Austria	9.6	9.5	Ireland	8.8	8.4
Belgium	12.5	9.3	Iceland	9.2	8.8
Bulgaria	12.5	11.8	Italy	12.0	12.4
Cyprus	11.9	11.3	Lithuania	12.4	11.8
Czech Republic	15.4	14.6	Luxembourg	8.9	8.2
Germany	12.1	13.1	Latvia	12.3	10.7
Denmark	11.9	7.7	Malta	10.4	10.5
Spain	12.1	9.6	Netherlands	10.8	7.0
Estonia	8.9	9.6	Poland	10.0	10.3
Finland	12.2	11.9	Portugal	10.3	9.2
France	10.6	10.0	Romania	17.7	17.7
Greece	13.5	13.5	Slovenia	12.7	12.2
Croatia	13.5	12.4	Sweden	7.6	9.3
Hungary	9.7	9.6	**EU28+ISL**	**11.8**	**10.4**

3.B.2.4.7 - Poultry - Implied emission factor

The implied emission factor for N_2O emissions in source category *3.B.2.4.7 - Poultry* decreased in EU28+ISL considerably between 1990 and 2016 by 15.1% or 0.000399 kg/head/year. Figure 5.54 shows the trend of the implied emission factor in EU28+ISL indicating also the range of values used by the countries. Table 5.40 shows the implied emission factor for N_2O emissions in source category *3.B.2.4.7 - Poultry* for the years 1990 and 2016 for all Member States and EU28+ISL. The implied emission factor decreased in eighteen countries and increased in nine countries. It was in 2016 at the level of 1990 in one country. No data were available for the Netherlands. The largest decreases occurred in Finland and Iceland with a mean absolute value of 0.0066 kg/head/year. The largest increase occurred in Luxembourg with an absolute value of 0.00099 kg/head/year.

Figure 5.54: 3.B.2.4.7 - Poultry: Trend in implied emission factor in the EU28+ISL and range of values reported by countries

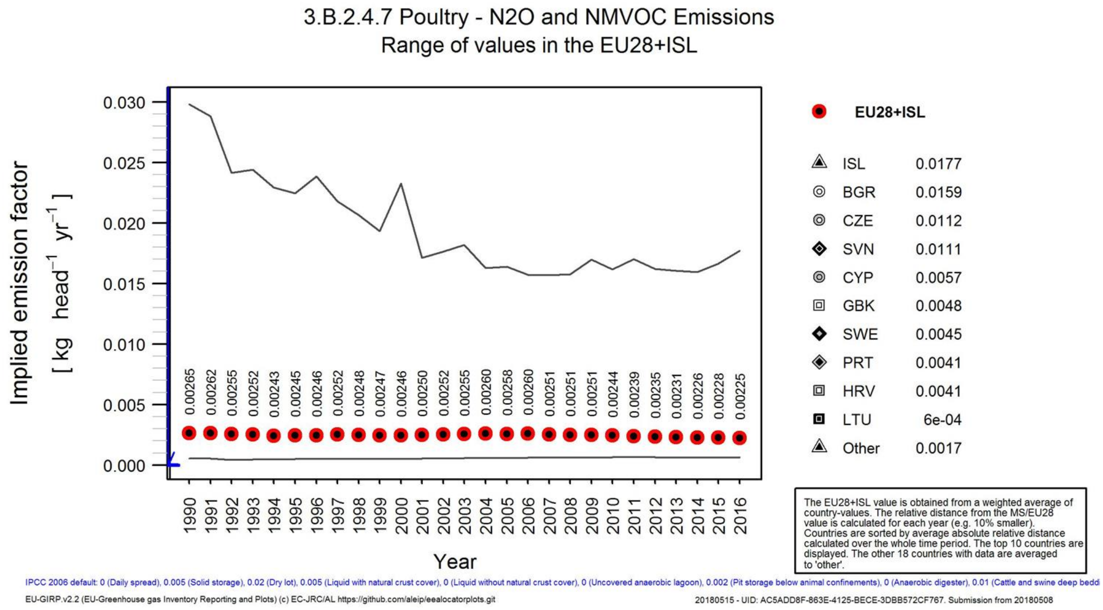


Table 5.40 3.B.2.4.7 - Poultry: Member States' and EU28+ISL implied emission factor (kg/head/year)

Member State	1990	2016		Member State	1990	2016
Austria	0.00092	0.00080	|	Ireland	0.00109	0.00103
Belgium	0.00094	0.00092	|	Iceland	0.02980	0.01771
Bulgaria	0.01585	0.01595	|	Italy	0.00409	0.00395
Cyprus	0.00715	0.00570	|	Lithuania	0.00053	0.00064
Czech Republic	0.01093	0.01125	|	Luxembourg	0.00344	0.00443
Germany	0.00110	0.00129	|	Latvia	0.00342	0.00267
Denmark	0.00112	0.00088	|	Malta	0.00107	0.00111
Spain	0.00112	0.00099	|	Poland	0.00078	0.00072
Estonia	0.00337	0.00330	|	Portugal	0.00435	0.00409
Finland	0.00288	0.00170	|	Romania	0.00119	0.00136
France	0.00074	0.00070	|	Slovakia	0.00181	0.00165
United Kingdom	0.00619	0.00484	|	Slovenia	0.00999	0.01111
Greece	0.00085	0.00085	|	Sweden	0.00473	0.00447
Croatia	0.00471	0.00407	|	**EU28+ISL**	**0.00265**	**0.00225**

Member State	1990	2016		Member State	1990	2016
Hungary	0.00135	0.00152	|			

3.B.2.4.7 - Poultry - Nitrogen excretion rate

The nitrogen excretion rate, a parameter used for calculating N_2O emissions in source category *3.B.2.4.7 - Poultry*, decreased in EU28+ISL moderately between 1990 and 2016 by 7.9% or 0.0503 kg/head/year. Figure 5.55 shows the trend of the nitrogen excretion rate in EU28+ISL indicating also the range of values used by the countries. Table 5.41 shows the nitrogen excretion rate in source category *3.B.2.4.7 - Poultry* for the years 1990 and 2016 for all Member States and EU28+ISL. Nitrogen excretion rate decreased in fifteen countries and increased in eight countries. It was in 2016 at the level of 1990 in five countries. No data were available for the Netherlands. The largest decreases occurred in Iceland and the United Kingdom with a mean absolute value of 0.4 kg/head/year. The largest increase occurred in Luxembourg with an absolute value of 0.1 kg/head/year.

Figure 5.55: 3.B.2.4.7 - Poultry: Trend in nitrogen excretion rate in the EU28+ISL and range of values reported by countries

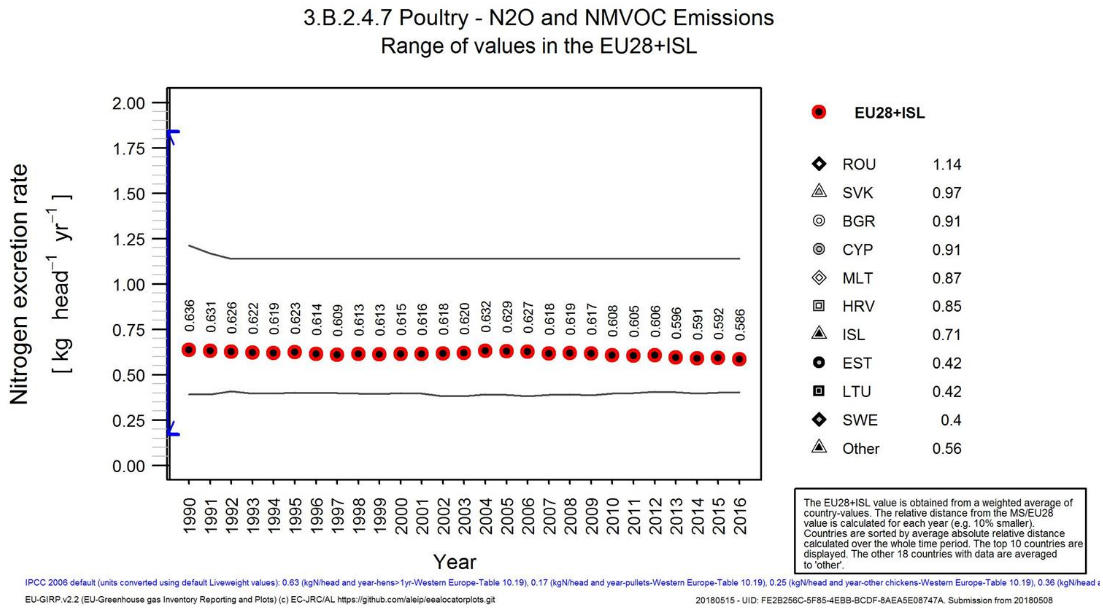


Table 5.41 3.B.2.4.7 - Poultry: Member States' and EU28+ISL nitrogen excretion rate (kg/head/year)

Member State	1990	2016		Member State	1990	2016
Austria	0.59	0.54	|	Ireland	0.60	0.54
Belgium	0.60	0.59	|	Iceland	1.21	0.71
Bulgaria	0.94	0.91	|	Italy	0.52	0.50
Cyprus	0.91	0.91	|	Lithuania	0.39	0.42
Czech Republic	0.73	0.75	|	Luxembourg	0.44	0.56
Germany	0.70	0.73	|	Latvia	0.45	0.45
Denmark	0.63	0.56	|	Malta	0.87	0.87
Spain	0.71	0.63	|	Poland	0.50	0.46
Estonia	0.44	0.42	|	Portugal	0.55	0.53

Member State	1990	2016		Member State	1990	2016
Finland	0.50	0.55	|	Romania	1.14	1.14
France	0.49	0.48	|	Slovakia	0.99	0.97
United Kingdom	0.78	0.58	|	Slovenia	0.47	0.52
Greece	0.50	0.50	|	Sweden	0.43	0.40
Croatia	0.85	0.85	|	**EU28+ISL**	**0.64**	**0.59**
Hungary	0.48	0.56	|			

The implied emission factor for N_2O emissions in source category *3.B.2.5 - Indirect N_2O emissions from manure management* - *Indirect N_2O emissions* decreased in EU28+ISL barely between 1990 and 2016 by 0.2% or 3.17e-05 kg N_2O/kg N. Figure 5.56 shows the trend of the implied emission factor in EU28+ISL indicating also the range of values used by the countries. Table 5.42 shows the implied emission factor for N_2O emissions in source category *3.B.2.5 - Indirect N_2O emissions from manure management* - *Indirect N_2O emissions* for the years 1990 and 2016 for all Member States and EU28+ISL. The implied emission factor decreased in one country and increased in eight countries. It was in 2016 at the level of 1990 in twenty countries. A decrease occurred in Germany with an absolute value of 5.7e-12 kg N_2O/kg N. The largest increase occurred in Malta with an absolute value of 0.0059 kg N_2O/kg N.

Table 5.42 3.B.2.5 - Indirect N_2O emissions from manure management: Member States' and EU28+ISL implied emission factor (kg N_2O/kg N)

Member State	1990	2016		Member State	1990	2016
Austria	0.016	0.016	|	Ireland	0.016	0.016
Belgium	0.016	0.016	|	Iceland	0.016	0.016
Bulgaria	0.016	0.016	|	Italy	0.016	0.016
Cyprus	0.016	0.016	|	Lithuania	0.016	0.016
Czech Republic	0.016	0.016	|	Luxembourg	0.016	0.016
Germany	0.016	0.016	|	Latvia	0.016	0.016
Denmark	0.016	0.016	|	Malta	0.019	0.025
Spain	0.016	0.016	|	Netherlands	0.016	0.016
Estonia	0.016	0.016	|	Poland	0.016	0.016
Finland	0.016	0.016	|	Portugal	0.016	0.016
France	0.016	0.016	|	Romania	0.016	0.016
United Kingdom	0.016	0.016	|	Slovakia	0.016	0.016
Greece	0.016	0.016	|	Slovenia	0.016	0.016
Croatia	0.025	0.025	|	Sweden	0.016	0.016
Hungary	0.016	0.016	|	**EU28+ISL**	**0.016**	**0.016**

3.B.2.5 - Indirect N_2O emissions from leaching from manure management - Implied emission factor

The implied emission factor for N_2O emissions in source category *3.B.2.5 - Indirect N_2O emissions from leaching from manure management* - *Indirect N_2O emissions* increased in EU28+ISL barely between 1990 and 2016 by 0.093% or 1.09e-05 kg N_2O/kg N. Figure 5.56 shows the trend of the implied emission factor in EU28+ISL indicating also the range of values used by the countries. Table 5.42 shows the implied emission factor for N_2O emissions in source category *3.B.2.5 - Indirect N_2O emissions from leaching from manure management* - *Indirect N_2O emissions* for the years 1990 and

2016 for all Member States and EU28+ISL. The implied emission factor decreased in four countries and increased in five countries. It was in 2016 at the level of 1990 in six countries. No data were available for fourteen countries (Austria, Bulgaria, Czech Republic, Germany, Denmark, Croatia, Ireland, Iceland, Luxembourg, Malta, the Netherlands, Slovakia, Slovenia and Sweden). The three countries with the largest decreases were Romania, Estonia and Finland with a mean absolute value of 0.00011 kg N_2O/kg N. The three countries with the largest increases were Cyprus, Poland and France with a mean absolute value of 8.2e-05 kg N_2O/kg N.

Figure 5.57: 3.B.2.5 - Indirect N_2O emissions from leaching from manure management: Trend in implied emission factor in the EU28+ISL and range of values reported by countries

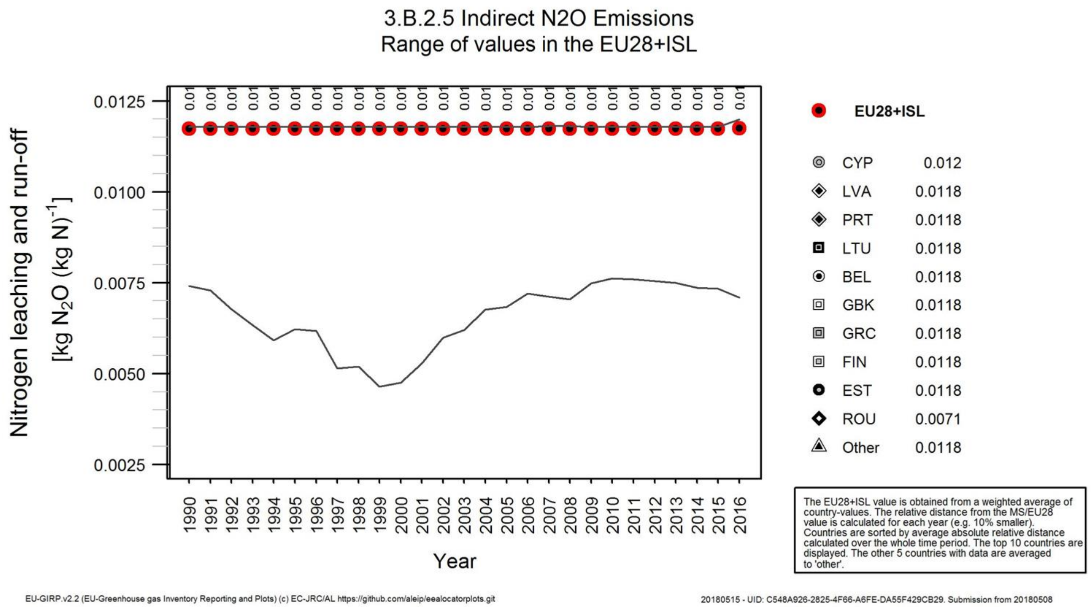


Table 5.43 3.B.2.5 - Indirect N_2O emissions from leaching from manure management: Member States' and EU28+ISL implied emission factor (kg N_2O/kg N)

Member State	1990	2016		Member State	1990	2016
Belgium	0.0118	0.0118	|	Hungary	0.0118	0.0118
Cyprus	0.0118	0.0120	|	Italy	0.0118	0.0118
Spain	0.0118	0.0118	|	Lithuania	0.0118	0.0118
Estonia	0.0118	0.0118	|	Latvia	0.0118	0.0118
Finland	0.0118	0.0118	|	Poland	0.0117	0.0117
France	0.0117	0.0117	|	Portugal	0.0118	0.0118
United Kingdom	0.0118	0.0118	|	Romania	0.0074	0.0071
Greece	0.0118	0.0118	|	**EU28+ISL**	**0.0117**	**0.0117**

5.3.4 Direct Emissions from Managed Soils - N_2O (CRF Source Category 3D1)

N_2O emissions in source category *3.D.1 - Direct N_2O Emissions From Managed Soils* are 2.7% of total EU28+ISL GHG emissions and 51% of total EU28+ISL N_2O emissions. They make 30.2% of total agricultural emissions and 71% of total agricultural N_2O emissions. The main sub-categories are 3.D.1.1 (Inorganic N Fertilisers), 3.D.1.2 (Organic N Fertilisers) and 3.D.1.4 (Crop Residues) as shown in Figure 5.58. Regarding the origin of emissions in the different Member States, Figure 5.59 shows the distribution of direct N_2O emissions from managed soils by emission source in all Member States and in the EU28+ISL. Each bar represents the total emissions of a country in the current emission category, where different shades of blue correspond to the emitting sub-categories.

Figure 5.58: Share of source category 3.D.1 on total EU28+ISL agricultural emissions (left panel) and decomposition into its sub-categories (right panel). The percentages refer to the emissions in the year 2016. Categories 3.D.1.1-3.D.1.5: direct N_2O emissions by N source (inorganic fertilisers, organic fertilisers, urine and dung deposited by grazing animals, crop residues and mineralization of soil organic matter); category 3.D.1.6: cultivation of histosols.

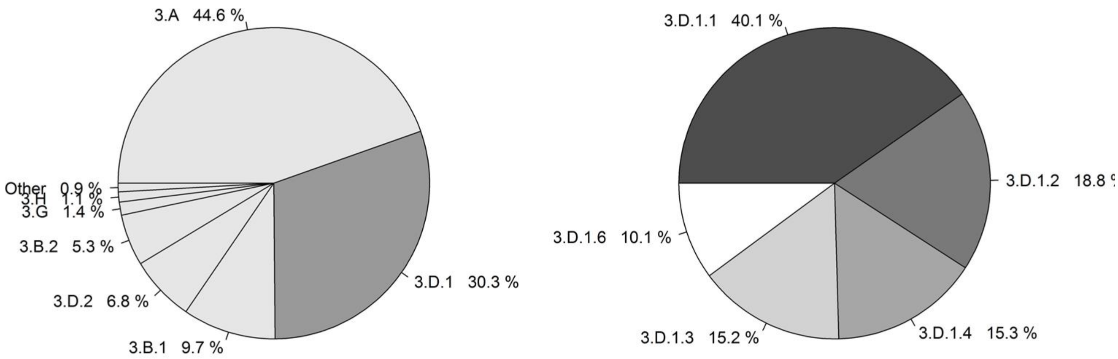
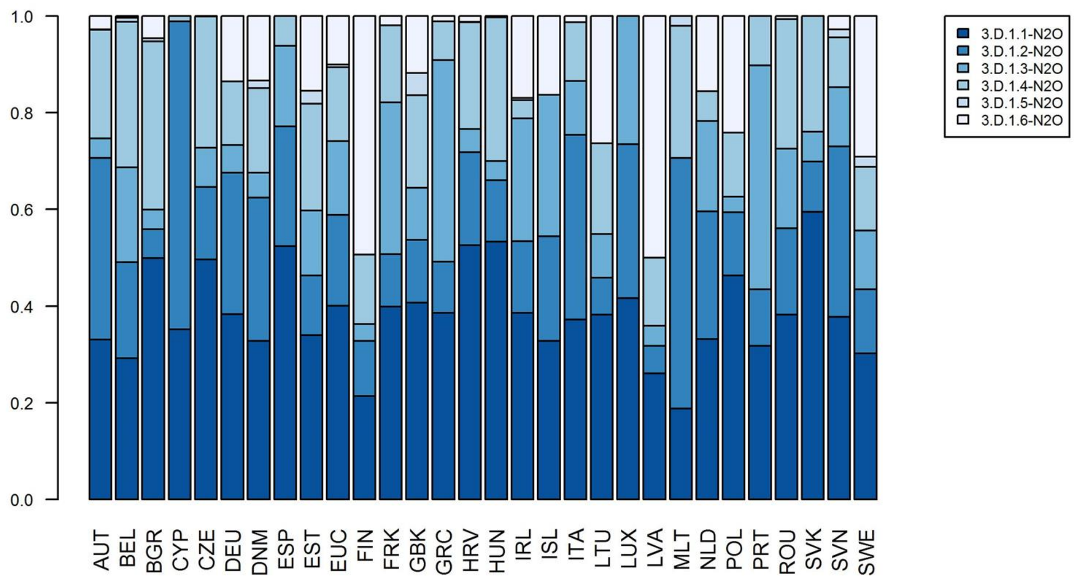


Figure 5.59: Decomposition of emissions in source category 3.D.1 - Direct N_2O Emissions From Managed Soils into its sub-categories by Member State in the year 2016. 3.D.1.1 inorganic N fertilisers, 3.D.1.2 organic N fertilisers, 3.D.1.3 urine and dung deposited by grazing animals, 3.D.1.4 crop residues incorporated in the soil, 3.D.1.5 mineralisation/immobilisation associated with loss/gain of soil organic matter, and 3.D.1.6 cultivation of organic soils (histosols).



Total GHG and N_2O emissions by Member State from 3.D.1 *Direct N_2O Emissions From Managed Soils* are shown in Table 5.44 by Member State plus Iceland, and the total EU-28 and EU-28+ISL for the first and the last year of the inventory (1990 and 2016). Values are given in kt CO_2-eq. Between 1990 and 2016, N_2O emission in this source category decreased by 17% or 25.9 Mt CO_2-eq. The decrease was largest in Slovakia in relative terms (45%) and in Poland in absolute terms (3.5 Mt CO_2-eq). From 2015 to 2016 emissions in the current category no changed by 0%.

Table 5.44 3.D.1 - Direct N_2O Emissions From Managed Soils: Member States' contributions to total EU-GHG and N_2O emissions

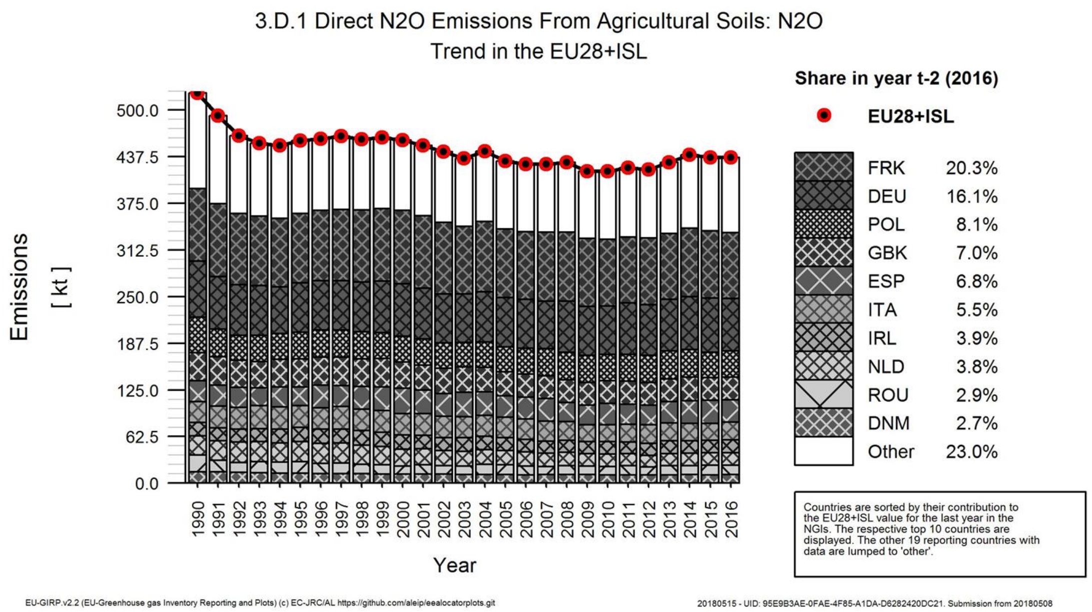
Member States	GHG emissions in 1990 (kt CO_2 equivalents)	GHG emissions in 2016 (kt CO_2 equivalents)	N_2O emissions in 1990 (kt CO_2 equivalents)	N_2O emissions in 2016 (kt CO_2 equivalents)
Austria	1,884	1,793	1,884	1,793
Belgium	3,364	2,500	3,364	2,500
Bulgaria	4,252	3,347	4,252	3,347
Croatia	1,057	813	1,057	813
Cyprus	118	108	118	108
Czech Republic	4,204	2,761	4,204	2,761
Denmark	4,585	3,463	4,585	3,463
Estonia	888	493	888	493
Finland	3,314	3,031	3,314	3,031
France	28,859	26,319	28,859	26,319
Germany	22,428	20,924	22,428	20,924
Greece	3,577	2,246	3,577	2,246
Hungary	3,235	3,211	3,235	3,211
Ireland	5,296	5,063	5,296	5,063
Italy	8,331	7,150	8,331	7,150
Latvia	2,229	1,408	2,229	1,408
Lithuania	2,689	1,965	2,689	1,965
Luxembourg	182	155	182	155
Malta	15	14	15	14
Netherlands	7,621	4,968	7,621	4,968
Poland	14,056	10,557	14,056	10,557
Portugal	1,807	1,676	1,807	1,676
Romania	6,696	3,796	6,696	3,796
Slovakia	1,795	994	1,795	994
Slovenia	336	337	336	337
Spain	8,402	8,777	8,402	8,777
Sweden	3,196	2,883	3,196	2,883
United Kingdom	11,227	9,053	11,227	9,053
EU-28	**155,642**	**129,805**	**155,642**	**129,805**
Iceland	170	154	170	154
EU-28 + ISL	**155,812**	**129,959**	**155,812**	**129,959**

5.3.4.1 Trends in Emissions and Activity Data

3.D.1 - Direct N_2O Emissions From Managed Soils - Emissions

Emissions in source category *3.D.1 - Direct N_2O Emissions From Managed Soils* decreased considerably in EU28+ISL by 17% or 25.9 Mt CO_2-eq in the period 1990 to 2016. Figure 5.60 shows the trend of emissions indicating the countries contributing most to EU28+ISL total. The figure represents the trend in N_2O emissions from direct N_2O emissions from managed soils for the different Member States along the inventory period. The ten countries with the highest emissions accounted together for 77% of the total. Emissions decreased in 27 countries and increased in two countries. The three countries with the largest decreases were Poland, Romania and the Netherlands with a total absolute decrease of 9.1 Mt CO_2-eq. The largest increases occurred in Spain, with a total absolute increase of 375 kt CO_2-eq.

Figure 5.60: 3.D.1 Direct N_2O Emissions From Managed Soils: Trend in emissions in the EU28+ISL and the countries contributing most to EU28+ISL values including their share to EU28+ISL emissions in 2016



The main driving force of direct N_2O emissions from agricultural soils is the use of nitrogen fertiliser and animal manure, which were 23% and 12% below 1990 levels in 2016, 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).

Another policy affecting GHG emissions, in this case through the application of sewage sludge, is the Urban Wastewater Treatment Directive[39]. In the UK, the input from sewage sludge sharply increased in 2001. This is explained by a step in the UK's estimates of sewage sludge collected around 2001, linked to the Urban Wastewater Treatment Directive, which enforced that all large wastewater treatment plants use secondary treatment. This additional treatment reduces the organic load in the effluent, and to achieve this a higher proportion of the organic load in the wastewater treatment plants as sewage sludge. A similar trend is observed in Ireland, where a significant increase (over double) in the quantity of sewage sludge applied to agricultural land took place around 1998 as a result of its diversion away from disposal at solid waste disposal sites.

3.D.1.1 - Direct N_2O emissions from inorganic N fertilisers - Emissions

Emissions in source category *3.D.1.1 - Direct N_2O Emissions From Inorganic N fertilisers* decreased considerably in EU28+ISL by 23% or 16 Mt CO_2-eq in the period 1990 to 2016. Figure 5.61 shows the trend of emissions indicating the countries contributing most to EU28+ISL total. The figure represents the trend in N_2O emissions from inorganic N fertilisers for the different Member States along the

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39 http://ec.europa.eu/environment/water/water-urbanwaste/legislation/directive_en.htm

inventory period. The ten countries with the highest emissions accounted together for 79.3% of the total. Emissions decreased in 27 countries and increased in two countries. The three countries with the largest decreases were the United Kingdom, Germany and France with a total absolute decrease of 6.2 Mt CO_2-eq. The largest increases occurred in Hungary, with a total absolute increase of 35 kt CO_2-eq.

3.D.1.1 - Direct N_2O emissions from inorganic N fertilisers - Application of inorganic fertilisers

Application of inorganic fertilisers decreased considerably in EU28+ISL by 23% or 3.3 kt N/year in the period 1990 to 2016. Figure 5.62 shows the trend of application of inorganic fertilisers indicating the countries contributing most to EU28+ISL total. The figure represents the trend in N_2O application of inorganic fertilisers from inorganic N fertilisers for the different Member States along the inventory period. The ten countries with the highest application of inorganic fertilisers accounted together for 79.9% of the total. Application of inorganic fertilisers decreased in 27 countries and increased in two countries. The three countries with the largest decreases were the United Kingdom, Germany and France with a total absolute decrease of 1.3 kt N/year. The largest increases occurred in Hungary, with a total absolute increase of 7 kt N/year.

Figure 5.61: 3.D.1.1 - Direct N_2O Emissions From Inorganic N fertilisers: Trend in emissions in the EU28+ISL and the countries contributing most to EU28+ISL values including their share to EU28+ISL emissions in 2016

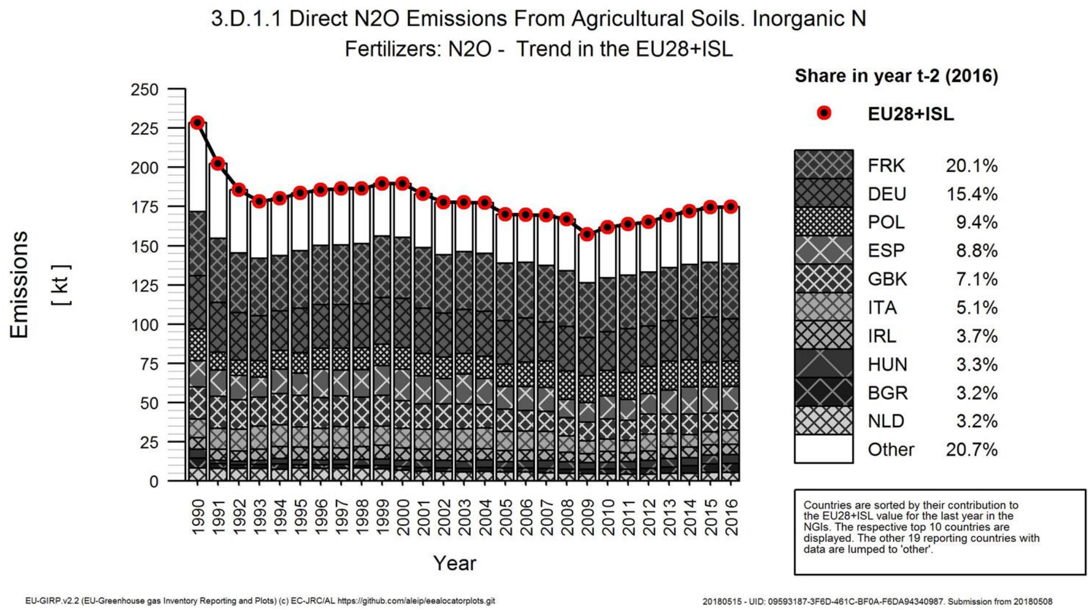
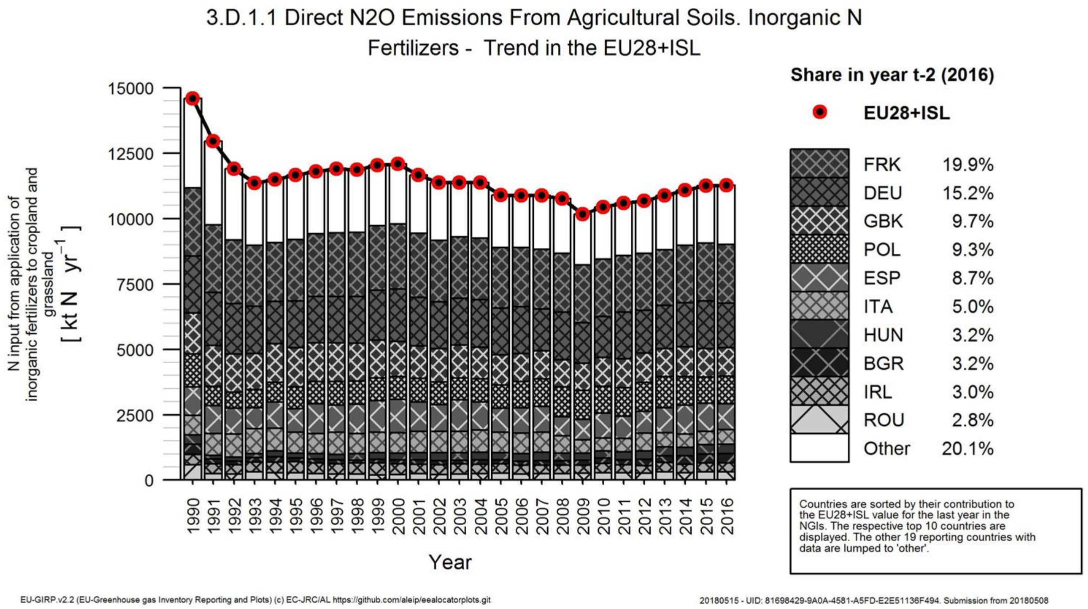


Figure 5.62: 3.D.1.1 - Direct N_2O Emissions From Inorganic N fertilisers: Trend in application of inorganic fertilisers in the EU28+ISL and the countries contributing most to EU28+ISL values including their share to EU28+ISL emissions in 2016



3.D.1.2 - Direct N_2O emissions from organic N fertilisers - Emissions

Emissions in source category *3.D.1.2 - Direct N_2O Emissions from organic N fertilisers* decreased moderately in EU28+ISL by 9.5% or 2.6 Mt CO_2-eq in the period 1990 to 2016. Figure 5.63 shows the trend of emissions indicating the countries contributing most to EU28+ISL total. The figure represents the trend in N_2O emissions from organic N fertilisers for the different Member States along the inventory period. The ten countries with the highest emissions accounted together for 82.9% of the total. Emissions decreased in nineteen countries and increased in ten countries. The four countries with the largest decreases were Romania, Poland, Czech Republic and Bulgaria with a total absolute decrease of 2.7 Mt CO_2-eq. The three countries with the largest increases were Spain, the Netherlands and Germany, with a total absolute increase of 1.7 Mt CO_2-eq.

3.D.1.2 - Direct N_2O emissions from organic N fertilisers - amount of N applied

N from applied organic N fertilisers decreased clearly in EU28+ISL by 12% or 784 kt N/year in the period 1990 to 2016. Figure 5.64 shows the trend of N from applied organic N fertilisers indicating the countries contributing most to EU28+ISL total. The figure represents the trend in N_2O N from applied organic N fertilisers from organic N fertilisers for the different Member States along the inventory period. The ten countries with the highest N from applied organic N fertilisers accounted together for 83.7% of the total. N from applied organic N fertilisers decreased in 21 countries and increased in eight countries. The three countries with the largest decreases were Romania, Poland and Czech Republic with a total absolute decrease of 483 kt N/year. The largest increases occurred in Spain and Germany, with a total absolute increase of 242 kt N/year.

Figure 5.63: 3.D.1.2 - Direct N_2O Emissions From Organic N fertilisers: Trend in emissions in the EU28+ISL and the countries contributing most to EU28+ISL values including their share to EU28+ISL emissions in 2016

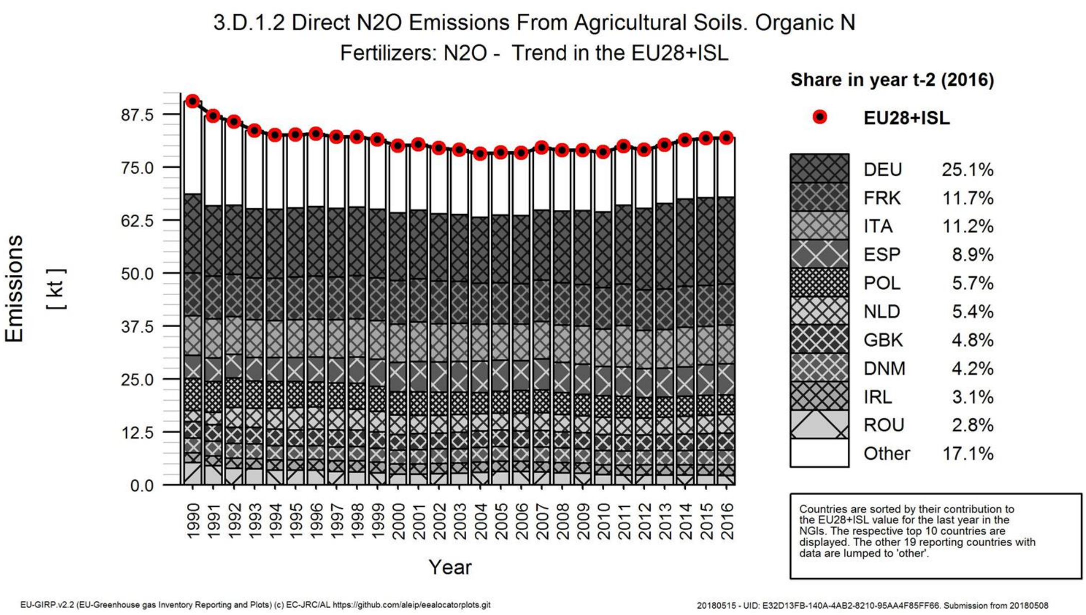
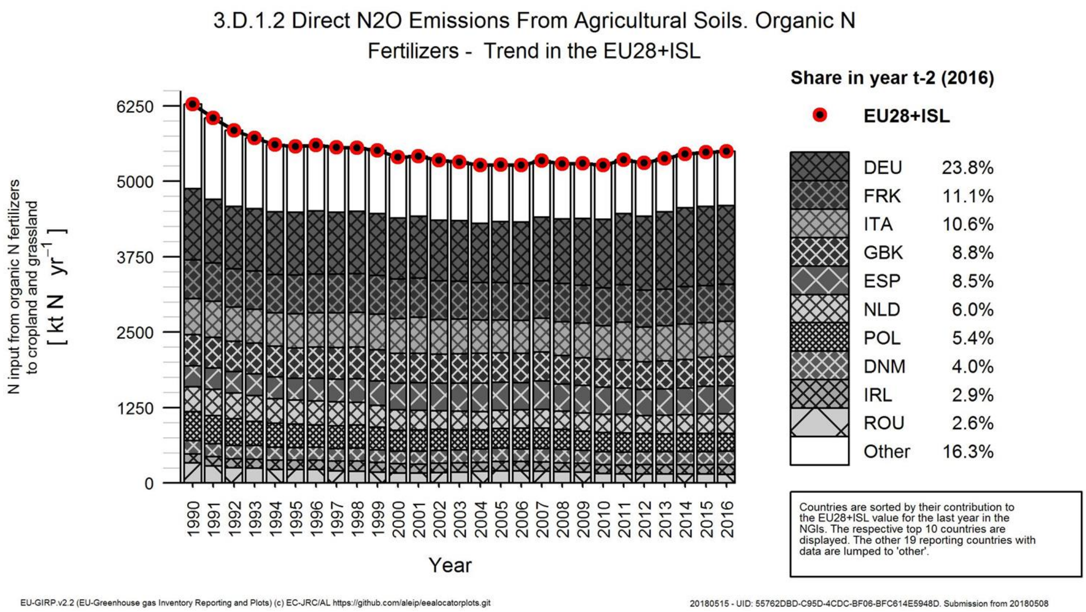


Figure 5.64: 3.D.1.2 - Direct N_2O Emissions From Organic N fertilisers: Trend in emissions in the EU28+ISL and the countries contributing most to EU28+ISL values including their share to EU28+ISL emissions in 2016



3.D.1.3 - Urine and Dung Deposited by Grazing Animals - Emissions

N_2O emissions in source category *3.D.1.3 - Urine and Dung Deposited by Grazing Animals* are 0.41% of total EU28+ISL GHG emissions and 7.8% of total EU28+ISL N_2O emissions. They make 4.6% of total agricultural emissions and 11% of total agricultural N_2O emissions.

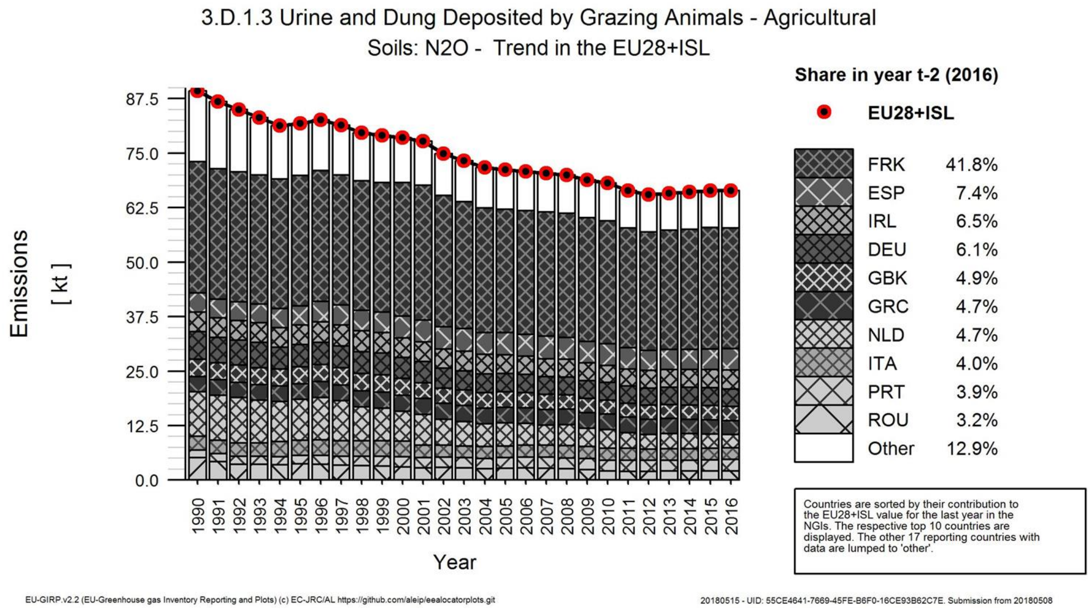
Total GHG and N_2O emissions by Member State from 3.D.1.3 *Grazing Animals* are shown in Table 5.45 by Member State plus Iceland, and the total EU-28 and EU-28+ISL for the first and the last year of the inventory (1990 and 2016). Values are given in kt CO_2-eq. Between 1990 and 2016, N_2O emission in this source category decreased by 26% or 6.8 Mt CO_2-eq. The decrease was largest in

Bulgaria in relative terms (78%) and in the Netherlands in absolute terms (2.1 Mt CO_2-eq). From 2015 to 2016 emissions in the current category no changed by 0%. Figure 5.65 shows the trend of emissions indicating the countries contributing most to EU28+ISL total. The figure represents the trend in N_2O emissions from grazing animals for the different Member States along the inventory period. The ten countries with the highest emissions accounted together for 87.1% of the total. Emissions decreased in 24 countries and increased in three countries. The three countries with the largest decreases were the Netherlands, Romania and France with a total absolute decrease of 3.7 Mt CO_2-eq. The largest increases occurred in Spain and Portugal, with a total absolute increase of 386 kt CO_2-eq.

Table 5.45 3.D.1.3 - Urine and Dung Deposited by Grazing Animals: Member States' contributions to total EU-GHG and N_2O emissions

Member State	N2O Emissions in kt CO2 equiv.			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016		Method	Emission factor Informa-tion
	1990	2015	2016		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	149	73	73	0.4%	-76	-51%	0	1%	T1	D
Belgium	693	491	490	2.5%	-203	-29%	-1	0%	T1	D
Bulgaria	616	136	133	0.7%	-482	-78%	-3	-2%	T1	D
Croatia	106	38	40	0.2%	-66	-63%	2	4%	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czech Republic	236	219	224	1.1%	-13	-5%	4	2%	T1	D
Denmark	298	177	177	0.9%	-121	-41%	0	0%	T1	D
Estonia	170	68	67	0.3%	-104	-61%	-1	-1%	T2	D
Finland	151	110	107	0.5%	-44	-29%	-2	-2%	T1	D
France	8 999	8 279	8 264	41.8%	-734	-8%	-15	0%	T1,T2	D
Germany	1 909	1 211	1 200	6.1%	-709	-37%	-11	-1%	T1	D
Greece	1 059	959	936	4.7%	-123	-12%	-23	-2%	T1	D
Hungary	193	120	127	0.6%	-67	-34%	7	6%	T1	D
Ireland	1 310	1 243	1 284	6.5%	-26	-2%	41	3%	T1	D
Italy	934	779	796	4.0%	-138	-15%	17	2%	T1	CS,D
Latvia	150	55	58	0.3%	-92	-61%	3	5%	T1	D
Lithuania	421	184	177	0.9%	-243	-58%	-7	-4%	T1	D
Luxembourg	42	40	41	0.2%	-1	-2%	1	2%	T1	D
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	3 028	999	927	4.7%	-2 101	-69%	-72	-7%	T1	D
Poland	1 048	348	340	1.7%	-707	-68%	-8	-2%	T1	CS,D
Portugal	538	757	776	3.9%	237	44%	18	2%	T1	D
Romania	1 522	622	625	3.2%	-897	-59%	3	0%	T1	D
Slovakia	137	63	62	0.3%	-75	-55%	-2	-3%	T1	CS
Slovenia	18	40	41	0.2%	23	123%	1	2%	T1	D
Spain	1 310	1 418	1 459	7.4%	149	11%	41	3%	CS,T1	D
Sweden	361	342	351	1.8%	-10	-3%	8	2%	T1	D
United Kingdom	1 168	981	975	4.9%	-194	-17%	-7	-1%	T2	CS
EU-28	**26 567**	**19 754**	**19 749**	**100%**	**-6 818**	**-26%**	**-4**	**-0.02%**	**-**	**-**
Iceland	47	45	45	0.2%	-1	-3%	0	0%	-	-
United Kingdom (KP)	1 168	981	975	4.9%	-194	-17%	-7	-1%	T2	CS
EU-28 + ISL	**26 614**	**19 799**	**19 794**	**100%**	**-6 819**	**-26%**	**-4**	**-0.02%**	**-**	**-**

Figure 5.65: 3.D.1.3 - Urine and Dung Deposited by Grazing Animals: Trend in emissions in the EU28+ISL and the countries contributing most to EU28+ISL values including their share to EU28+ISL emissions in 2016



5.3.4.2 Implied EFs and Methodological Issues

In this section we discuss the implied emission factor for the main N sources contributing to direct N_2O emissions from managed soils.

3.D.1.1 - Direct N_2O Emissions From Inorganic N fertilisers - Implied emission factor

The implied emission factor for N_2O emissions in source category *3.D.1.1 - Direct N_2O Emissions From Inorganic N fertilisers* decreased in EU28+ISL barely between 1990 and 2016 by 0.88% or 8.8e-05 kg N_2O-N/kg N. Figure 5.66 shows the trend of the implied emission factor in EU28+ISL indicating also the range of values used by the countries. Table 5.46 shows the implied emission factor for N_2O emissions in source category *3.D.1.1 - Direct N_2O Emissions From Inorganic N fertilisers* for the years 1990 and 2016 for all Member States and EU28+ISL. The implied emission factor decreased in four countries and increased in four countries. It was in 2016 at the level of 1990 in 21 countries. The three countries with the largest decreases were the United Kingdom, Luxembourg and France with a mean absolute value of 0.00037 kg N_2O-N/kg N. The three countries with the largest increases were Ireland, Cyprus and Belgium with a mean absolute value of 4.6e-05 kg N_2O-N/kg N.

Figure 5.66: 3.D.1.1 - Direct N_2O Emissions From Inorganic N fertilisers: Trend in implied emission factor in the EU28+ISL and range of values reported by countries

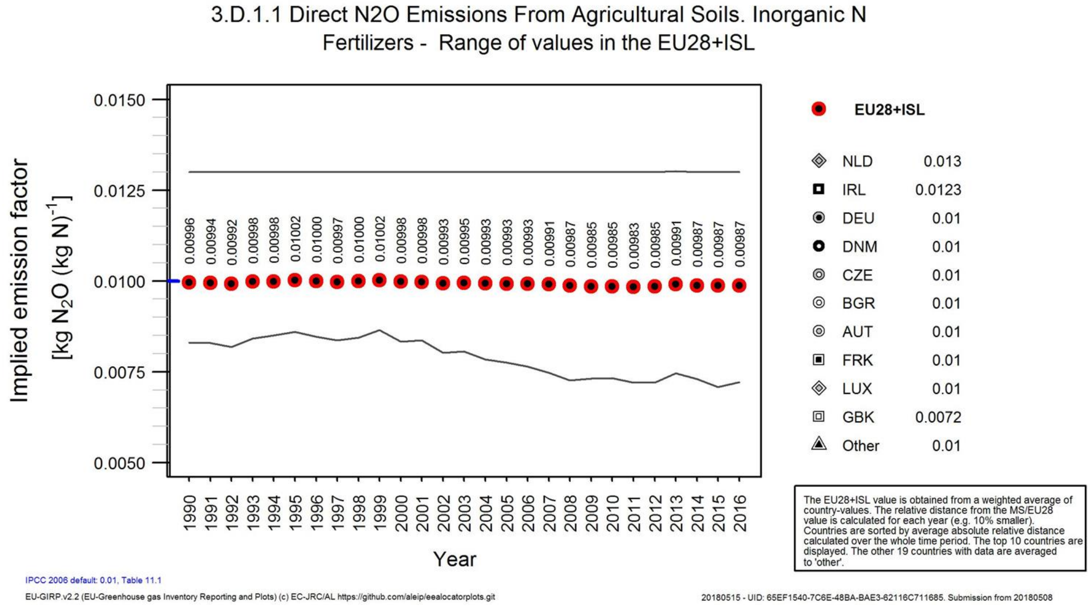


Table 5.46 3.D.1.1 - Direct N_2O Emissions From Inorganic N fertilisers: Member States' and EU28+ISL implied emission factor (kg N_2O-N/kg N)

Member State	1990	2016		Member State	1990	2016
Austria	0.0100	0.0100	|	Ireland	0.0122	0.0123
Belgium	0.0100	0.0100	|	Iceland	0.0100	0.0100
Bulgaria	0.0100	0.0100	|	Italy	0.0100	0.0100
Cyprus	0.0100	0.0100	|	Lithuania	0.0100	0.0100
Czech Republic	0.0100	0.0100	|	Luxembourg	0.0100	0.0100
Germany	0.0100	0.0100	|	Latvia	0.0100	0.0100
Denmark	0.0100	0.0100	|	Malta	0.0100	0.0100
Spain	0.0100	0.0100	|	Netherlands	0.0130	0.0130
Estonia	0.0100	0.0100	|	Poland	0.0100	0.0100
Finland	0.0100	0.0100	|	Portugal	0.0100	0.0100
France	0.0100	0.0100	|	Romania	0.0100	0.0100
United Kingdom	0.0083	0.0072	|	Slovakia	0.0100	0.0100
Greece	0.0100	0.0100	|	Slovenia	0.0100	0.0100
Croatia	0.0100	0.0100	|	Sweden	0.0100	0.0100
Hungary	0.0100	0.0100	|	**EU28+ISL**	**0.0100**	**0.0099**

3.D.1.2 - Direct N_2O Emissions From Organic N fertilisers - Implied emission factor

The implied emission factor for N_2O emissions in source category *3.D.1.2 - Direct N_2O Emissions From Organic N fertilisers* increased in EU28+ISL slightly between 1990 and 2016 by 3.4% or 0.000309 kg N_2O-N/kg N. Figure 5.67 shows the trend of the implied emission factor in EU28+ISL indicating also the range of values used by the countries. Table 5.47 shows the implied emission factor for N_2O emissions in source category *3.D.1.2 - Direct N_2O Emissions From Organic N fertilisers* for the years 1990 and 2016 for all Member States and EU28+ISL. The implied emission factor decreased in four countries and increased in six countries. It was in 2016 at the level of 1990 in nineteen countries. The three countries with the largest decreases were Belgium, Cyprus and France with a mean absolute value of 8.2e-05 kg N_2O-N/kg N. The largest increase occurred in the Netherlands with an absolute value of 0.0045 kg N_2O-N/kg N.

Figure 5.67: 3.D.1.2 - Direct N_2O Emissions From Organic N fertilisers: Trend in implied emission factor in the EU28+ISL and range of values reported by countries

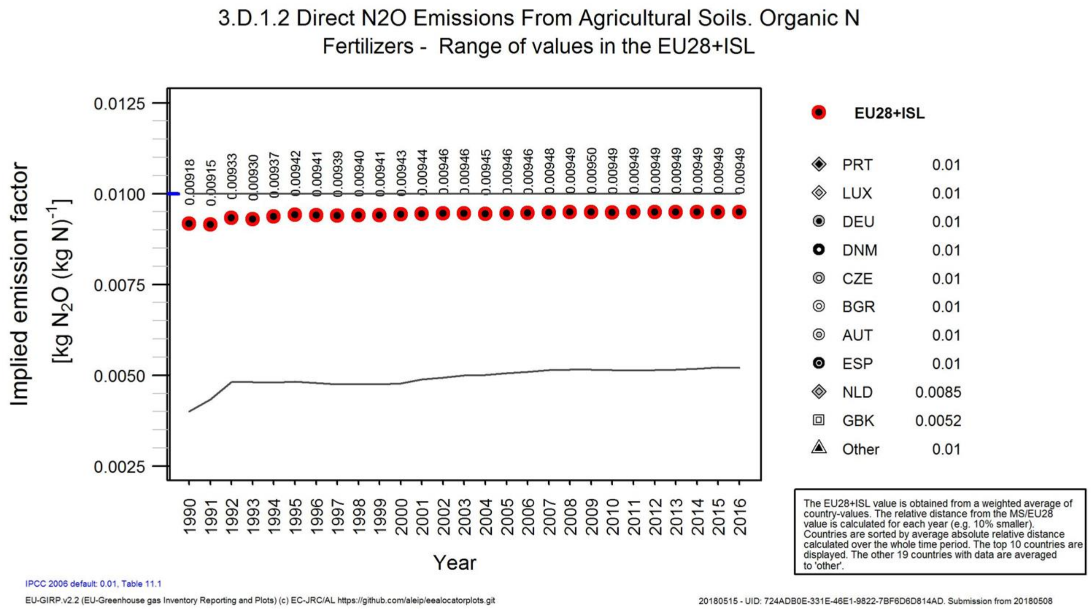


Table 5.47 3.D.1.2 - Direct N_2O Emissions From Organic N fertilisers: Member States' and EU28+ISL implied emission factor (kg N_2O-N/kg N)

Member State	1990	2016		Member State	1990	2016
Austria	0.0100	0.0100	|	Ireland	0.0100	0.0100
Belgium	0.0100	0.0098	|	Iceland	0.0100	0.0100
Bulgaria	0.0100	0.0100	|	Italy	0.0100	0.0100
Cyprus	0.0100	0.0100	|	Lithuania	0.0100	0.0100
Czech Republic	0.0100	0.0100	|	Luxembourg	0.0100	0.0100
Germany	0.0100	0.0100	|	Latvia	0.0100	0.0100
Denmark	0.0100	0.0100	|	Malta	0.0100	0.0100
Spain	0.0100	0.0100	|	Netherlands	0.0040	0.0085
Estonia	0.0100	0.0100	|	Poland	0.0100	0.0100
Finland	0.0100	0.0100	|	Portugal	0.0100	0.0100
France	0.0100	0.0100	|	Romania	0.0100	0.0100
United Kingdom	0.0048	0.0052	|	Slovakia	0.0100	0.0100
Greece	0.0100	0.0100	|	Slovenia	0.0100	0.0100
Croatia	0.0100	0.0100	|	Sweden	0.0100	0.0100
Hungary	0.0100	0.0100	|	**EU28+ISL**	**0.0092**	**0.0095**

3.D.1.3 - Urine and Dung Deposited by Grazing Animals - Implied emission factor

The implied emission factor for N_2O emissions in source category *3.D.1.3 - Urine and Dung Deposited by Grazing Animals* could not be evaluated at EU28+ISL level. Table 5.48 shows the implied emission factor for N_2O emissions in source category *3.D.1.3 - Urine and Dung Deposited by Grazing Animals* for the years 1990 and 2016 for all Member States and EU28+ISL. The implied emission factor decreased in fifteen countries and increased in eleven countries. It was in 2016 at the level of 1990 in one country. No data were available for Cyprus and Malta. The three countries with the largest decreases were Croatia, Austria and Romania with a mean absolute value of 0.0025 kg N_2O-N/kg N. The three countries with the largest increases were Portugal, Poland and Spain with a mean absolute value of 0.0014 kg N_2O-N/kg N.

Table 5.48 3.D.1.3 - Urine and Dung Deposited by Grazing Animals: Member States' implied emission factor (kg N_2O-N/kg N)

Member State	1990	2016		Member State	1990	2016
Austria	0.0182	0.0155	|	Ireland	0.0088	0.0087
Belgium	0.0197	0.0195	|	Iceland	0.0108	0.0111
Bulgaria	0.0120	0.0126	|	Italy	0.0112	0.0111
Czech Republic	0.0174	0.0183	|	Lithuania	0.0190	0.0192
Germany	0.0191	0.0190	|	Luxembourg	0.0197	0.0194
Denmark	0.0187	0.0180	|	Latvia	0.0196	0.0190
Spain	0.0133	0.0143	|	Netherlands	0.0330	0.0330
Estonia	0.0190	0.0185	|	Poland	0.0178	0.0191
Finland	0.0179	0.0169	|	Portugal	0.0163	0.0181
France	0.0185	0.0188	|	Romania	0.0174	0.0149
United Kingdom	0.0045	0.0047	|	Slovakia	0.0165	0.0154
Greece	0.0104	0.0105	|	Slovenia	0.0184	0.0174
Croatia	0.0141	0.0117	|	Sweden	0.0174	0.0170
Hungary	0.0138	0.0146	|			

5.3.5 Indirect Emissions from Managed Soils - N_2O (CRF Source Category 3D2)

N_2O the emissions in source category *3.D.2 - Indirect Emissions from Managed Soils* for N_2O emissions in source category *3.D.2 - Indirect Emissions from Managed Soils* are 0.61% of total EU28+ISL GHG emissions and 12% of total EU28+ISL N_2O emissions. They make 6.8% of total agricultural emissions and 16% of total agricultural N_2O emissions. The main sub-categories are 3.D.2.2 (Nitrogen Leaching and Run-off), and 3.D.2.1 (Atmospheric Deposition) as shown in Figure 5.68. Regarding the origin of emissions in the different Member States, Figure 5.69 shows the distribution of indirect N_2O emissions from managed soils by emission source in all Member States and in the EU28+ISL. Each bar represents the total emissions of a country in the current emission category, where different shades of blue correspond to the emitting sub-categories.

Figure 5.68: Share of source category 3.D.2 on total EU28+ISL agricultural emissions (left panel) and decomposition into its sub-categories (right panel). The percentages refer to the emissions in the year 2016.

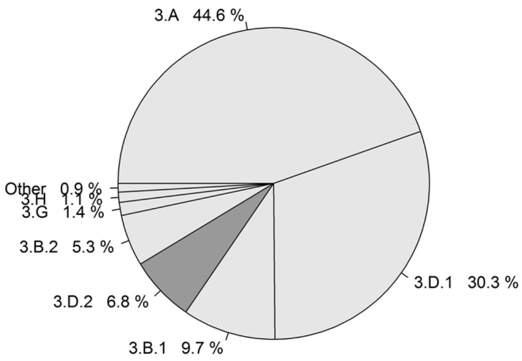
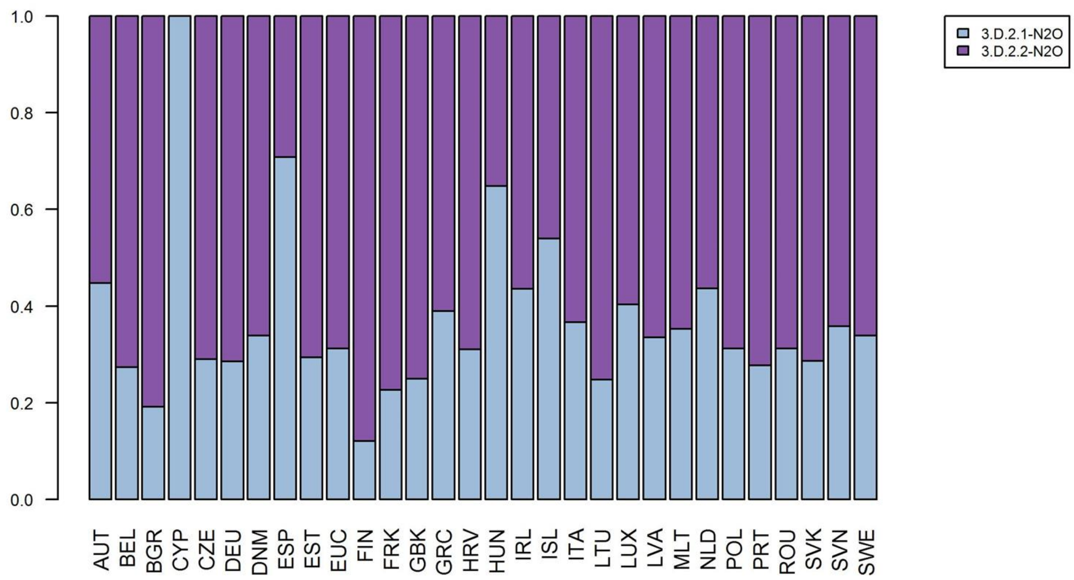


Figure 5.69: Decomposition of emissions in source category 3.D.2 - Indirect Emissions from Managed Soils into its sub-categories by Member State in the year 2016. 3.D.2.1 Atmospheric Deposition and 3.D.2.2 Nitrogen Leaching and Run-off.



Total GHG and N_2O emissions by Member State from 3.D.2 *Indirect Emissions from Managed Soils* are shown in Table 5.49 by Member State plus Iceland, and the total EU-28 and EU-28+ISL for the first and the last year of the inventory (1990 and 2016). Values are given in kt CO_2-eq. Between 1990 and 2016, N_2O emission in this source category decreased by 21% or 7.6 Mt CO_2-eq. The decrease was largest in the Netherlands in relative terms (60%) and in Poland in absolute terms (985 kt CO_2-eq). From 2015 to 2016 emissions in the current category no changed by 0%.

Table 5.49 3.D.2 - Indirect Emissions from Managed Soils: Member States' contributions to total EU-GHG and N_2O emissions

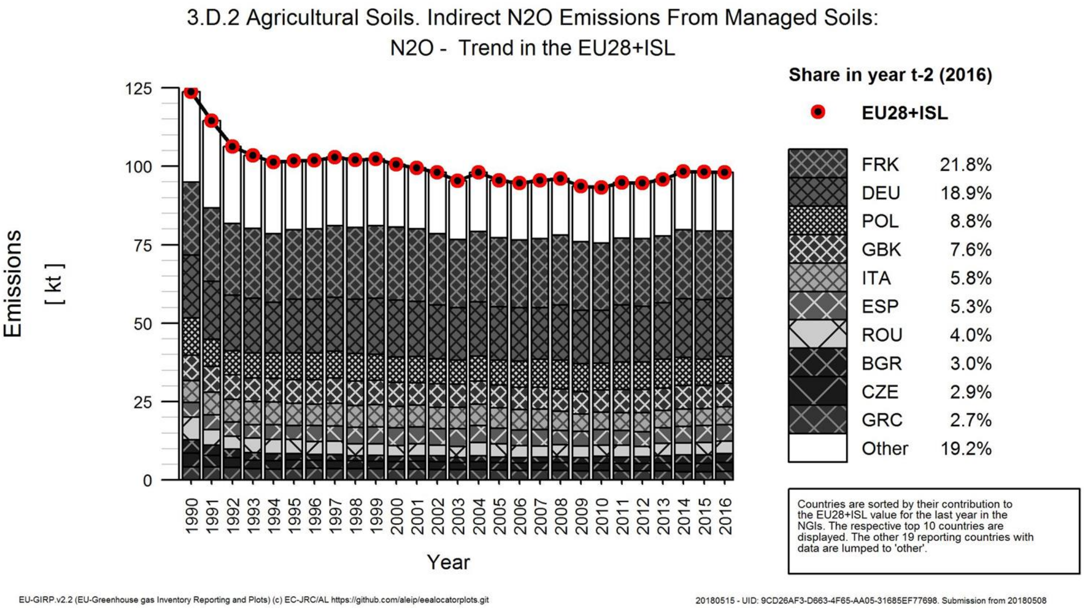
Member State	N2O Emissions in kt CO2 equiv.			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016		Method	Emission factor Informa-tion
	1990	2015	2016		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	363	342	353	1.2%	-10	-3%	12	3%	T1	D
Belgium	1 102	723	692	2.4%	-410	-37%	-31	-4%	T1	D
Bulgaria	1 252	822	881	3.0%	-371	-30%	60	7%	T1	D
Croatia	344	247	260	0.9%	-84	-24%	14	6%	T1	D
Cyprus	16	17	18	0.1%	1	8%	1	5%	T1	D
Czech Republic	1 328	788	843	2.9%	-485	-37%	55	7%	T1	D
Denmark	905	581	567	1.9%	-337	-37%	-13	-2%	T2	D
Estonia	236	129	123	0.4%	-112	-48%	-6	-5%	D,T1	D
Finland	483	389	381	1.3%	-101	-21%	-7	-2%	T1	D
France	6 928	6 499	6 378	21.8%	-549	-8%	-121	-2%	T1,T2	CS,D
Germany	5 964	5 678	5 512	18.9%	-452	-8%	-166	-3%	T1	D
Greece	1 245	785	803	2.7%	-443	-36%	18	2%	T1	D
Hungary	355	258	261	0.9%	-94	-27%	3	1%	T1	D
Ireland	557	516	536	1.8%	-21	-4%	20	4%	T1	CS,D
Italy	2 066	1 611	1 707	5.8%	-359	-17%	96	6%	T1	CS,D
Latvia	312	175	176	0.6%	-137	-44%	0	0%	T1	D
Lithuania	608	427	407	1.4%	-201	-33%	-20	-5%	T1	D
Luxembourg	60	49	51	0.2%	-9	-15%	2	3%	T1	D
Malta	5	5	5	0.0%	0	-9%	0	-3%	T1	D
Netherlands	1 615	630	639	2.2%	-976	-60%	9	1%	T1	D
Poland	3 552	2 476	2 567	8.8%	-985	-28%	91	4%	T2	D
Portugal	499	422	414	1.4%	-84	-17%	-8	-2%	T1,T2	CS,D
Romania	2 151	1 165	1 169	4.0%	-982	-46%	4	0%	T1	D
Slovakia	574	280	307	1.0%	-267	-47%	27	10%	T1	D
Slovenia	112	108	109	0.4%	-3	-3%	0	0%	T1	D
Spain	1 403	1 600	1 554	5.3%	151	11%	-46	-3%	CS,T1,T2	D
Sweden	370	284	281	1.0%	-88	-24%	-2	-1%	CS	D
United Kingdom	2 410	2 212	2 211	7.6%	-198	-8%	-1	0%	T1	D
EU-28	**36 815**	**29 217**	**29 206**	**100%**	**-7 609**	**-21%**	**-11**	**-0.04%**	**-**	**-**
Iceland	33	31	30	0.1%	-3	-9%	-1	-4%	T1b	D
United Kingdom (KP)	2 410	2 212	2 211	7.6%	-198	-8%	-1	0%	T1	D
EU-28 + ISL	**36 847**	**29 248**	**29 236**	**100%**	**-7 612**	**-21%**	**-12**	**-0.04%**	**-**	**-**

5.3.5.1 Trends in Emissions and Activity Data

3.D.2 - Indirect Emissions from Managed Soils - Emissions

Emissions in source category *3.D.2 - Indirect Emissions from Managed Soils* decreased considerably in EU28+ISL by 21% or 7.6 Mt CO_2-eq in the period 1990 to 2016. Figure 5.70 shows the trend of emissions indicating the countries contributing most to EU28+ISL total. The figure represents the trend in N_2O emissions from indirect emissions from managed soils for the different Member States along the inventory period. The ten countries with the highest emissions accounted together for 80.8% of the total. Emissions decreased in 27 countries and increased in two countries. The three countries with the largest decreases were Poland, Romania and the Netherlands with a total absolute decrease of 2.9 Mt CO_2-eq. The largest increases occurred in Spain, with a total absolute increase of 151 kt CO_2-eq.

Figure 5.70: 3.D.2 Indirect Emissions from Managed Soils: Trend in emissions in the EU28+ISL and the countries contributing most to EU28+ISL values including their share to EU28+ISL emissions in 2016



3.D.2.1 - Indirect N_2O Emissions from Atmospheric Deposition - Emissions

Emissions in source category *3.D.2.1 - Indirect N_2O Emissions from Atmospheric Deposition* decreased strongly in EU28+ISL by 26% or 3.2 Mt CO_2-eq in the period 1990 to 2016. Figure 5.71 shows the trend of emissions indicating the countries contributing most to EU28+ISL total. The figure represents the trend in N_2O emissions from atmospheric deposition for the different Member States along the inventory period. The ten countries with the highest emissions accounted together for 80% of the total. Emissions decreased in 26 countries and increased in three countries. The three countries with the largest decreases were the Netherlands, Romania and Poland with a total absolute decrease of 1.5 Mt CO_2-eq. The largest increases occurred in Spain, with a total absolute increase of 72 kt CO_2-eq.

3.D.2.1 - Indirect N_2O Emissions from Atmospheric Deposition - Volatilized N from agricultural N inputs

Volatilized N from agricultural N inputs decreased strongly in EU28+ISL by 26% or 676 kt N/year in the period 1990 to 2016. Figure 5.72 shows the trend of volatilized N from agricultural N inputs indicating the countries contributing most to EU28+ISL total. The figure represents the trend in N_2O volatilized N from agricultural N inputs from atmospheric deposition for the different Member States along the inventory period. The ten countries with the highest volatilized N from agricultural N inputs accounted together for 80.1% of the total. Volatilized N from agricultural N inputs decreased in 26 countries and increased in three countries. The three countries with the largest decreases were the Netherlands, Romania and Poland with a total absolute decrease of 315 kt N/year. The largest increases occurred in Spain, with a total absolute increase of 15 kt N/year.

Figure 5.71: 3.D.2.1 - Indirect N_2O Emissions from Atmospheric Deposition: Trend in emissions in the EU28+ISL and the countries contributing most to EU28+ISL values including their share to EU28+ISL emissions in 2016

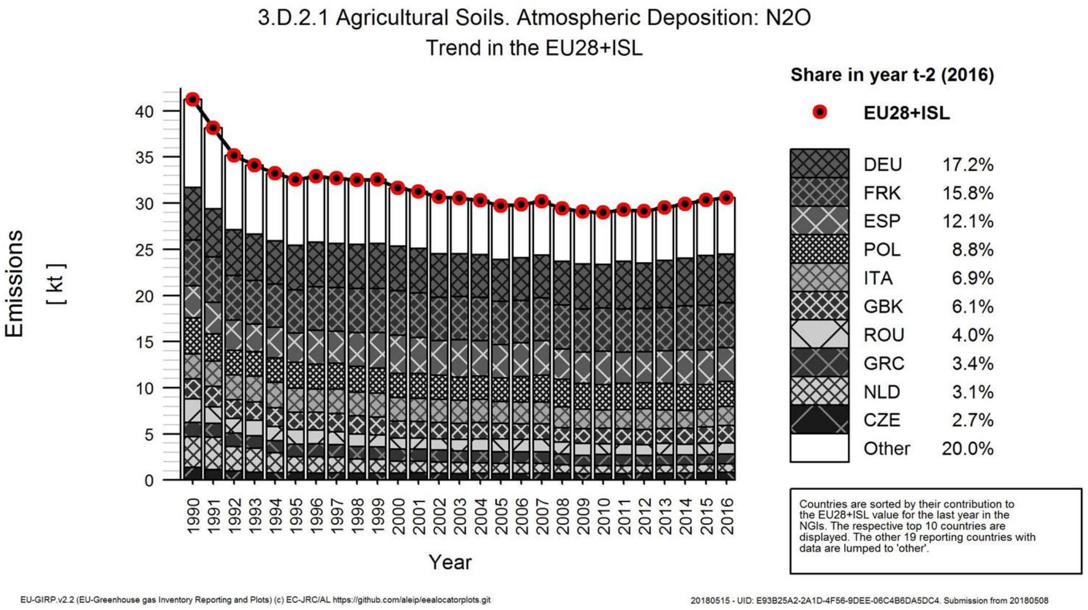
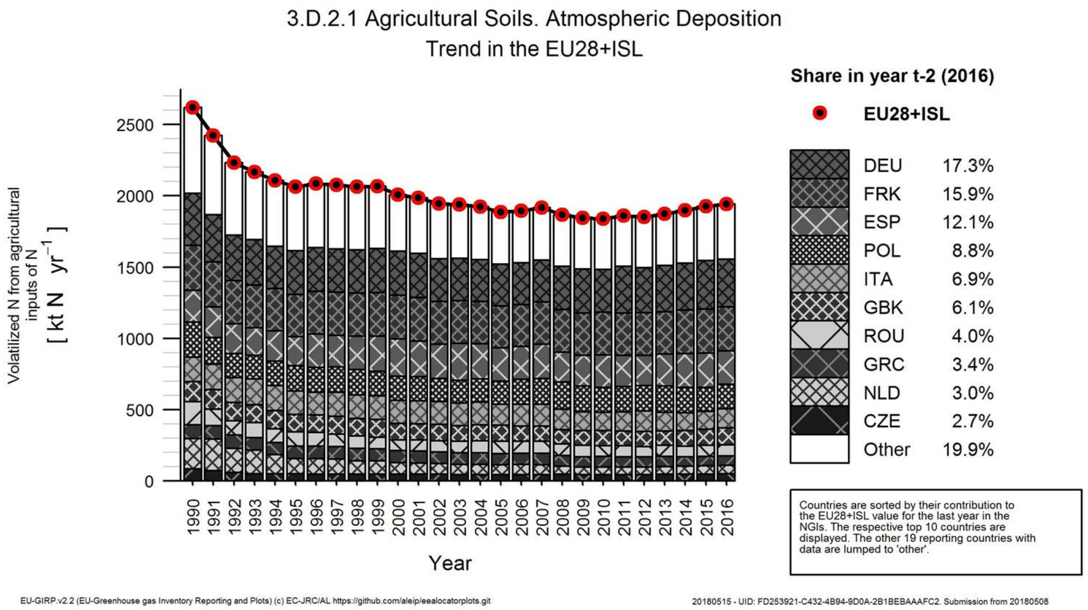


Figure 5.72: 3.D.2.1 - Indirect N_2O Emissions from Atmospheric Deposition: Trend in emissions in the EU28+ISL and the countries contributing most to EU28+ISL values including their share to EU28+ISL emissions in 2016



3.D.2.2 - Indirect N_2O Emissions from Nitrogen leaching and run-off - Emissions

Emissions in source category *3.D.2.2 - Indirect N_2O Emissions from Nitrogen leaching and run-off* decreased considerably in EU28+ISL by 18% or 4.4 Mt CO_2-eq in the period 1990 to 2016. Figure 5.73 shows the trend of emissions indicating the countries contributing most to EU28+ISL total. The figure represents the trend in N_2O emissions for the different Member States along the inventory period. The ten countries with the highest emissions accounted together for 82% of the total. Emissions decreased in 27 countries and increased in one country. The three countries with the largest decreases were Poland, Romania and France with a total absolute decrease of 1.7 Mt CO_2-eq. Emissions increased in Spain, with a total absolute increase of 79 kt CO_2-eq.

3.D.2.2 - Indirect N_2O Emissions from Nitrogen leaching and run-off - N from fertilisers and other agricultural inputs that is lost through leaching and run-off

N from fertilisers and other agricultural inputs that is lost through leaching and run-off decreased considerably in EU28+ISL by 20% or 1.5 kt N/year in the period 1990 to 2016. Figure 5.74 shows the trend of N from fertilisers and other agricultural inputs that is lost through leaching and run-off indicating the countries contributing most to EU28+ISL total. The figure represents the trend in N_2O N from fertilisers and other agricultural inputs that is lost through leaching and run-off for the different Member States along the inventory period. The ten countries with the highest N from fertilisers and other agricultural inputs that is lost through leaching and run-off accounted together for 82.2% of the total. N from fertilisers and other agricultural inputs that is lost through leaching and run-off decreased in 27 countries and increased in one country. The three countries with the largest decreases were Czech Republic, Poland and Romania with a total absolute decrease of 650 kt N/year. N from fertilisers and other agricultural inputs that is lost through leaching and run-off increased in Spain, with a total absolute increase of 22 kt N/year.

Figure 5.73: 3.D.2.2 - Indirect N_2O Emissions from Nitrogen leaching and run-off: Trend in emissions in the EU28+ISL and the countries contributing most to EU28+ISL values including their share to EU28+ISL emissions in 2016

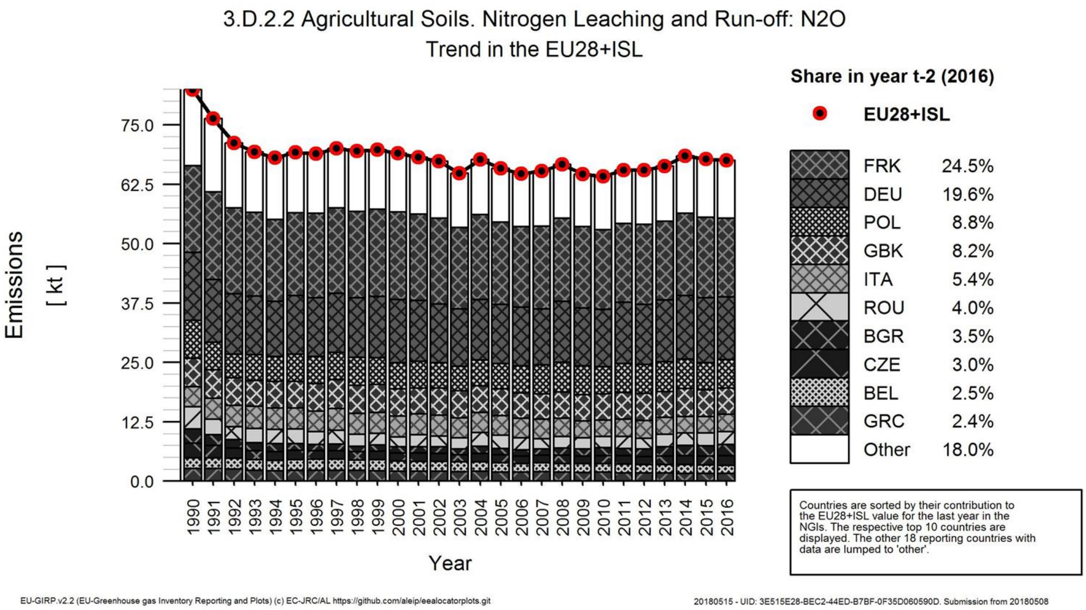
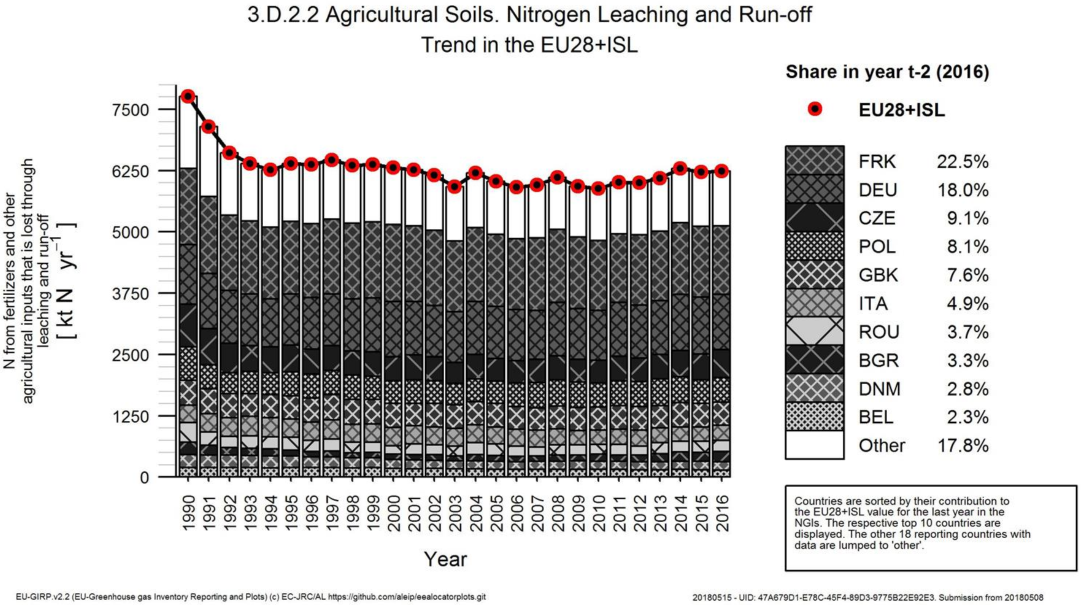


Figure 5.74: 3.D.2.2 - Indirect N_2O Emissions from Nitrogen leaching and run-off: Trend N leached from fertilisers and other agricultural inputs in the EU28+ISL and the countries contributing most to EU28+ISL values including their share to EU28+ISL emissions in 2016



5.3.5.2 Implied EFs and Methodological Issues

In this section we discuss the implied emission factor for the main N sources contributing to indirect N_2O emissions from managed soils. Furthermore, we present the most relevant parameters related with indirect N_2O emissions:

- $Frac_{GASF}$: Fraction of synthetic fertiliser N applied to soils that volatilises as NH_3 and NO_X
- $Frac_{GASM}$: Fraction of livestock N excretion that volatilises as NH_3 and NO_X
- FracLEACH: Fraction of N input to managed soils that is lost through leaching and run-off.

3.D.2.1 - Indirect N_2O Emissions from Atmospheric Deposition

The implied emission factor for N_2O emissions in source category *3.D.2.1 - Indirect N_2O Emissions from Atmospheric Deposition* increased in EU28+ISL barely between 1990 and 2016 by 0.008% or 8.05e-07 kg N_2O-N/kg N. Figure 5.75 shows the trend of the implied emission factor in EU28+ISL indicating also the range of values used by the countries. Table 5.50 shows the implied emission factor for N_2O emissions in source category *3.D.2.1 - Indirect N_2O Emissions from Atmospheric Deposition* for the years 1990 and 2016 for all Member States and EU28+ISL. The implied emission factor decreased in five countries and increased in seven countries. It was in 2016 at the level of 1990 in seventeen countries. The three countries with the largest decreases were Luxembourg, Belgium and Germany with a mean absolute value of 2.6e-08 kg N_2O-N/kg N. The three countries with the largest increases were Cyprus, Slovenia and Czech Republic with a mean absolute value of 0.00022 kg N_2O-N/kg N.

Figure 5.75: 3.D.2.1 - Indirect N_2O Emissions from Atmospheric Deposition: Trend in implied emission factor in the EU28+ISL and range of values reported by countries

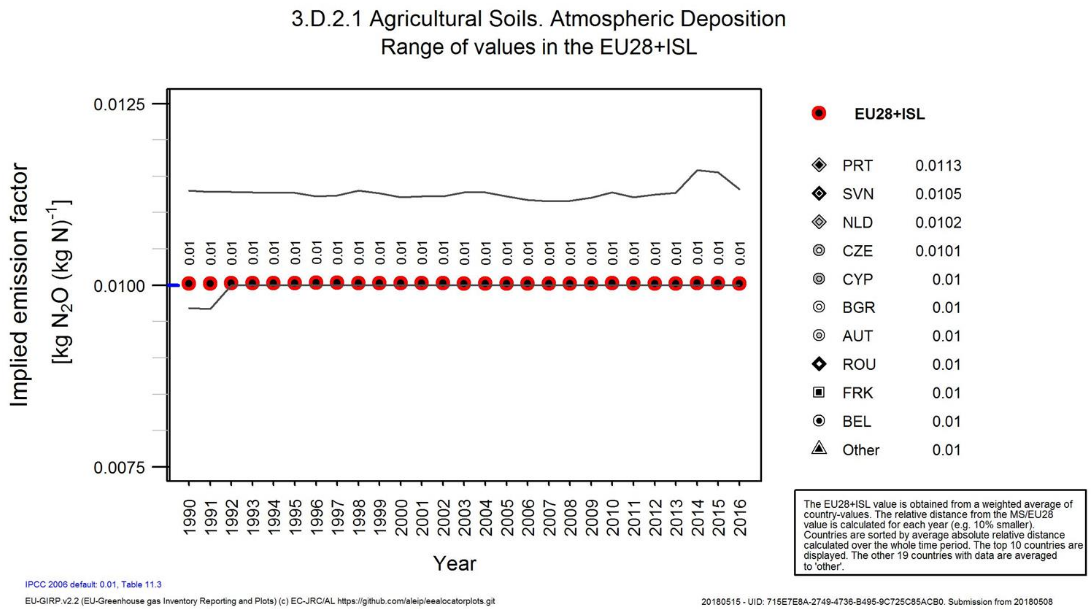


Table 5.50 3.D.2.1 - Indirect N_2O Emissions from Atmospheric Deposition: Member States' and EU28+ISL implied emission factor (kg N_2O-N/kg N)

Member State	1990	2016		Member State	1990	2016
Austria	0.0100	0.010	|	Ireland	0.0100	0.010
Belgium	0.0100	0.010	|	Iceland	0.0100	0.010
Bulgaria	0.0100	0.010	|	Italy	0.0100	0.010
Cyprus	0.0097	0.010	|	Lithuania	0.0100	0.010
Czech Republic	0.0100	0.010	|	Luxembourg	0.0100	0.010
Germany	0.0100	0.010	|	Latvia	0.0100	0.010
Denmark	0.0100	0.010	|	Malta	0.0100	0.010
Spain	0.0100	0.010	|	Netherlands	0.0101	0.010
Estonia	0.0100	0.010	|	Poland	0.0100	0.010
Finland	0.0100	0.010	|	Portugal	0.0113	0.011
France	0.0100	0.010	|	Romania	0.0100	0.010
United Kingdom	0.0100	0.010	|	Slovakia	0.0100	0.010
Greece	0.0100	0.010	|	Slovenia	0.0102	0.010
Croatia	0.0100	0.010	|	Sweden	0.0100	0.010
Hungary	0.0100	0.010	|	**EU28+ISL**	**0.0100**	**0.010**

3.D.2.1 - Indirect emissions from Atmospheric Deposition - FracGASF

The $Frac_{GASF}$, a parameter used for calculating N_2O emissions in source category *3.D.2.1 - Indirect emissions from Atmospheric Deposition*, could not be evaluated at EU28+ISL level. Table 5.51 shows the $Frac_{GASF}$ in source category *3.D.2.1 - Indirect emissions from Atmospheric Deposition* for the years 1990 and 2016 for all Member States and EU28+ISL. The $Frac_{GASF}$ decreased in seven countries and increased in nine countries. It was in 2016 at the level of 1990 in thirteen countries. The largest decrease occurred in Hungary with an absolute value of 0.018. The three countries with the largest increases were Germany, Austria and the United Kingdom with a mean absolute value of 0.014.

Table 5.51 3.D.2.1 - Indirect emissions from Atmospheric Deposition: Member States' $Frac_{GASF}$ (-)

Member State	1990	2016		Member State	1990	2016
Austria	0.041	0.056	|	Ireland	0.030	0.027
Belgium	0.064	0.071	|	Iceland	0.029	0.026
Bulgaria	0.064	0.064	|	Italy	0.089	0.104
Cyprus	0.100	0.100	|	Lithuania	0.063	0.069
Czech Republic	0.100	0.100	|	Luxembourg	0.100	0.100
Germany	0.042	0.060	|	Latvia	0.100	0.100
Denmark	0.059	0.050	|	Malta	0.100	0.100
Spain	0.100	0.100	|	Netherlands	0.040	0.050
Estonia	0.100	0.100	|	Poland	0.100	0.100
Finland	0.016	0.016	|	Portugal	0.063	0.064
France	0.060	0.066	|	Romania	0.100	0.100
United Kingdom	0.034	0.043	|	Slovakia	0.100	0.100
Greece	0.100	0.100	|	Slovenia	0.040	0.040
Croatia	0.100	0.100	|	Sweden	0.022	0.021
Hungary	0.064	0.046	|			

3.D.2.2 - Indirect emissions from Atmospheric Deposition - FracGASM

The $Frac_{GASM}$, a parameter used for calculating N_2O emissions in source category *3.D.2.2 - Indirect emissions from Atmospheric Deposition*, could not be evaluated at EU28+ISL level. Table 5.52 shows the $Frac_{GASM}$ in source category *3.D.2.2 - Indirect emissions from Atmospheric Deposition* for the years 1990 and 2016 for all Member States and EU28+ISL. The $Frac_{GASM}$ decreased in nine countries and increased in five countries. It was in 2016 at the level of 1990 in fourteen countries. No data were available for the Netherlands. The largest decrease occurred in Denmark with an absolute value of 0.1. The three countries with the largest increases were Finland, France and Ireland with a mean absolute value of 0.0077.

Table 5.52 3.D.2.2 - Indirect emissions from Atmospheric Deposition: Member States' $Frac_{GASM}$ (-)

Member State	1990	2016		Member State	1990	2016
Austria	0.176	0.173	|	Hungary	0.186	0.184
Belgium	0.175	0.176	|	Ireland	0.082	0.085
Bulgaria	0.200	0.200	|	Iceland	0.226	0.232
Cyprus	0.200	0.200	|	Italy	0.232	0.209
Czech Republic	0.200	0.200	|	Lithuania	0.200	0.200
Germany	0.196	0.161	|	Luxembourg	0.200	0.200
Denmark	0.141	0.086	|	Latvia	0.200	0.200
Spain	0.200	0.200	|	Malta	0.200	0.200
Estonia	0.200	0.200	|	Poland	0.200	0.200
Finland	0.076	0.087	|	Portugal	0.201	0.162
France	0.095	0.104	|	Romania	0.200	0.200
United Kingdom	0.079	0.077	|	Slovakia	0.200	0.200
Greece	0.200	0.200	|	Slovenia	0.232	0.190
Croatia	0.200	0.200	|	Sweden	0.172	0.162

3.D.2.2 - Indirect N_2O Emissions from Nitrogen leaching and run-off

The implied emission factor for N_2O emissions in source category *3.D.2.2 - Indirect N_2O Emissions from Nitrogen leaching and run-off* increased in EU28+ISL slightly between 1990 and 2016 by 2% or 0.000132 kg N_2O-N/kg N. Figure 5.76 shows the trend of the implied emission factor in EU28+ISL indicating also the range of values used by the countries. Table 5.53 shows the implied emission factor for N_2O emissions in source category *3.D.2.2 - Indirect N_2O Emissions from Nitrogen leaching and run-off* for the years 1990 and 2016 for all Member States and EU28+ISL. The implied emission factor decreased in six countries and increased in three countries. It was in 2016 at the level of 1990 in nineteen countries. No data were available for Cyprus. The three countries with the largest decreases were Slovenia, Belgium and Iceland with a mean absolute value of 1.1e-05 kg N_2O-N/kg N. Increases occurred in Denmark, Luxembourg and the Netherlands with a mean absolute value of 8e-05 kg N_2O-N/kg N.

Figure 5.76: 3.D.2.2 - Indirect N_2O Emissions from Nitrogen leaching and run-off: Trend in implied emission factor in the EU28+ISL and range of values reported by countries

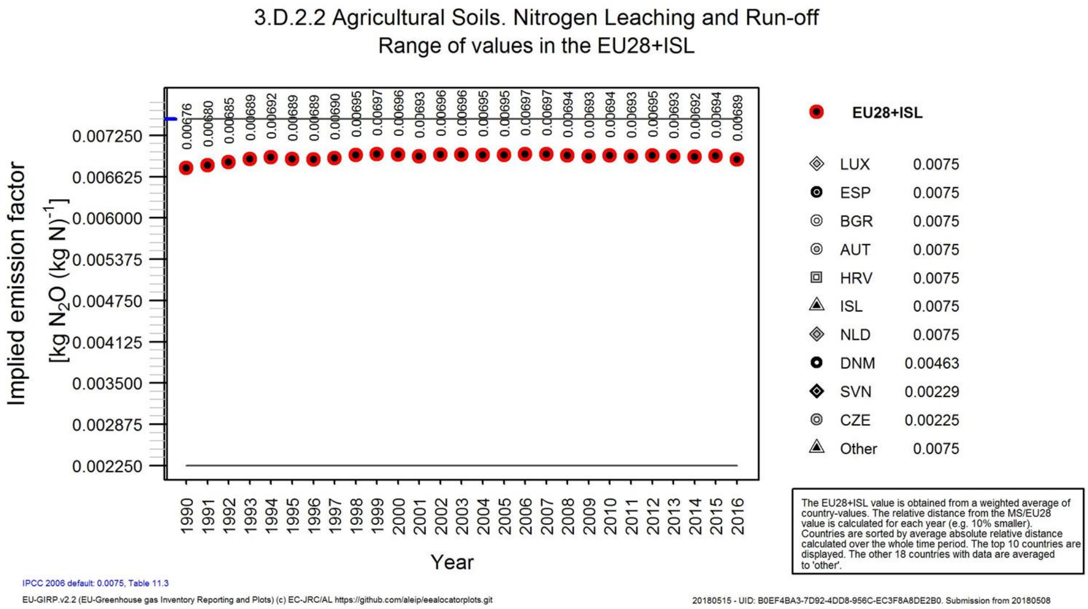


Table 5.53 3.D.2.2 - Indirect N_2O Emissions from Nitrogen leaching and run-off: Member States' and EU28+ISL implied emission factor (kg N_2O-N/kg N)

Member State	1990	2016		Member State	1990	2016
Austria	0.0075	0.0075	|	Iceland	0.0075	0.0075
Belgium	0.0075	0.0075	|	Italy	0.0075	0.0075
Bulgaria	0.0075	0.0075	|	Lithuania	0.0075	0.0075
Czech Republic	0.0022	0.0022	|	Luxembourg	0.0075	0.0075
Germany	0.0075	0.0075	|	Latvia	0.0075	0.0075
Denmark	0.0044	0.0046	|	Malta	0.0075	0.0075
Spain	0.0075	0.0075	|	Netherlands	0.0075	0.0075
Estonia	0.0075	0.0075	|	Poland	0.0075	0.0075
Finland	0.0075	0.0075	|	Portugal	0.0075	0.0075
France	0.0075	0.0075	|	Romania	0.0075	0.0075
United Kingdom	0.0075	0.0075	|	Slovakia	0.0075	0.0075
Greece	0.0075	0.0075	|	Slovenia	0.0023	0.0023
Croatia	0.0075	0.0075	|	Sweden	0.0075	0.0075
Hungary	0.0075	0.0075	|	**EU28+ISL**	**0.0068**	**0.0069**
Ireland	0.0075	0.0075	|			

3.D.2.2 - Indirect emissions from Nitrogen Leaching and Run-off - $Frac_{LEACH}$

The $Frac_{LEACH}$, a parameter used for calculating N_2O emissions in source category *3.D.2.2 - Indirect emissions from Nitrogen Leaching and Run-off*, could not be evaluated at EU28+ISL level. Table 5.54 shows the $Frac_{LEACH}$ in source category *3.D.2.2 - Indirect emissions from Nitrogen Leaching and Run-off* for the years 1990 and 2016 for all Member States and EU28+ISL. $Frac_{LEACH}$ decreased in three countries and increased in two countries. It was in 2016 at the level of 1990 in 22 countries. No data were available for Romania and Cyprus. Decreases occurred in Sweden, Denmark and the Netherlands with a mean absolute value of 0.037. Increases occurred in the United Kingdom and Spain with a mean absolute value of 0.018.

Table 5.54 3.D.2.2 - Indirect emissions from Nitrogen Leaching and Run-off: Member States' $Frac_{LEACH}$ (-)

Member State	1990	2016		Member State	1990	2016
Austria	0.152	0.152	|	Hungary	0.300	0.300
Belgium	0.300	0.300	|	Ireland	0.100	0.100
Bulgaria	0.300	0.300	|	Iceland	0.300	0.300
Cyprus			|	Italy	0.207	0.207
Czech Republic	0.300	0.300	|	Lithuania	0.300	0.300
Germany	0.300	0.300	|	Luxembourg	0.300	0.300
Denmark	0.332	0.278	|	Latvia	0.230	0.230
Spain	0.075	0.082	|	Malta	0.300	0.300
Estonia	0.300	0.300	|	Netherlands	0.150	0.130
Finland	0.300	0.300	|	Poland	0.300	0.300
France	0.300	0.300	|	Portugal	0.300	0.300
United Kingdom	0.169	0.198	|	Slovakia	0.300	0.300
Greece	0.300	0.300	|	Slovenia	0.300	0.300
Croatia	0.300	0.300	|	Sweden	0.166	0.131

5.3.6 Agriculture- non key categories

Table 5.55: aggregated GHG emissions from non key categories in the agriculture sector

EU-28 + ISL	Aggregated GHG emissions in kt CO_2 equ.			Share in sector 3. Agriculture in 2016	Change 1990-2016		Change 2015-2016	
	1990	2015	2016		kt CO_2 equ.	%	kt CO_2 equ.	%
3.A.1 Enteric Fermentation: Growing Cattle (CH4)	5 430	3 164	3 033	0.70%	-2 397	-44%	-131	-4%
3.A.1 Enteric Fermentation: Other Mature Cattle (CH4)	803	637	704	0.16%	-99	-12%	67	11%
3.A.3 Enteric Fermentation: Other Swine (CH4)	5 600	4 326	4 263	0.99%	-1 337	-24%	-63	-1%
3.C.1 Irrigated: Farming (CH4)	2 781	2 603	2 641	0.61%	-140	-5%	38	1%
3.C.2 Rainfed: Farming (CH4)	0.0	0.0	0.0	0.00%	0	0%	0	0%
3.C.3 Deep Water: Farming (CH4)	0.0	0.0	0.0	0.00%	0	0%	0	0%
3.C.4 Other Rice Cultivation: Farming (CH4)	0.0	0.0	0.0	0.00%	0	0%	0	0%
3.E Forest land (specify ecological zone): Farming (CH4)	0.0	0.0	0.0	0.00%	0	0%	0	0%
3.E Forest land (specify ecological zone): Farming (N2O)	0.0	0.0	0.0	0.00%	0	0%	0	0%
3.E Grassland (specify ecological zone): Farming (CH4)	0.0	0.0	0.0	0.00%	0	0%	0	0%
3.E Grassland (specify ecological zone): Farming (N2O)	0.0	0.0	0.0	0.00%	0	0%	0	0%
3.E Prescribed Burning of Savannas: Farming (CH4)	0.0	0.0	0.0	0.00%	0	0%	0	0%
3.E Prescribed Burning of Savannas: Farming (N2O)	0.0	0.0	0.0	0.00%	0	0%	0	0%
3.F.1 Field Burning of Agricultural Residues: Cereals (CH4)	1 023	602	539	0.12%	-484	-47%	-63	-10%
3.F.1 Field Burning of Agricultural Residues: Cereals (N2O)	342	210	187	0.04%	-155	-45%	-23	-11%
3.F.2 Field Burning of Agricultural Residues: Pulses (CH4)	7	0.5	0.4	0.00%	-7	-94%	0	-24%
3.F.2 Field Burning of Agricultural Residues: Pulses (N2O)	2	0.3	0.2	0.00%	-2	-91%	0	-35%
3.F.3 Field Burning of Agricultural Residues: Tubers and Roots (CH4)	478	5	6	0.00%	-472	-99%	1	12%
3.F.3 Field Burning of Agricultural Residues: Tubers and Roots (N2O)	151	2	3	0.00%	-148	-98%	0	20%
3.F.4 Field Burning of Agricultural Residues: Sugar Cane (CH4)	5	1	1	0.00%	-3	-71%	0	-3%
3.F.4 Field Burning of Agricultural Residues: Sugar Cane (N2O)	1	0.4	0.4	0.00%	-1	-71%	0	-3%
3.F.5 Field Burning of Agricultural Residues: Other Agricultural residues (CH4)	651	84	85	0.02%	-566	-87%	0	0%
3.F.5 Field Burning of Agricultural Residues: Other Agricultural residues (N2O)	213	38	39	0.01%	-174	-82%	1	2%
3.G.1 Limestone CaCO3: Farming (CO2)	8 031	4 836	4 790	1.11%	-3 241	-40%	-46	-1%
3.G.2 Dolomite CaMg(CO3)2: Farming (CO2)	2 389	803	1 023	0.24%	-1 366	-57%	220	27%
3.H Urea Application: Farming (CO2)	3 766	4 299	4 532	1.05%	766	20%	234	5%
3.I Other Carbon-containing Fertilizers: Farming (CO2)	564	337	310	0.07%	-254	-45%	-27	-8%
3.J Other agriculture emissions: Farming (CH4)	276	1 555	1 565	0.36%	1 290	468%	11	1%
3.J Other agriculture emissions: Farming (CO2)	3	2	2	0.00%	0	-10%	0	0%
3.J Other agriculture emissions: Farming (N2O)	135	359	361	0.08%	225	167%	2	1%

5.4 Uncertainties

Table 5.56 shows the total EU-28 uncertainty estimates for the sector Agriculture and the uncertainty estimates for the relevant gases of each source category. The highest level uncertainty was estimated for N_2O from 3D and the lowest for CH_4 from sector 3A. With regard to the uncertainty on trend N_2O from sector 3J shows the highest uncertainty estimates, CH_4 from sector 3A the lowest. For a description of the Tier 1 uncertainty analysis carried out for the EU-28 see Chapter 1.6.

Table 5.56 Sector Agriculture: EU-28 uncertainty estimates

Source category	Gas	Emissions 1990	Emissions 2016	Emission trends 1990-2016	Level uncertainty estimates based on MS uncertainty estimates	Trend uncertainty estimates based on MS uncertainty estimates
3.A Enteric Fermentation	CO2	0	0		0.0%	
3.A Enteric Fermentation	CH4	241 698	190 110	-21.3%	12.0%	0.0%
3.A Enteric Fermentation	N2O	6	5	-23.2%	55.9%	0.1%
3.B Manure Mangement	CO2	3	3	14.5%	70.7%	1.1%
3.B Manure Mangement	CH4	52 395	41 485	-20.8%	18.9%	0.0%
3.B Manure Mangement	N2O	31 496	23 679	-24.8%	81.4%	0.1%
3.C Rice Cultivation	CO2	0	0		0.0%	
3.C Rice Cultivation	CH4	2 441	2 201	-9.8%	17.9%	0.0%
3.C Rice Cultivation	N2O	28	26	-5.5%	39.2%	0.0%
3.D Agricultural Soils	CO2	0	0		0.0%	
3.D Agricultural Soils	CH4	0	0		0.0%	
3.D Agricultural Soils	N2O	191 104	158 007	-17.3%	121.6%	0.1%
3.E Prescribed burning of savannas	CO2	0	0		0.0%	
3.E Prescribed burning of savannas	CH4	0	0		0.0%	
3.E Prescribed burning of savannas	N2O	0	0		0.0%	
3.F Field Burning of Agricultural Residues	CO2	0	0		0.0%	
3.F Field Burning of Agricultural Residues	CH4	2 235	631	-71.8%	52.3%	0.3%
3.F Field Burning of Agricultural Residues	N2O	735	229	-68.8%	54.5%	0.3%
3.G Liming	CO2	9 349	5 769	-38.3%	25.9%	0.1%
3.G Liming	CH4	0	0		0.0%	
3.G Liming	N2O	0	0		0.0%	
3.H Urea application	CO2	3 448	4 059	17.7%	17.7%	0.0%
3.H Urea application	CH4	0	0		0.0%	
3.H Urea application	N2O	0	0		0.0%	
3.I Other carbon-containing fertilizers	CO2	494	309	-37.4%	9.8%	0.1%
3.I Other carbon-containing fertilizers	CH4	0	0		0.0%	
3.I Other carbon-containing fertilizers	N2O	0	0		0.0%	
3.J Other	CO2	0	0		0.0%	0.0%
3.J Other	CH4	3	1 360	39448.0%	41.2%	162.6%
3.J Other	N2O	1	267	17742.5%	97.6%	173.1%
3 (where no subsector data were submitted)	all	774	752	-2.8%	0.0%	0.0%
Total - 3	**all**	**536 210**	**428 892**	**-20.0%**	**45.4%**	**2.8%**

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 of the EU-NIR because uncertainty estimates are not available for all source categories in each of this 28 EU Member States

5.5 Sector-specific quality assurance and quality control and verification

5.5.1 Introduction

This section gives an overview of the QA/QC procedures applied specifically for the agriculture sector of the EU GHG inventory. It first gives an overview of the development of the agriculture QA/QC system with an outlook of further improvements to be discussed and/or implemented in coming years. A brief description of the QA/QC procedures used to process the data and interact with the Member States is given.

This is followed by brief summaries of selected activities that have been carried out in the past to improve and/or verify national and EU wide GHG emissions from agriculture in the frame of the EU GHG inventory system. The list is not comprehensive.

5.5.2 Improvements

5.5.2.1 Brief overview of the development of the QA/QC in the agriculture sector

A major revision of the present chapter on methodological issues and uncertainty in the sector agriculture was done for the submission in 2006 giving for the first time a complete overview of all relevant parameters required for the estimation of GHG emissions and the calculation of all background parameter in the CRF tables for agriculture.

The changes were 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 included (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, several errors identified in the background tables of the Member States could be eliminated, thus improving the calculation of EU-wide background information. Further details were added to the inventory report for the submission in 2008, based on recommendations by the Expert Review Team of the in-country review in 2007. For the submissions in 2009 through 2014, background information was further developed.

In 2008, 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 has been complemented by a series of tables giving background information for the estimates of the uncertainty levels for activity data and emission factors.

Over the time, several sections were added describing specific QA/QC and verification activities (see also sections below), such as:

- Summary of the workshop on 'Inventories and Projections of Greenhouse Gas Emissions from Agriculture' (2003)
- Summary of the findings of the GGELS project (Evaluation of the livestock sector's contribution to the EU greenhouse gas emissions.
- A comparison between submissions and data from the FAO GHG database (2014)
- An analysis on the share of manure excretion by IPCC climate zones with EU wide independent data
- A description of the Survey on agricultural production methods (SAPM 2010)
- A summary of the LiveDate project on Nitrogen Excretion factors
- Workshop on improving national inventories for agriculture (2013)
- Comparison of Cultivated Organic Soil at the FAO GHG database and JRC calculations

5.5.2.2 Major changes for the 2015 submissions

The submission in the year 2015 the QA/QC system brought a complete revision of the approach taken for the EU GHG inventory report in general and for the agriculture chapter in particular, driven by the need to adapt to new CRF software, increased number of countries to describe, and a series of new communication software products (e.g. EEA review tool, EU-GIRP). For this purpose, the EU GHG inventory was thoroughly revised. While this was true for the whole EU GHG inventory, this was particularly true for the agriculture sector. The following specific issues with regard to the GHG inventory in the agriculture sector were identified to require improvements:

- Focusing of the agriculture chapter in the EU-GHG inventory report on key categories and factors and parameters which have a significant relevance for EU total emissions.
- The agricultural chapter applied a specific methodology to calculate "Tier levels" and aggregated uncertainties to more accurately account for correlation between the uncertainty estimates of the

individual countries. The methodology was developed for the EU GHG inventory and published in peer-reviewed literature[40]. While this method was shown to provide additional insight for the uncertainty assessment of the EU GHG inventory, it was of no practical relevance for the overall GHG inventory, as a different method was used for other sectors. It was therefore decided to be not continued.

- One major drawback of previous GHG inventories was the difficulties to account for 'other' animal types or nitrogen inputs. With the new data processing framework[41], *all* data are now available so that a comprehensive analysis is possible
- Streamlining with other sector chapters was improved, not the least by using of harmonized plots to present trend-data at EU level while also showing data from those countries contributing most to EU values
- The writing of the agriculture chapter of the EU-GHG inventory report has been highly automated[42]. The process is directly based on the data submitted by the countries and are calculated on the fly thus no quantitative data are introduced 'manually'. This allows to provide a report with quantitative information avoiding inconsistencies with the CRF data.

The newly developed system is described in the section QA/QC system in the agriculture sector.

5.5.2.3 Main improvements since 2016

Since the 2016 submission, the system implemented in 2015 was further developed, providing now some additional 'checks' that identify issues requiring clarification or justification. Particular attention is paid to 'country outlier' and 'time series' checks, as well as to a series of specific checks for the agriculture sector focusing on consistency of the data reported and on the completeness of background data which are important for transparency.

Furthermore, chapters comparing GHG emissions and activity data reported by countries with data from the FAO-STAT data base and the CAPRI model are included.

5.5.2.4 Further improvements

The following further improvements are foreseen for the next submission:

- Further addition of sector-specific checks that could not be performed for the current submission
- Further development of the comparison with FAO and CAPRI data

5.5.3 QA/QC system in the agriculture sector

5.5.3.1 Quality checks

Several quality checks are performed in the EU-GIRP[43] software. They are documented in various modules of EU-GIRP and can be examined in the open source repository. The checks include:

- **Recommendations**: Country were checked if they had implemented last years' recommendations from the ESD review and from the UNFCCC review. From all recommendations, 16 were still unresolved and therefore the corresponding issues were reopened.

[40] Leip, A., 2010. Quantitative quality assessment of the greenhouse gas inventory for agriculture in Europe. Clim. Change. 103, 245-261. doi:http://dx.doi.org/10.1007/s10584-010-9915-5.

[41] EU-GIRP: EU-Greenhouse gas Inventory Reporting and Plots, see https://github.com/aleip/eealocatorplots.git

[42] For an overview of the QA/QC system of the agriculture sector for the 2013 GHG inventory see presentation given for the ICR2013 at https://prezi.com/f1d3elxzd4gn/20131002_icr_agri/

[43] EU-GIRP: EU-Greenhouse gas Inventory Reporting and Plots, see https://github.com/aleip/eealocatorplots.git

- **Check on NEs**[44] and empty cells has been done by extracting all reported 'NE's and the empty cells, respectively, from the data base. The results were compared with the data contained in the file NE_checks_20180122.xlsx provided which also contained a list of empty cells.
- **Notation keys**: we identified emission categories where a Member State reported a notation key, while 20 or more Member States reported emission estimates, in order to assess the potential over/underestimations (these also contained in NE checks in the file above).
- **Outliers in activity data and emissions**: Data were checked on outliers in AD and emissions. For each source category the share of AD and emissions by the countries to total EU28+ISL values were determined. A share above 95% was further assessed and in case this was not linked to a source category which is dominated by single countries (such as emissions from buffalo, which are dominated by Italy) the country was notified
- **Check on erroneous units**: In several case, countries report background data using different units (e.g. fractions instead of percent values or vice versa; values per day instead of per year of vice versa; absolute values instead of values per head etc.). While these inconsistencies do not influence the reported emission estimates, a harmonization (at EU28+ISL level) is important to ensure correct comparison of countries' values and a correct calculation of EU28+ISL background data. An automated check[45] is carried out detecting *seven* cases which can easily be recognised. Other 'mistakes' in units used were detected following the outlier analysis (see below). The countries were notified via the review tool and in many cases corrections have already been implemented.
- **Within-country outliers**: within-country outliers in IEFs and other parameters are detected on the basis of the distribution of the values provided[46]. We used the method based on the mean values and the standard deviation. Specifically, those values were identified as outliers which were more distant from than 1.5 time the standard deviation in the data from the mean (both in positive and negative direction). As an additional criterion, the relation to the median was used. In case the value was within 10% of the median it was not considered as an outlier. This removed cases where a country uses a country-specific parameter while most countries use the default value.
- **Identification of potentially significant issues**: For each of the outliers identified it was determined whether or not this could be a potentially significant issue based on the criterion of a share of 0.05% of national total GHG emissions. The 'size' of the possible over- or under-estimation was quantified comparing the reported value with an estimate using the median IEF or parameter as reported by all countries[47]. All outliers were 'manually' cross-checked and analysed. Countries were notified on the results of the analysis.
- **Time series outliers**: Time series outliers were detected on the basis of the same method as also used for the within-country-outlier check. Basis for the underlying distribution of data in this case, however, was not the values reported from all countries during the whole time series, but only the data reported by the country assessed. Only growth rates larger than ±3% could qualify as 'outliers'. However, this generated a large number of potential outliers which require further assessment. The following types of 'issues' were identified, which might be linked either to an inconsistent time series or be the consequence of 'real' trends:
  - *Period outphased*: Relative constant trend with few years above/below the trend that 'looks plausible'.

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44 https://github.com/aleip/eealocatorplots/blob/master/eugirp_checknes.r

45 https://github.com/aleip/eealocatorplots/blob/master/eugirp_checkunits.r

46 https://github.com/aleip/eealocatorplots/blob/master/eugirp_checkoutliers.r

47 See function `ispotentialissue()` in the file https://github.com/aleip/eealocatorplots/blob/master/eugirp_functions.r

– *Trend break*: Time series in steps, in a stair shape: a few similar values, then a jump, and the same again.

– *One break group trend*: Regular time series with a different trend for a group of years, and a step when jumping from/coming back to the general trend.

– *Inflection point*: Trend suddenly changes from a specific year from which the growth of the values changes sign.

– *Single outlier*: One or few isolated year(s) where the value is out of the general trend

– *Smooth group trend change*: A series of years where the trend changes compared to the rest of the time series, but without any jumps

– *Trend jump*: There is a jump at some point in the time trend but it continues running parallel to the first section, after the jump.

– *Jump and shape*: There is a jump at some point in the time trend and, after the jump, the trend changes shape

• **Sector-specific checks**: Several checks were performed tailored to the reporting in the sector agriculture[48,49]. First, the data are checked on consistency in reporting of activity data throughout the tables. Further, several other tests are performed:

– Difference between the sum of nitrogen excreted and reported in the different manure management system (MMS) versus the total reported nitrogen excreted

– Difference between the total nitrogen excreted and the product of animal population and nitrogen excretion rate

– Difference of the sum of N handled in MMS over animal type vs. total N handled in each MMS

– Check of the reported IEF per MMS with the total N excreted and the reported emissions

– Calculation and evaluation of the IEF in category 3.B.2 by animal type and in relation to the total N excreted

– Check that the sum of manure allocated to climate regions adds up to 100% over all MMS and climate regions

– Check that compares the Manure 'managed' in Pasture Range and Paddock in category 3.B.2 with AD in 3.D.1.3 (Urine and Dung Deposited by Grazing Animals). The sum of FRPR over all animal types should therefore equal the AD in category 3.D.1.3.

– Comparison of the IEF in 3.D.1.3 (N_2O emissions from Urine and Dung Deposited by Grazing Animals) with default IEFs $EF3_{\_RPR\_CPP}$ for Cattle - Pigs and Poultry (0.02) and, $EF3_{\_RPR\_SO}$ for Sheep and other animals (0.01) using the shares $Frac_{RPR\_CPP}$ and $Frac_{RPR\_SO}$ of manure deposited by the two animal groups.

– Comparison of the fraction of N lost in MMS (via volatilization of NH_3+NO_x) versus total managed manure. According to IPCC Table 50.22 most of the loss fractions are between 20% and 45% of N in managed manure and N loss ratios are identified that are higher than 45% or lower than 20%.

48 https://github.com/aleip/eealocatorplots/blob/master/agrichecks1ADs.r

49 https://github.com/aleip/eealocatorplots/blob/master/agrichecks2Nex.r

– Comparison of the manure 'managed' and not lost as NH_3+NO_x or leaching in MMS (3B2) with Animal manure applied to soil (3D12a). Manure available for application is obtained from N managed in MMS and not lost ($Frac_{LOSSMS}$) according to Table 50.23 plus any addition of bedding material. The loss fractions in Table 50.23 include also losses of N2, which are not included in the indirect emissions-volatilisation. Therefore, FAM is expected to be smaller than N managed in MMS minus N lost as NH_3+NO_x+leaching unless bedding material has been accounted for. In case of crop residues as bedding material care has to be taken to avoid double counting.

- **Recalculation**: Countries were asked for justifications of recalculations of more than 0.05% of national total emissions (excluding LULUCF) for years 1990 and 2016, focusing on key categories.

A much lower number of issues were identified, compared to last year (340 issues were identified in 2017):

- 12 completeness issues (related to 'NE'/'empty'/'notation keys')
- 11 country-outlier issues
- 14 recalculation issues
- 17 time trend issues
- 18 recommendations
- 34 agricheck issues
- 20 other issues (wrong units, same values reported for 2015 and 2016)

The status of responses as of May 16, 2018 is given in Table 5.57:

Table 5.57 Status of issues as of May 16, 2018

Check	Total number of issues	Resolved	Partly resolved	Unresolved
Completeness	12	33%	50%	17%
Outliers	11	36%	36%	27%
Recalculations	14	79%	7%	14%
Time series	17	81%	19%	0%
Recommendations	18	31%	63%	6%
Agrichecks	34	32%	26%	41%
Units/other	20	71%	29%	0%

All issues had been responded by May 16, 2018, being the time series the type of issues with the highest percentage of resolution, followed by the recalculations. Most of the time series and the recalculation issues required just an explanation and some of the recalculations were due to mistakes which have mostly been corrected. The agrichecks are the type of issues with the highest share of questions still unresolved, often requiring detailed information which sometimes the countries cannot easily obtain. Similarly happens with the recommendations, 63% of which have not been resolved yet but countries are working on getting the necessary data for the resolution of the issues. Regarding outliers, 63% of the issues are still partly resolved or unresolved, probably needing more time to justify.

5.5.3.2 Calculation of EU background data

EU-wide background data were calculated as weighted averages of the parameters provided by the countries, using activity data (animal numbers in category 3A and 3B and N input in category 3D) as weighting factors[50].

Care is being taken to not include in the calculation erroneous values:

- Data which had been identified as being reported with a different unit than the values reported by other countries (see above) were *converted* into the appropriate unit before calculating EU28+ISL weighted averages
- Data which *obviously* wrong (very large outliers) but for which no clear correction could be identified were *eliminated* from the calculation of the EU28+ISL weighted averages to avoid biases in the results. Therefore, the EU28+ISL weighted averages - in some cases - could not represent 100% of EU28+ISL activity data.

5.5.3.3 Compilation of the chapter agriculture for the EU-GHG inventory report

The agriculture chapter of the EU-GHG inventory report takes advantage of the data base generated by EU-GIRP. All numeric data presented in the chapter are calculated directly using the processed data as described above, thus eliminating the risk of transcription or copy errors. This does not eliminate the possibility of mistakes completely. Therefore, all values are cross-checked.

5.5.4 Workshops and activities to improve the quality of the inventory in agriculture

5.5.4.1 Workshop on 'Inventories and Projections of Greenhouse Gas Emissions from Agriculture' (2003)

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

50 https://github.com/aleip/eealocatorplots/blob/master/eugirp_euweightedaverages.r

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.

The workshop report including the Recommendations formulated at the workshop are available here[51]

5.5.4.2 Survey on agricultural production methods (SAPM 2010)

The Survey on agricultural production methods, abbreviated as SAPM, is a once-only survey carried out in 2010 to collect data at farm level on agri-environmental measures. EU Member States could choose whether to carry out the SAPM as a sample survey or as a census survey. Data were collected on tillage methods, soil conservation, landscape features, animal grazing, animal housing, manure application, manure storage and treatment facilities and irrigation. With reference to irrigation, Member States were asked to provide estimation (possibly by means of models) of the volume of water used for irrigation on the agricultural holding.

The characteristics that were collected are given in the Regulation (EC) No 1166/2008 of the European Parliament and of the Council 19 November 2008 on farm structure surveys[52] and the survey on agricultural production methods and further defined in the Commission Regulation (EC) No 1200/2009 of 30 November 2009 implementing Regulation (EC) No 1166/2008 of the European Parliament and of the Council on farm structure surveys and the survey on agricultural production methods, as regards livestock unit coefficients and definitions of the characteristics[53].

A list of characteristics of potential relevance for the quantification of GHG emissions is given in Table 5.58.

[51] Leip, A., 2005. N2O emissions from agriculture. Report on the expert meeting on 'improving the quality for greenhouse gas emission inventories for category 4D', Joint Research Centre, 21-22 October 2004, Ispra. Office for Official Publication of the European Communities, Luxembourg. doi:http://dx.doi.org/10.13140/RG.2.1.4706.7607.

[52] http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:32008R1166

[53] http://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1448050507039&uri=CELEX:32009R1200

Table 5.58 Selected characteristics included in the 'Survey on agricultural production methods' (SAPM)

Characteristic			Units/categories
Animal Grazing	Grazing on holding	Area grazed during the last year	ha
		Amount of time when animals are outdoors on pasture	Month per year
	Common land grazing	Total number of animals grazing on common land	Head
		Amount of time when animals are grazing on common land	Month per year
Animal housing	Cattle	Stanchion-tied table - with solid dung and liquid manure	Places
		Stanchion-tied table - with slurry	Places
		Loose housing - with solid dung and liquid manure	Places
		Loose housing - with slurry	Places
		Other	Places
	Pigs	On partially slatted floors	Places
		On completely slatted floors	Places
		On straw beds (deep litter housing)	Places
		Other	Places
	Laying hens	On straw beds (deep litter housing)	Places
		Battery cage (all types)	Places
		Battery cage with manure belt	Places
		Battery cage with deep pit	Places
		Battery cage with stilt house	Places
		Other	Places
Manure application	Used agricultural area on which solid/farmyard manure is applied	Total	UAA % band (2)
	Used agricultural area on which solid/farmyard manure is applied	With immediate incorporation	UAA % band (2)
	Used agricultural area on which slurry is applied	Total	UAA % band (2)
	Used agricultural area on which slurry is applied	With immediate incorporation	UAA % band (2)
	Percent of the total produced manure exported from the holding		Percentage band (3)

Characteristic			Units/categories
Manure storage and treatment facilities	Storage facilities for:	Solid dung	Yes/No
		Liquid manure	Yes/No
		Slurry: Slurry tank	Yes/No
		Slurry: Lagoon	Yes/No
	Are the storage facilities covered?	Solid dung	Yes/No
		Solid dung	Yes/No
		Slurry	Yes/No

Note 1: Utilised agricultural area (UAA) percentage band: (0), (> 0-< 25), (=25-< 50), (=50-< 75), (=75)

Note 2: Percentage band: (0), (> 0-< 25), (=25-< 50), (=50-< 75), (=75).

5.5.4.3 The LiveDate project on Nitrogen Excretion factors

The key indicator 'Gross Nutrient Balance' (GNB) is part of the set of agri-environmental indicators defined in the Commission Communication on the "Development of agri-environmental indicators for monitoring the integration of environmental concerns into the common agricultural policy"[54]. The Eurostat/OECD Methodology and Handbook on Nutrient Budgets has been updated and amended in 2013[55]. Nitrogen excretion coefficients have been identified of a major source of uncertainty for the estimation of the GNB, with high relevance for other reporting obligations, including the nitrate directive, reporting of ammonia emissions under the CLRTAP and the NEC directive, as well (and importantly) for the quantification of N_2O emissions from manure management and agricultural soils. An expert workshop was therefore organized on 28/03/2014 at Eurostat to discuss the possibility to improve the quality of N-excretion data by using a common improved methodology. A recommendation on such a common methodology served as the basis for discussion. The workshop was co-organized by JRC under the WG on Annual GHG inventories under the EU Climate Change Committee and was attended by agricultural experts of the EU GHG inventory system.

The following gives some information on the project that prepared the recommendations, as extracted from the report from Oenema et al. (2014)[56].

The general objective of the study "Nitrogen and phosphorus excretion coefficients for livestock; Methodological studies in the field of Agro-Environmental Indicators; Lot1" (2012/S 87-142068) is "to bring clarity into the issue of excretion coefficients so that a recommendation on a single, common methodology to calculate N and P excretion coefficients can be identified". The recommendation for a uniform and standard methodology for estimating N and P excretion coefficients must be based on a thorough analysis of the strength and weaknesses of the existing methodologies and on the data availability and quality in the Member States.

The specific objectives of the study were:

- To create an overview of the different methodologies used in Europe to calculate excretion factors for N and P, and analyse their strengths and weaknesses;

54 http://epp.eurostat.ec.europa.eu/portal/page/portal/agri_environmental_indicators/introduction

55 http://epp.eurostat.ec.europa.eu/portal/page/portal/agri_environmental_indicators/documents/Nutrient_Budgets_Handbook_%28CPSA_AE_109%29_corrected3.pdf

56 Oenema, O., Sebek, L., Kros, H., Lesschen, J.P., van Krimpen, M., Bikker, P., van Vuuren, A., Velthof, G., 2014. Guidelines for a common methodology to estimate nitrogen and phosphorus excretion coefficients per animal category in eu-28. final report to eurostat, in: Eurostat (Ed.), Methodological studies in the field of Agro-Environmental Indictors. Eurostat, Luxembourg, pp. 1?108.

- To set up a database with the excretion factors presently used in different reporting systems and describe the main factors that cause distortion within a country and across the EU;
- To provide guidelines for a coherent methodology, consistent with IPCC and CLTRP guidelines, for calculating N and P excretion factors, and taking into consideration the animal balance and taking into account different methodologies identifies under the first bullet point;
- To create default P-excretion factors that can be used by the countries who do not have yet own factors calculated;

The recommendations of the LiveDate project from the authors of the report were:

- It is recommended to use the mass balance as a common and universally applicable method to estimate N and P excretion coefficients per animal category across EU-28:
  - $N_{excretion} = N_{intake} - N_{retention}$
  - $P_{excretion} = P_{intake} - P_{retention}$
- We recommend that the European Commission encourages Member States to invest in Tier 2 and 3 methods for key animal categories (and hence in country-specific, region-specific and/or year-specific excretion coefficients).
- We recommend that the European Commission encourages Member States to use a 3-Tier approach for the collection of data and information needed to estimate N and P excretion coefficients, so as to address differences between countries in livestock production and data collecting/processing infrastructure, and to economize on data collection/processing efforts. The three Tiers differ in the origin, scale and frequency of data and information collection.
- We recommend that the European Commission encourages Member States to use a Tier 3 approach for all key animal categories when livestock density in a country is > 2 livestock units per ha (>2 LSU per ha), equivalent to an excretion of about > 200 kg N or the inter-annual variation in N excretion by key animal categories is relatively large due to the effects of changing weather conditions and market prices.
- We recommend that the European Commission encourages Member States to use a Tier 2 approach for all main animal categories when livestock density in a country is between 0.5 and 2 LSU per ha (equivalent to an excretion of between about 50 and 200 kg N, under the condition that the inter-annual variation in N excretion by key animal categories is relatively small.
- We recommend that the European Commission reviews the current default N and P excretion coefficients of all animal categories and decides on a list of N and P excretion coefficients. Member States are recommended to use this list as a Tier 1 approach for all animal categories within a country when livestock density is <0.5 livestock units per ha (<0.5 LSU per ha, also at regional levels), which is equivalent to about 50 kg N and 10 kg P per ha agricultural land per year.
- We recommend that the European Commission encourages Member States to use region-specific N and P excretion coefficients when N and P excretion coefficients of the main animal categories differ significantly (>20%) between regions.
- We recommend that the European Commission makes computer programs available to Member States to encourage the calculation of the N and P excretion per animal category at regional and national levels in a uniform way. It is also recommended to provide training courses for the use of these programs and the calculation of the N and P excretion coefficients.
- We recommend that the European Commission encourages Member States to have well-documented and accessible methods for the estimation of N and P excretion coefficients per animal category. These reports should be updated once every 3-5 years and reviewed by external experts.

- We recommend that the European Commission encourages Member States to harmonise the various animal categories in formal policy reporting. We recommend that the FSS categorization is taken as the main list of animal categories for policy reporting, also because the inventory of the number of animals takes place regularly according to the FSS list of animal categories. We recommend also that a transparent scheme and computer program is developed for translating the inventory data of FSS into the animal categories of secondary databases (e.g., UNFCCC/IPCC-2006, EMEP/EEA, Nitrates Directive, FAO and OECD). The development of a uniform nomenclature for animal categories would be useful too, which should include definitions about key, main, minor, primary, secondary, functional categories
- We recommend that the European Commission encourages Member States to conduct a secondary animal categorization for key animal categories (e.g., cattle, pigs and poultry), when more than 20% of the animals are in another system and when the N and/or P excretion coefficients differ by more than 20% from the overall mean N and P excretion coefficients. We recommend that the following aspects are considered for distinguishing different production systems:
  - Fast-growing and heavy breeds vs slow-growing breeds
  - Organic production systems vs common production systems
  - Housed ruminants vs grazing ruminants
  - Caged poultry vs free-range poultry
- Equally important is that the excretion coefficients can be translated in a transparent and well-documented manner from such secondary categories to the main categories of the FSS.
- We recommend that the European Commission conducts a review of the diversity of production systems and feeding practices within a country for the main animal categories cattle, pigs and poultry once in 5 yrs, so as to trace changes in production systems, including organic versus conventional systems, housed vs grazing ruminants, caged versus free range poultry, and fast growing breeds versus slow growing breeds.
- We recommend that the European Commission encourages Member States to review and update the N and P retention coefficients for all animal categories once in 5-10 yrs. All data should be stored in a database accessible by all Member States.
- We recommend that the European Commission conducts a review and adjusts/modifies/updates the classification system of livestock units (as presented also in Table 5 of this report), and livestock density, so as to better reflect the diversity of animals within an category and more in general the impact of livestock on the environment.

5.5.4.4 Regionalisation of the Gross Nutrient Budget with the CAPRI model

The JRC was cooperating with EUROSTAT on a methodology to use the CAPRI model[57] for the regionalisation of the Gross Nutrient Budget (GNB) indicators (nitrogen and phosphorus) that needs to be reported regularly by countries to EUROSTAT and OECD. The GNBs are identified as one of the key agro-environmental indicators. Current reporting occurs at the national level. For policy making, a higher resolution, matching with legislative and environmental boundaries (NVZ, watershed) rather than administrative boundaries (country) is required. The CAPRI model is an economic model for agriculture, which has an environmental accounting model integrated. It has a spatial resolution of NUTS2 and reports, a.o. Nitrogen Balances at this level. The CAPRI model has a down-scaling module integrated which estimates land use shares and environmental indicators at the pixel level (1 km by 1 km). The use of the CAPRI model is motivated in view of the lack of methodology for

[57] http://www.capri-model.org/

regionalisation of the GNB and the high costs associated with building up such systems in the countries at one hand, and the thrive to harmonise the conceptual approaches.

The Working Group (WG) on agri-environmental indicators (AEI, February 2012) and the subsequent Standing Committee for Agricultural Statistics (CPSA, May 2012) decided to start a pilot projects on regionalising Gross Nitrogen Balance (GNB) with the CAPRI model. The objective of the pilot project is to evaluate differences between national GNB and the GNB calculated with CAPRI at the country and the NUTS2 scale. Italy, France, Germany and Hungary volunteered for this pilot project. The RegNiBal project (Regionalisation of Nitrogen Balances with the CAPRI Model - Pilot Project) started in February 2013. The overall goal was to use the CAPRI model to provide (operationally) regional GNB data to complement the national Eurostat/OECD GNBs.

Four countries volunteered to share their national GNB estimates with the CAPRI team which were analysed on differences with CAPRI estimates and recommendations were formulated to improve both national methods and the CAPRI model:

- France
- Germany
- Italy
- Hungary

The conclusions formulated in the final RegNiBal report[58] included:

A total of 31 'issues' were identified that were related to major discrepancies between the methods and warranted further assessment. At the end of the project, 12 of the identified issues were solved, one was partially solved and 18 could not be solved, but some progress was achieved and concrete recommendations were made for almost all of them. The results and achievements of RegNiBal are summarised in Annex 12.

At the start of the RegNiBal project CAPRI data was generally judged to be more reliable than national data. The situation has changed with the improvements described above; at present, further analysis is needed to see whether CAPRI or national data is ?better? with regard to the remaining unresolved issues.

Overall, N excretion by swine and N removal by grass are considered the most important unresolved issues because of their considerable impact on N-input and N-output. The animal budget analysis for swine of DE and FR shows that CAPRI estimates higher feed intake than the national methodologies. Countries are not always sufficiently accurate in estimating and/or using the average number of animals and N-excretion coefficients in N manure excretion estimations. For the estimates of dry matter yields of grassland, the differentiation of permanent grassland according to the proposal of the GRASSDATE project (Velthof et al 2014)[59] would likely help (grassland out of production but maintained, unimproved grassland (including both sole use and common land) and improved grassland (by N-input levels <50, 50-100, >100 kg N/ha/yr, sole use and common land).

The CAPRI model is very strong in several parts of GNB calculations, and the RegNiBal project enabled us to identify several possible improvements in national data and methods. The use of the animal budget to estimate N excretion is a major asset in the CAPRI methodology, but runs the risk of outliers if the use of feed in the statistical sources is overestimated. There is large uncertainty in grass yield and other (non-

[58] Özbek, F.S., Leip, A., Weiss, F., Grassart, L., Hofmeier, M., Kukucka, M., Pallotti, A., Patay, A., Thuen, T., 2015. Regionalisation of Nitrogen Balances with the CAPRI Model (RegNiBal) Pilot project in support of the Eurostat Working Group on Agri-Environmental Indicators. Publications Office of the European Union, Luxembourg. doi: http://dx.doi.org/10.2788/078406.

[59] Velthof, G.L., Lesschen, J.P., Schils, R.L.M., Smit, A., Elbersen, B.S., Hazeu, G.W., Mucher, C.A., Oenema, O., 2014. Grassland areas , production and use. Lot 2. Methodological studies in the field of Agro-Environmental Indicators. Alterra Wageningen UR, Wageningen, The Netherlands.

marketable) fodder yield and their N content. This affects the accuracy of national data as well. The other major areas of difficulties for the CAPRI model are the following: (i) Seed and planting materials should be explicit in the CAPRI GNB; (ii) N from organic fertilisers (other than manure) and manure withdrawal, stocks, and import estimations are not considered in the CAPRI model.

The CAPRI model can be used to calculate both land N budgets (GNB) and farm N budgets. The possibility of comparing the GNB with the farm N-budget helps to constrain the N-surplus results. For the farm N-budget, feed and fodder produced in the country (or region) and manure excreted and applied within the country (or region) are considered as internal flows and thus do not need to be estimated to quantify the N-surplus; data on imported feed and exported animal products are needed instead (for details on the comparison of the two approaches, see Leip et al 2011[60]). In the CAPRI model, data on animal products and imported feeds are available from statistical sources and are thus more reliable than the data on the N intake of fodder and manure excretion, which would not be required. Generally, the RegNiBal project showed that the CAPRI model could be adequate to provide national (and later regional and spatially explicit) GNBs. However, for the four countries assessed, additional work needs to be carried out to understand residual disagreements in the data.

5.5.4.5 Workshop on improving national inventories for agriculture (2014)

Under the WG1 on Annual GHG inventories under the EU Climate Change Committee a workshop on improving GHG inventories in the sector agriculture was organized by the Joint Research Centre as part of the 7th Non-CO_2 Greenhouse Gas Conference (NCGG7), held November 5-7, 2014 Amsterdam, the Netherlands[61]. The workshop was co-organized by CEH in support of the UK greenhouse gas inventory programme.

The session raised a high interest, contained high quality presentations and allowed scientists, IPCC and FAO representatives and country delegates to discuss about greenhouse accounting methods, their difficulties and challenges to use IPCC guidelines, to select the appropriate tier methods and to design country-specific methodologies which allow reducing uncertainties. From a total attendance of about 200 conference participants and five parallel sessions, this session was temporary attended by almost 100 scientists.

The workshop focused on N_2O emissions from agricultural soils, as they are highly uncertain yet are often estimated with default methodology in lack of country-specific data of sufficient quality. N_2O emissions from agricultural soils are dominating the uncertainty of the total GHG emissions for many countries. The programme included presentations covering the whole range of aspects of N_2O emission estimates: the availability of flux data in Europe and network design strategies (Rene Dechow, Thuenen Institute, DE), use of process-based models in GHG inventories (Steve del Grosso, USDA) to inverse methods to estimated national total N_2O emissions (Rona Thompson, NILU, NO). Further presentation gave national examples on GHG improvements, such as UK (general), NZ (pasture emissions), Thailand (emissions from rice), Norway (emissions from dairy farms) and on the link to IPCC guidelines and the IPCC Emission Factor Database (Kiyoto Tanabe (see below) and Baasansuren Jamsranjav, IPCC TFI TSU). A broader picture was given on the basis of the FAOSTAT GHG Database (FrancescoTubiello) and the CAPRI model (Carmona and Leip: The calculation of greenhouse gas emissions in the European agricultural sector; how much does the method matter?). Introduction and expectations were formulated by a presentation from Velina Pendolovska (DG Climate Action).

A final brainstorming exercise was done about how modelling and measurements could be improved in a way to reduce uncertainties, improve accuracy of measures and optimise resources. There was a debate around whether new models are needed or focusing on reducing the uncertainty in current

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60 Leip, A., Britz, W., Weiss, F., de Vries, W., 2011. Farm, land, and soil nitrogen budgets for agriculture in Europe calculated with CAPRI. Environ. Pollut. 159, 3243?53. doi: http://dx.doi.org/10.1016/j.envpol.2011.01.040.

61 http://www.ncgg.info/

models would be preferable, for example using the results of inverse modelling to contrast results. There is an agreement on the acceptability of simple models or inverse models for emission accounting at high scales, while more complex process-based models are needed when designing mitigation options. The problem of nitrogen surplus was pointed out as a proxy of N_2O emissions, which also informs about other additional pollution problems. About the estimation of uncertainties, the group agreed on the need, first of all, to improve their estimation. It seemed a general impression that uncertainties are usually overestimated, but it is difficult to quantify objectively. Another point that needs attention is the activity data: statistics do not always match at national level, and sometimes models demand a high quantity of data which is not available. Getting better activity data is important prior to focus on emission estimations.

As a conclusion, the combination of an expert meeting in support of the EU GHG inventory system and an international scientific conference was very successful, as it provided a high density of expertise that country delegates could use. The NCGG conference series is ideal for this purpose.

5.5.5 Verification

5.5.5.1 Allocation to climate regions

In the year 2013, an analysis was performed to compare the allocation of livestock over the IPCC climate regions at the national scale between data available at high spatial resolution at the Joint Research Centre and data provided in the national GHG inventory reports.

For the submission in the year 2014, this section had been updated and is available at the JRC website[62]

5.5.5.2 Comparison of national inventories with EU-wide calculations with the CAPRI model

In the context of the GGELS project (http://afoludata.jrc.ec.europa.eu/group/ggels-results), an in-depth comparison between data provided by Parties in the national inventories and greenhouse gases estimates as calculated with the CAPRI model for the year 2002 was done. A summary of this project was included in previous EU GHG emission inventories in the agriculture chapter. The Joint Research Centre is working on a more comprehensive comparison between CAPRI and the national GHG inventories and compare the development of emissions over the timespan 1990 to last reported year.

To this purpose, for the submission in the year 2016, a pilot project was carried out to provide a preliminary comparison. In the CAPRI model, GHG emissions are calculated based on activity data contained in the CAPRI database drawing mainly from data obtained from Eurostat and complemented with other sources (e.g. FAOSTAT)). First results of that project were presented in the EU National Inventory Report of the year 2016.

The results revealed considerable differences for certain sub-categories of emissions, due to diverse reasons such as: some discrepancies in population numbers, the use of different emission factors, underlying assumptions taken in the model for certain parameters, and different methodologies for the calculation of emissions. For example, for the nitrogen compounds emitted, CAPRI uses a mass-preserving N balance approach, which consistently accounts for all nitrogen flows and quantifies available N at each step of the system (see Leip et al., 2010, Velthof et al., 2007). Furthermore, while countries may use different Tiers according to the emission category and their availability of resources, and often country specific methods and parameters, CAPRI applies the same calculation method for all reporting parties, always in compliance with 2006 IPCC guidelines.

Since 2016, we have been working on the improvement of a comparison module in the CAPRI model, which incorporates some elements allowing the comparison with national inventory data along the whole time series. The module considers dynamic evolution of parameters which were originally considered as fixed, and in particular feed requirements. It is now possible to compare data for the

[62] ftp://mars.jrc.ec.europa.eu/Afoludata/Public/363_eughginventory2014/koeble_leip2014.livestockallocation.pdf

whole time series from 1990 until the last year that is available in the CAPRI data base, which is currently the year 2014. For the year 2016, a CAPRI 'now-casting' is made. This is a projection of the data for the year 2016 based on a trend analysis keeping consistency between all variables (i.e., areas and herd sizes, yields, production volumes, technology development etc.).

Preliminary results show that for some emission categories there are difference whose reasons have to be analysed. For example, Figure 5.77 shows emissions from enteric fermentation from non-dairy cattle. As we can see, emissions calculated by CAPRI are higher than emissions reported by NI. According to figure 5.78, differences in population between the two databases are much smaller, therefore another reason other than activity data must be behind discrepancies in emissions (for example feed rations or feed digestibility etc).

Figure 5.77 Comparison of CH_4 emissions from source category 3.A.1. Non-Dairy Cattle Enteric Fermentation between the CAPRI model and National GHG inventories for the years 1990-2014 (CAPRI time series) and 2016 (CAPRI now-casting)

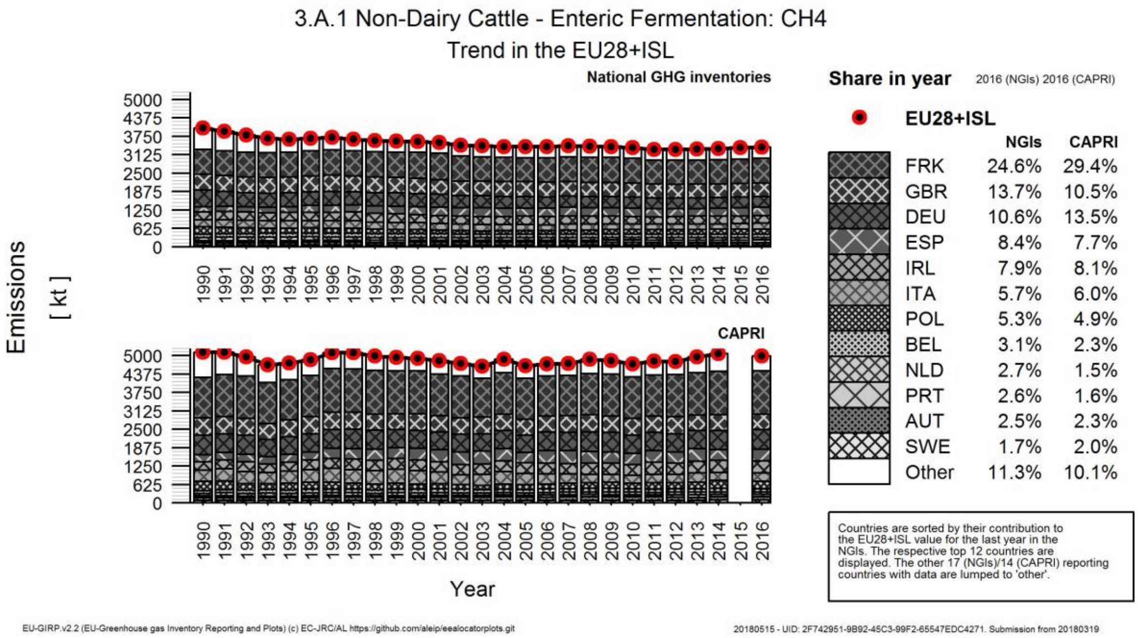
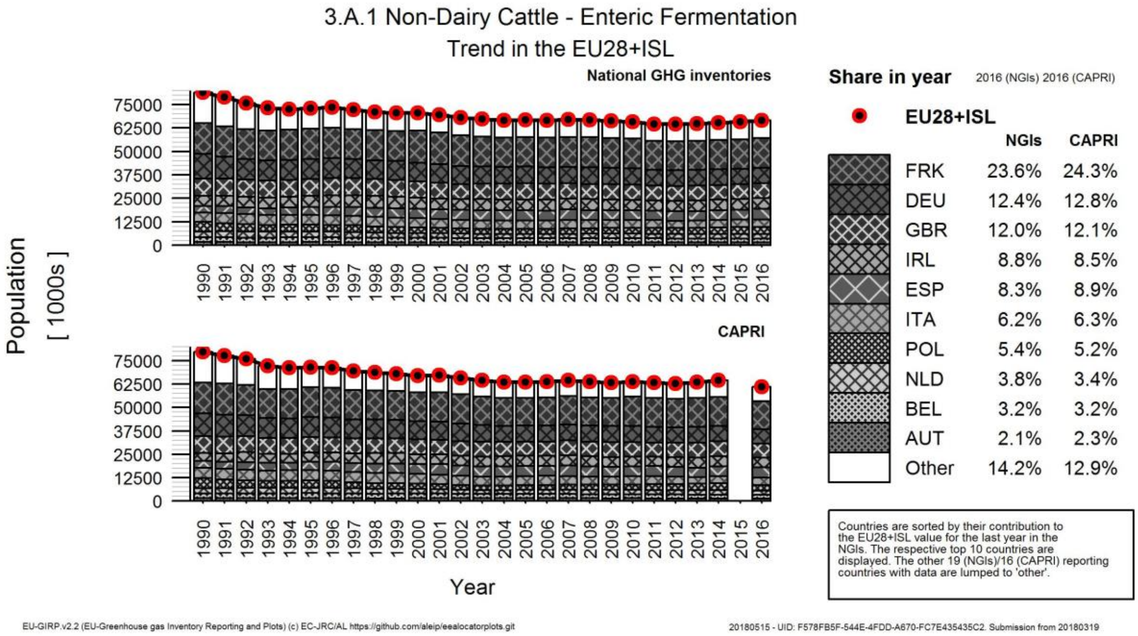


Figure 5.78 Comparison of Non-Dairy Cattle Population between the CAPRI model and National GHG inventories for the years 1990-2014 (CAPRI time series) and 2016 (CAPRI now-casting)



CAPRI estimates of CH_4 emissions from manure management, for example for dairy cattle, are lower CH_4 in CAPRI than in the national GHG inventories. Population in CAPRI is also a bit lower but not as much as emissions. In the contrary, N_2O emissions are higher in CAPRI than the reported in national inventories, although total N excretion is much closer in both databases. One potential explanation could lay on differing distributions of manure nitrogen across manure management systems. The data source used for the distribution of manure management systems in CAPRI is GAINS. Figures 5.79, 5.80 and 5.81 compare the amount of N managed in liquid systems, solid systems and pastures between CAPRI and NI. The share of manure in liquid systems is similar, but CAPRI has a lower share of manure on pastures and higher share of solid manure, which could explain relatively higher N_2O emissions, compared to CH_4. These differences are bigger as we approach current year. After these findings, it seems that CAPRI manure management system distribution does not completely correspond to current practices and might require updating.

Figure 5.79 Comparison of Nitrogen excretion by Dairy Cattle and managed in liquid systems between the CAPRI model and National GHG inventories for the years 1990-2014 (CAPRI time series) and 2016 (CAPRI now-casting)

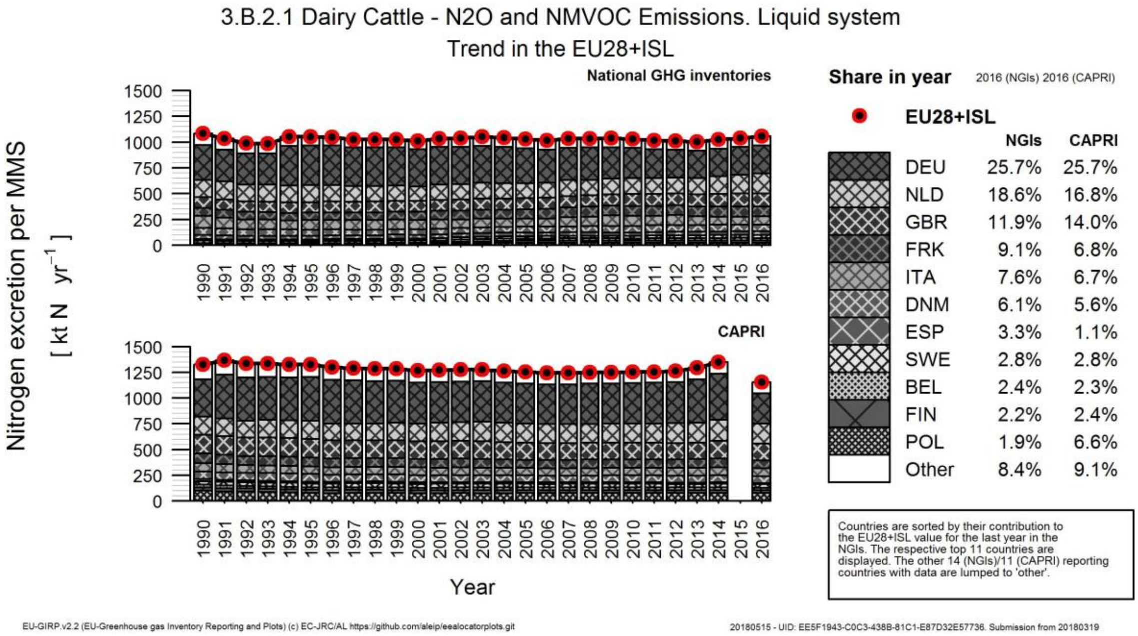


Figure 5.80 Comparison of Nitrogen excretion by Dairy Cattle on pasture, range and paddock between the CAPRI model and National GHG inventories for the years 1990-2014 (CAPRI time series) and 2016 (CAPRI now-casting)

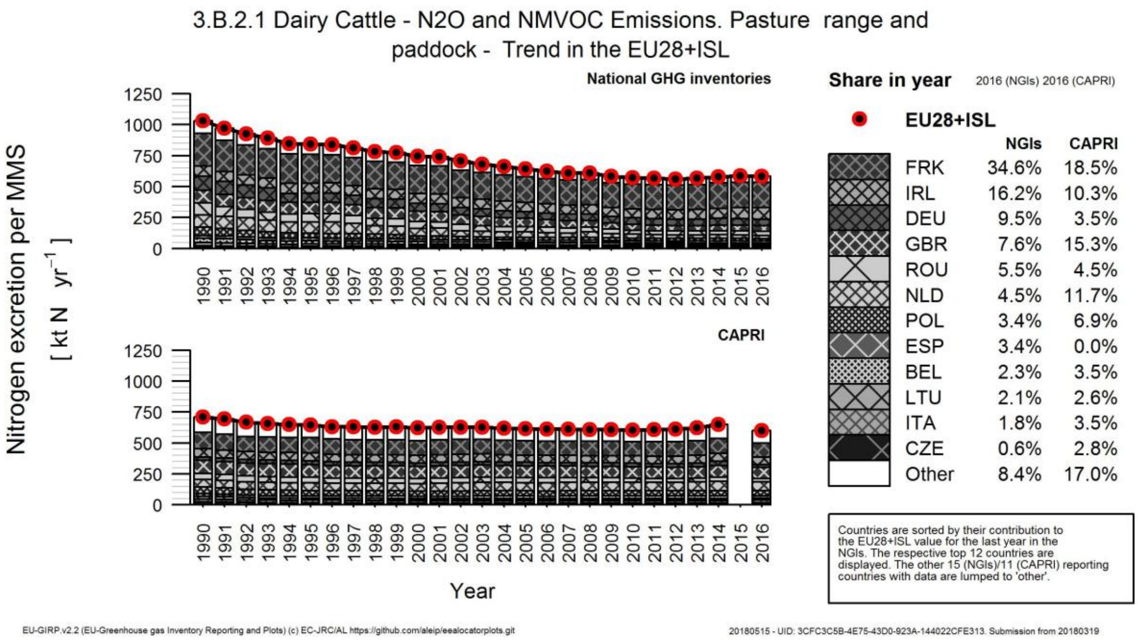
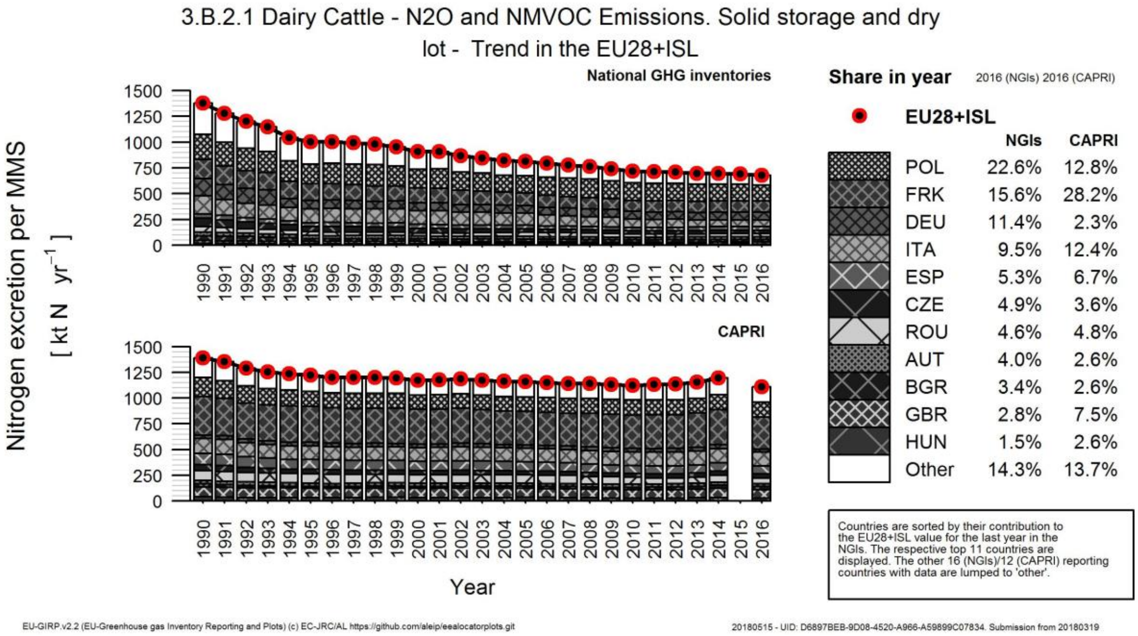


Figure 5.81 Comparison of Nitrogen excretion by Dairy Cattle and managed in liquid systems between the CAPRI model and National GHG inventories for the years 1990-2014 (CAPRI time series) and 2016 (CAPRI now-casting)



Another example is shown in figures 5.82 and 5.83, where we can see direct N_2O emissions from the application of inorganic fertilisers to soils and the corresponding activity data. In this case, differences between the two databases are very small for both activity data and for N_2O emissions from soils.

Figure 5.82 Comparison of Direct N_2O emissions from application of inorganic N fertilizers to agricultural soils between the CAPRI model and National GHG inventories for the years 1990-2014 (CAPRI time series) and 2016 (CAPRI now-casting)

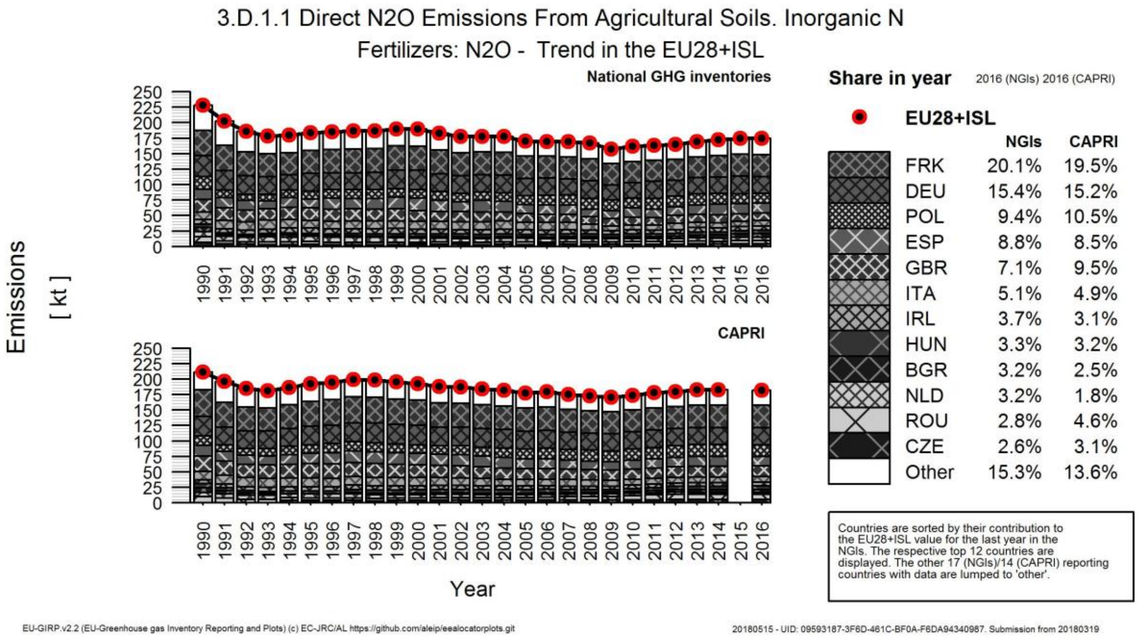
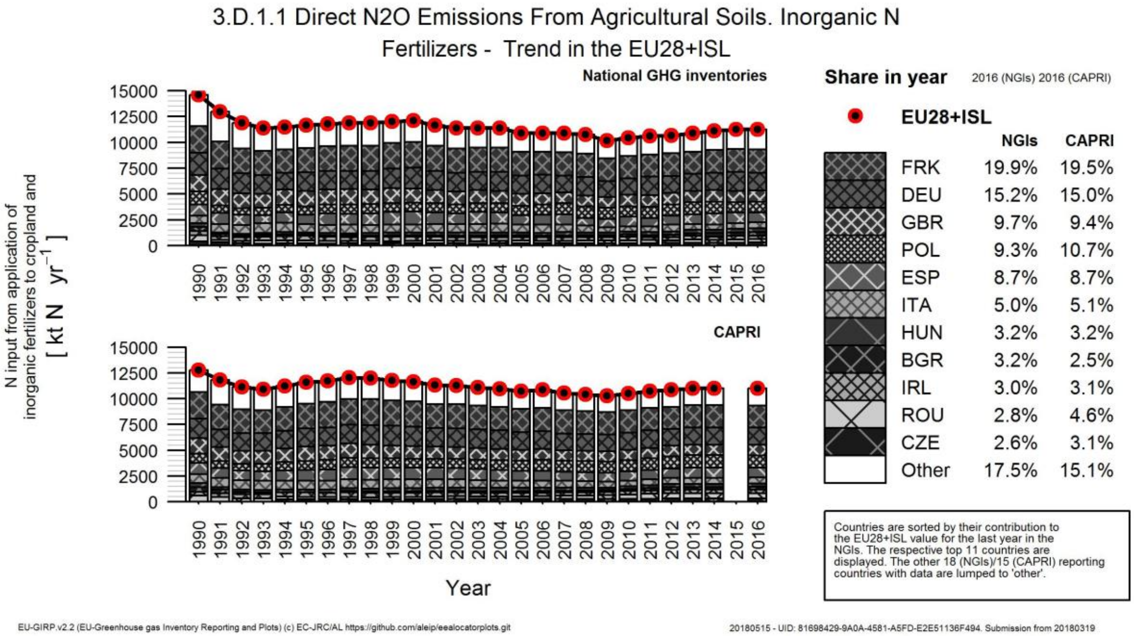


Figure 5.83 Comparison of N input to agricultural soils from inorganic fertilizers between the CAPRI model and National GHG inventories for the years 1990-2014 (CAPRI time series) and 2016 (CAPRI now-casting)



5.5.5.3 Comparison of activity data in the FAO GHG database on the national inventory reports

The Food and Agriculture Organization of the United Nations (FAO) has developed a database of greenhouse gas emissions, contained in FAOSTAT, which provides estimations of the emissions of main gases in the agricultural sector (CH_4 and N_2O) and statistics on the activity data related to these emissions that generally cover the period 1990-2016. The data base can be consulted at the following link:

http://faostat3.fao.org/faostat-gateway/go/to/download/G1/*/E

Emissions are specified for the different agricultural sub-domains, estimated by FAO following Tier 1 approach from the 2006 IPCC Guidelines for National GHG Inventories (IPCC, 2006), using activity data provided by countries and default emission factors by IPCC. The data provided by FAO does not necessarily match the numbers reported by countries to the UNFCCC in their national inventory reports.

The FAOSTAT database is intended primarily as a service to help member countries assess and report their emissions, as well as a useful international benchmark. FAOSTAT emissions data are disseminated publicly to facilitate continuous feedback from member countries. The following table presents total GHG emissions of the agricultural sector by emission source category for the whole EU-28+Iceland and year 2016 (last year available in FAOSTAT). It compares emission values and the share of emissions by category in FAOSTAT database vs. UNFCCC values reported by countries in their National Inventory Reports (NIR).

Table 5.61 GHG emissions from the agricultural sector by emission source category, in kt CO_2-eq/year and % of total emissions, for the whole EU-28+ISL, averaged over the years 2000 to 2016, for which reported data from all countries are available in both the FAOSTAT and the UNFCCC data bases are available.

Source category	Gas	NIR [kt CO_2-eq yr^{-1}]	NIR [%]	FAO [kt CO_2-eq yr^{-1}]	FAO [%]
3.A - Enteric Fermentation	**CH_4**	192,753	44.6	193,951	45.1
3.B.1 - CH_4 Emissions	*CH_4*	*43,990*	*10.2*	*50,126*	*11.7*
3.B.2 - N_2O Emissions	*N_2O*	*24,057*	*5.6*	*14,046*	*3.3*
3.C - Rice Cultivation	*CH_4*	*2,660*	*0.6*	*5,348*	*1.2*
3.D.1.1 - Direct N_2O Emissions - Inorganic N Fertilisers	**N_2O**	51,179	11.8	46,965	10.9
3.D.1.2 - Direct N_2O Emissions - Organic N Fertilisers	**N_2O**	23,737	5.5	24,581	5.7
3.D.1.3 - Urine and Dung Deposited by Grazing Animals	**N_2O**	20,899	4.8	22,366	5.2
3.D.1.4 - Crop Residues	**N_2O**	19,491	4.5	14,925	3.5
3.D.1.5 - Mineralization of Soil Organic Matter	**N_2O**	696	0.2	0	0.0
3.D.1.6 - Cultivation of Organic Soils	**N_2O**	13,189	3.0	20,465	4.8
3.D.2 - Indirect N_2O Emissions	**N_2O**	28,747	6.6	35,554	8.3
3.F - Field Burning of Agricultural Residues	**CH_4**	839	0.2	1,325	0.3
3.F - Field Burning of Agricultural Residues	**N_2O**	303	0.1	410	0.1
3.G - Liming	**CO_2**	5,893	1.4	0	0.0
3.H - Urea Application	**CO_2**	3,705	0.9	0	0.0
3.I - Other Carbon-containing Fertilisers	**CO_2**	327	0.1	0	0.0
Total	**GHGs**	432,463	100.0	430,062	100.0

Comparing both databases, we can see that UNFCCC reports slightly higher total emissions than FAOSTAT (432.5 versus 430.1) Mt CO_2-eq yr^{-1}, even if categories 3.D.1.5, 3.G, 3.H and 3.I are not estimated in FAOSTAT (421.8 versus 430.1) Mt CO_2-eq yr^{-1}. Looking at the individual emission categories, we can also identify differences between the two databases, which can be due to different reasons:

1. Differences in the methodology used for the estimation of emissions. While countries apply tier 1 to tier 3 approaches, depending on the emission category, FAOSTAT estimations are based on a tier 1 approach, using always default emission factors.
2. The use of different activity data, coming from different sources or suffering different processing after data collection.

Comparing the estimations of FAOSTAT with the UNFCCC inventory data, we find that the biggest absolute difference corresponds to:

- N_2O emissions from category 3.B.2 (10011 kt CO_2-eq yr^{-1}, with larger emissions reported by NIR), followed by

- N_2O emissions from category 3.D.1.6 - Cultivation of Organic Soils (-7276 kt CO_2-eq yr^{-1}, with larger emissions reported by FAO) and
- Indirect N_2O emissions from category 3.D.2 (-6807 kt CO_2-eq yr^{-1}, with larger emissions reported by FAO).

These three emission categories represent a significant share of the total agricultural emissions in the NIR and FAO data bases, accounting for 3.2-5.6%, 3-4.7% and 6.6-8.2%, respectively.

The largest three differences in relative terms are:

- CH_4 emissions from category 3.C - Rice Cultivation (-101.1 %, with larger emissions reported by FAO), followed by
- CH_4 emissions from category 3.F - Field Burning of Agricultural Residues (-57.9 %, with larger emissions reported by FAO) and
- N_2O emissions from category 3.D.1.6 - Cultivation of Organic Soils (-55.2 %, with larger emissions reported by FAO).

The two source categories with the highest absolute and relative differences are N_2O emissions from category 3.D.1.6 - Cultivation of Organic Soils and CH_4 emissions from category 3.C - Rice Cultivation.

In the next sections, we will focus on the comparison of activity data, trying to find out if the differences found in both databases can explain the differences in emissions, analysing the trends of livestock population, fertiliser use and cultivated area along the inventory years (1990-2016).

We will employ two types of figures throughout this section. Figure of the type as in Figure 5.84 show the trend of EU28+ISL for both NIR and FAO, similar to the Figures used also in Section 5.2. The upper panel of the figure shows the trend in the data from NIR, and the lower panel shows the trend in the FAO data. The 10 most important countries are plotted explicitly with the pattern used also in the previous sections. The share of AD in the last reported year given next to the legend, and all other countries lumped together into the category 'Other'. This category contains only the 'other' countries with respect to the data base, thus the countries could be different for NIR and FAO.

Figures of the type as in Figure 5.85 show three different perspectives on the comparison of the two data sets, using the average of data for the years 1990-2016: the chart on the left side shows the reported values in absolute units for both NIR and FAO; the chart in the middle shows the relative difference between both data sets, calculated as (FAO-NIR)/NIR. Thus, positive values indicate that the value from FAO are larger than the value from NIR, and negative values indicate that the values from NIR are larger. Large relative differences indicate a problem in data reporting by the countries, but is not necessarily an indication that this has a large impact for the overall total EU emissions. Therefore, the chart on the right side shows the importance of the difference observed in each countries, as compared to the EU28+ISL total: $(FAO_{country}-NIR_{country})/NIR_{EU}$.

Animal populations

Trends of population data in the two data sets and a comparison of average data in the period 1990 to 2016 are shown for dairy Cattle (Figure 5.84 and Figure 5.85), non-dairy Cattle (Figure 5.86 and Figure 5.87), sheep (Figure 5.88 and Figure 5.89), swine (Figure 5.90 and Figure 5.91) and poultry (Figure 5.92 and Figure 5.93). The trends in the NIR data are discussed in detail in Section 5.2.

Dairy cattle population data from FAO are sometimes smaller and sometimes larger than NIR data. Differences are in the range between -14.1% and 0.4%. 25 years showing values that are larger in NIR (on average by 1148.5 thousand heads) and 2 years when FAO data are larger (on average by 60 thousand heads). Comparing all years, NIR is larger by 1059 thousand heads or -3.82% of the average value in the EU. The three countries with the largest differences in single years are Romania, Italy and Poland. The largest deviations (FAO minus NIR) are -1048 thousand heads (Romania, 1990), corresponding to 2.7% of total EU dairy cattle population in this year (NIR), -532 thousand heads (Romania, 1991), and -503 thousand heads (Romania, 1993).

Non-dairy cattle population data from FAO are smaller than NIR data for all years. Comparing all years, NIR is larger by 2410 thousand heads or -3.47% of the average value in the EU. The three countries with the largest differences in single years are Ireland, Romania and Germany. The largest deviations (FAO minus NIR) are 2354 thousand heads (Germany, 1991), corresponding to 3% of total EU non-dairy cattle population in this year (NIR), 2022 thousand heads (Romania, 1990), and 1610 thousand heads (Romania, 1991).

Sheep population data from FAO are smaller than NIR data for all years. Comparing all years, NIR is larger by 2480 thousand heads or -2.1% of the average value in the EU. The three countries with the largest differences in single years are Ireland, Italy and Spain. The largest deviations (FAO minus NIR) are -2995 thousand heads (Ireland, 1998), corresponding to 2.3% of total EU sheep population in this year (NIR), -2988 thousand heads (Ireland, 1999), and -2868 thousand heads (Ireland, 1993).

Swine population data from FAO are sometimes smaller and sometimes larger than NIR data. Differences are in the range between -8.3% and 2.8%. 13 years showing values that are larger in NIR (on average by 7675.5 thousand heads) and 14 years when FAO data are larger (on average by 2236 thousand heads). Comparing all years, NIR is larger by 2536 thousand heads or -1.63% of the average value in the EU. The three countries with the largest differences in single years are Germany, Romania and Spain. The largest deviations (FAO minus NIR) are 8636 thousand heads (Germany, 1991), corresponding to 5.1% of total EU swine population in this year (NIR), 7675 thousand heads (Germany, 1990), and 4927 thousand heads (Germany, 1994).

Poultry population data from FAO are smaller than NIR data for all years. Comparing all years, NIR is larger by 220484 thousand heads or -14.1% of the average value in the EU. The three countries with the largest differences in single years are Poland, Italy and France. The largest deviations (FAO minus NIR) are -150668 thousand heads (Poland, 1991), corresponding to 9.5% of total EU poultry population in this year (NIR), -148084 thousand heads (Poland, 1996), and -147475 thousand heads (Poland, 2001).

Figure 5.84: 3.A.1: Comparison of dairy cattle population in the EU28+ISL and range of values reported by countries in the UNFCCC and the FAO.

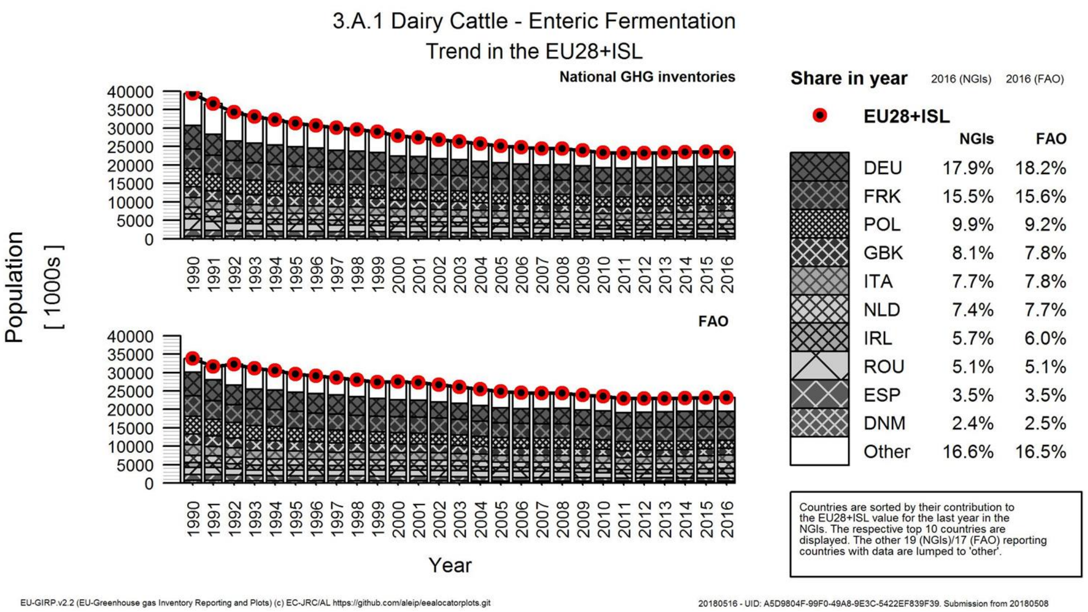


Figure 5.85: 3.A.1: (a) Average Dairy Cattle population in the EU28+ISL in the UNFCCC and the FAO, (b) Importance of range of difference in the databases for total EU28+ISL value and (c) Relative difference of mean values by country.

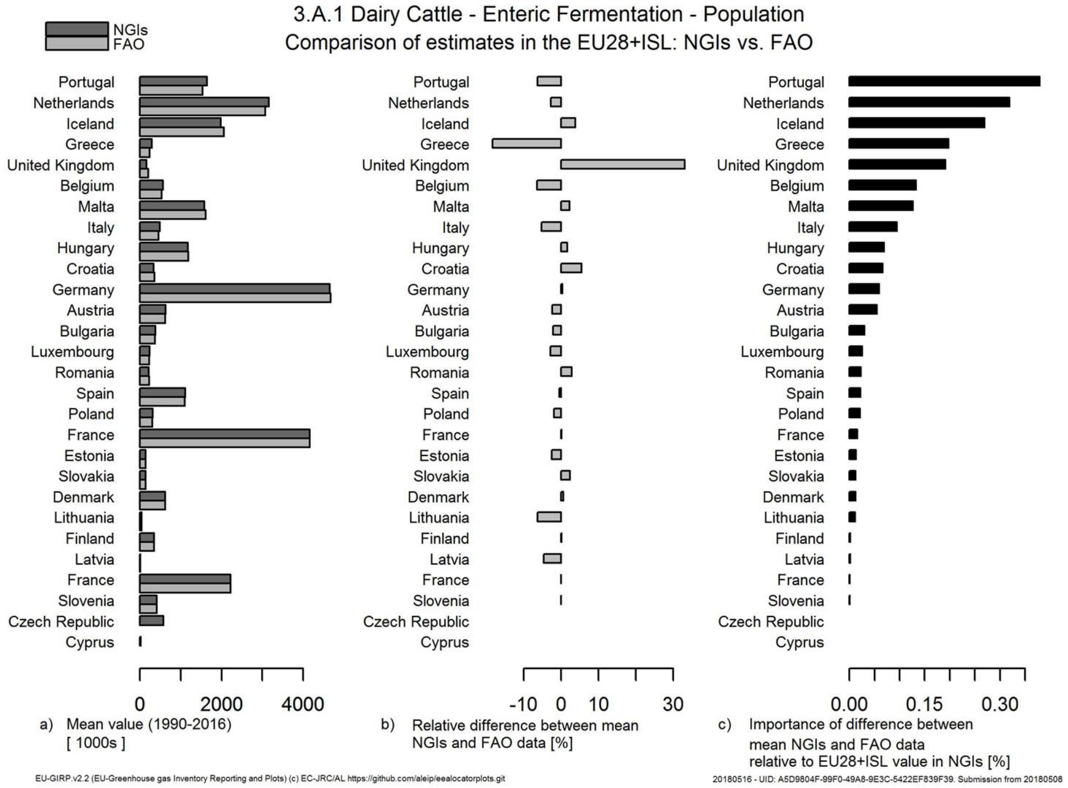


Figure 5.86: 3.A.1: Comparison of non-dairy cattle population in the EU28+ISL and range of values reported by countries in the UNFCCC and the FAO.

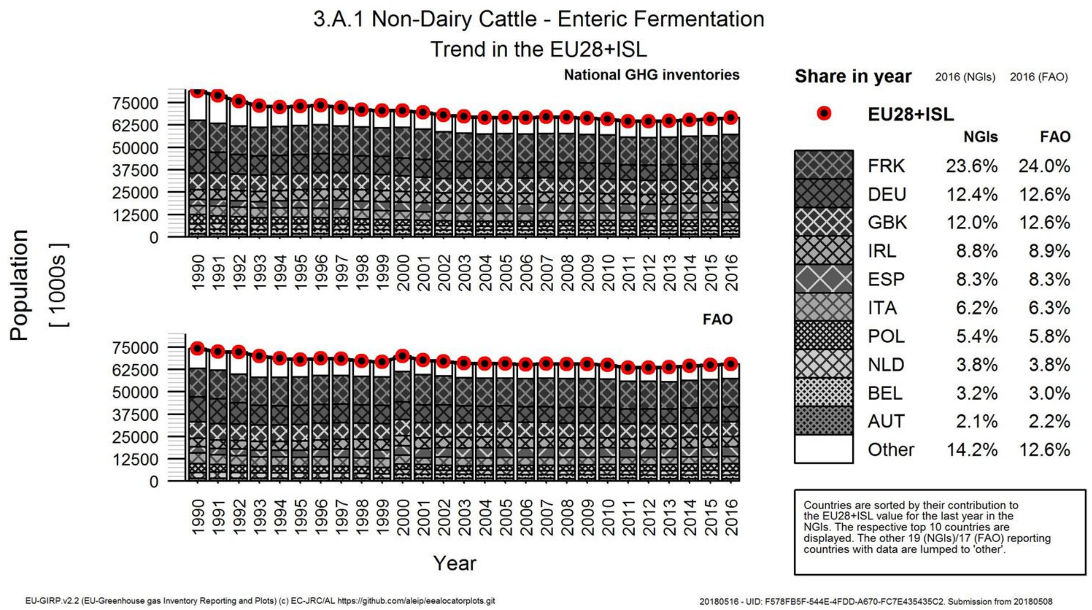


Figure 5.87: 3.A.1: (a) Average Non-Dairy Cattle population in the EU28+ISL in the UNFCCC and the FAO, (b) Importance of range of difference in the databases for total EU28+ISL value and (c) Relative difference of mean values by country.

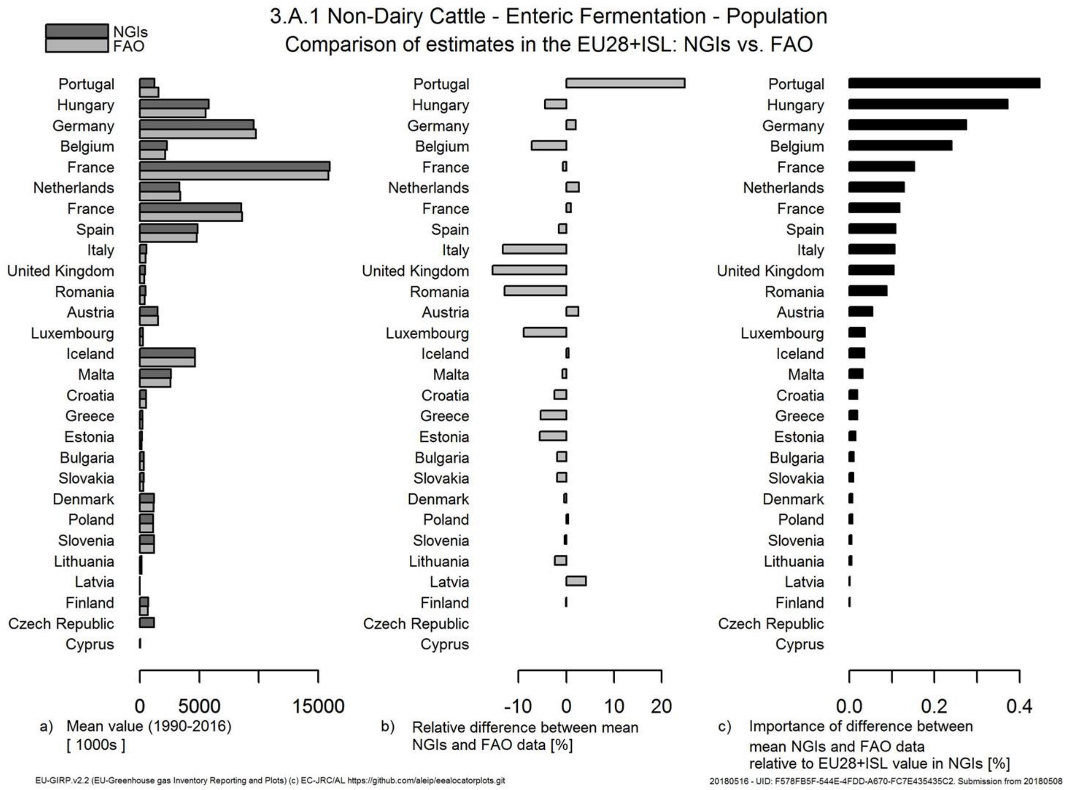


Figure 5.88: 3.A.1: Comparison of sheep population in the EU28+ISL and range of values reported by countries in the UNFCCC and the FAO.

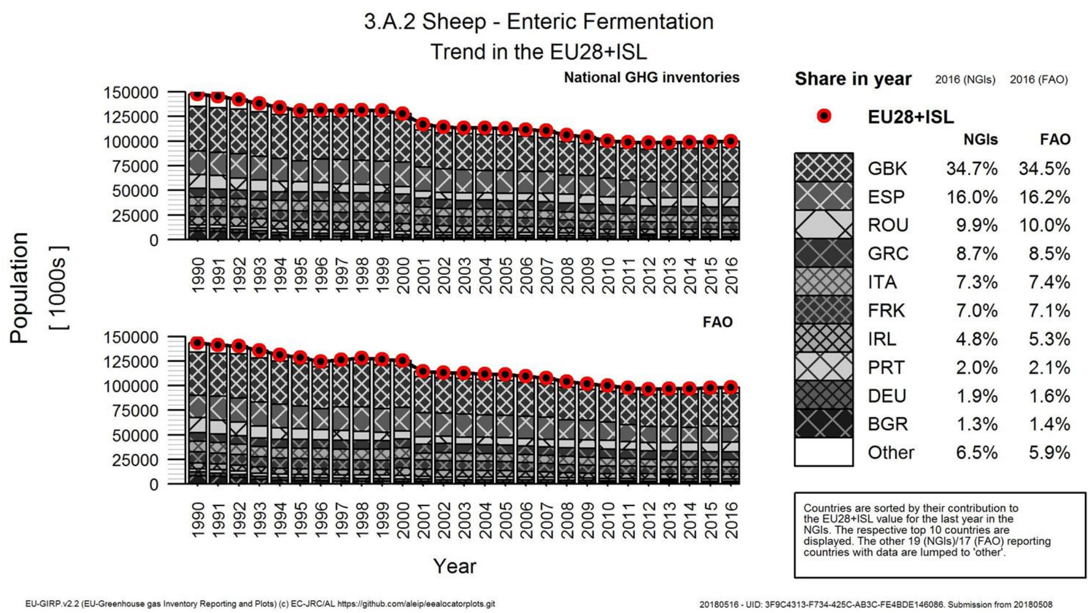


Figure 5.89: 3.A.1: (a) Average Sheep population in the EU28+ISL in the UNFCCC and the FAO, (b) Importance of range of difference in the databases for total EU28+ISL value and (c) Relative difference of mean values by country.

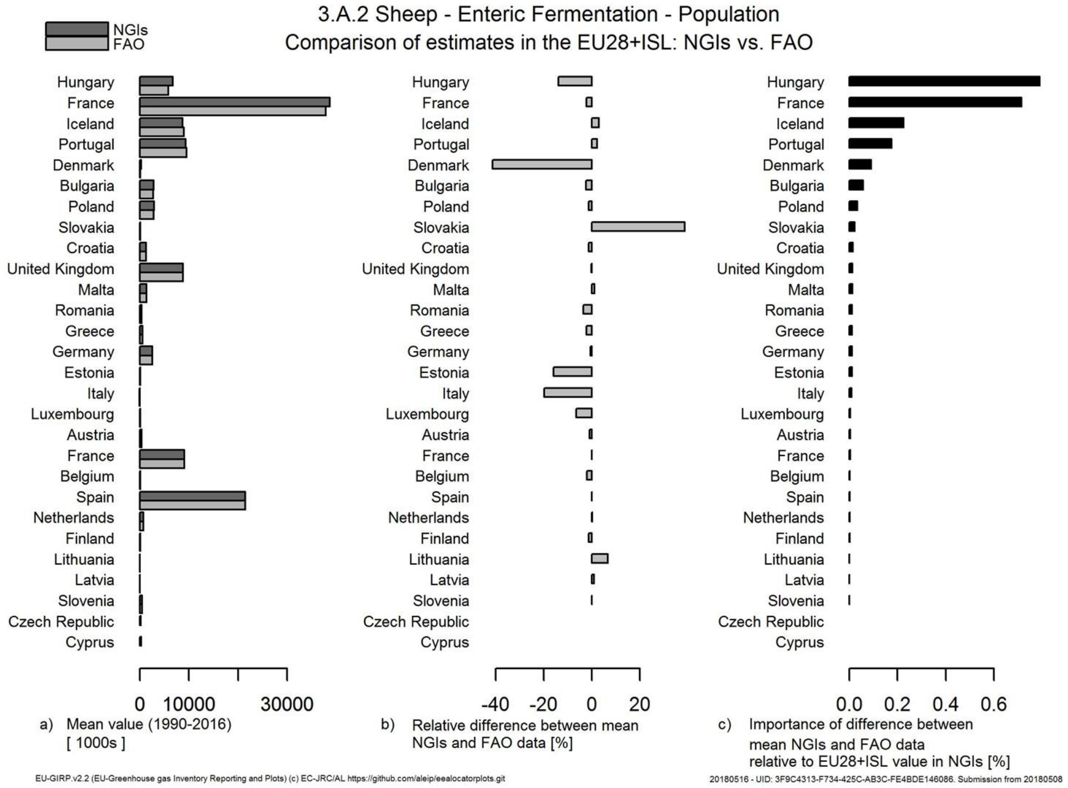


Figure 5.90: 3.A.1: Comparison of swine population in the EU28+ISL and range of values reported by countries in the UNFCCC and the FAO.

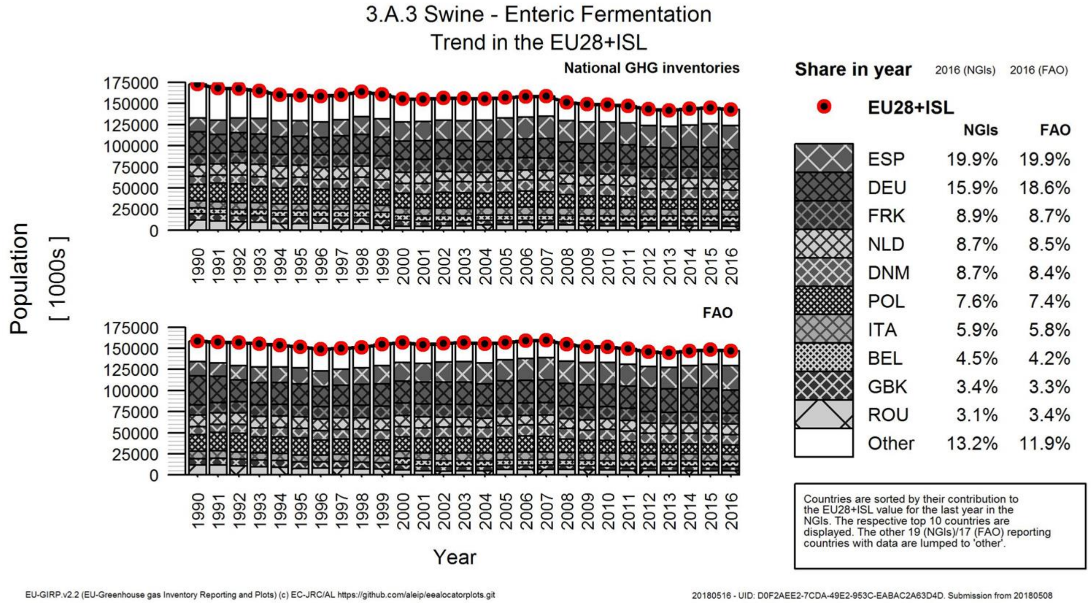


Figure 5.91: 3.A.1: (a) Average Swine population in the EU28+ISL in the UNFCCC and the FAO, (b) Importance of range of difference in the databases for total EU28+ISL value and (c) Relative difference of mean values by country.

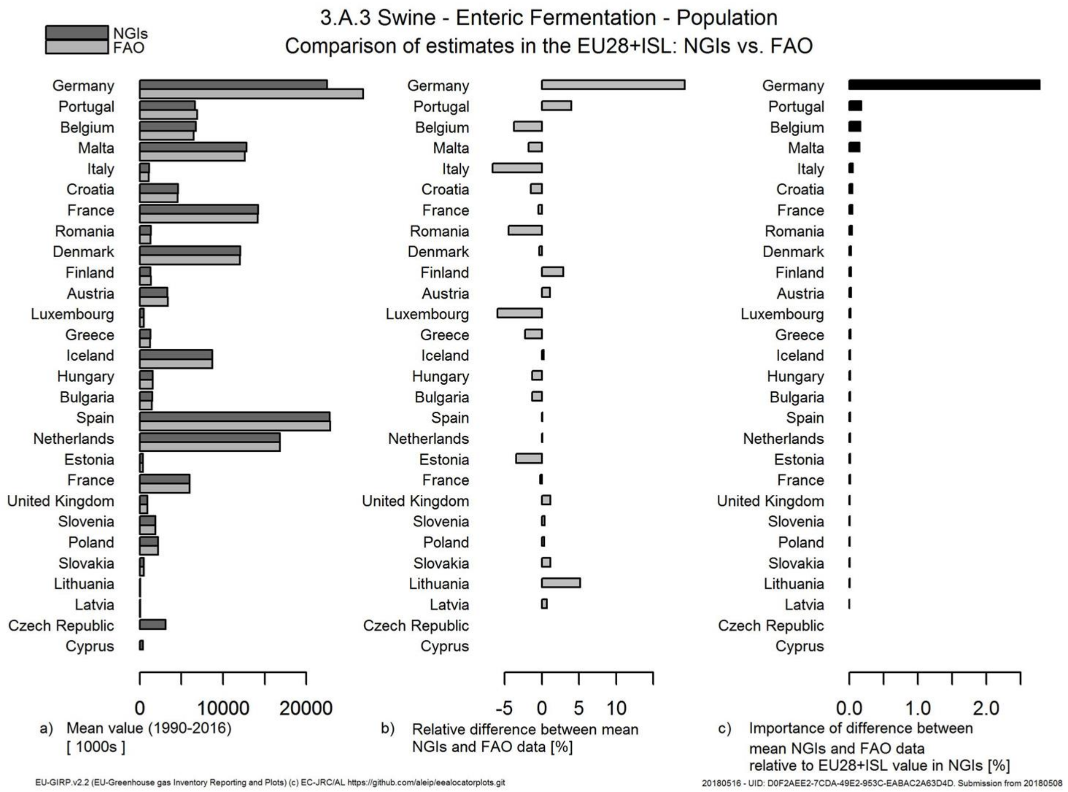


Figure 5.92: 3.A.1: Comparison of poultry population in the EU28+ISL and range of values reported by countries in the UNFCCC and the FAO.

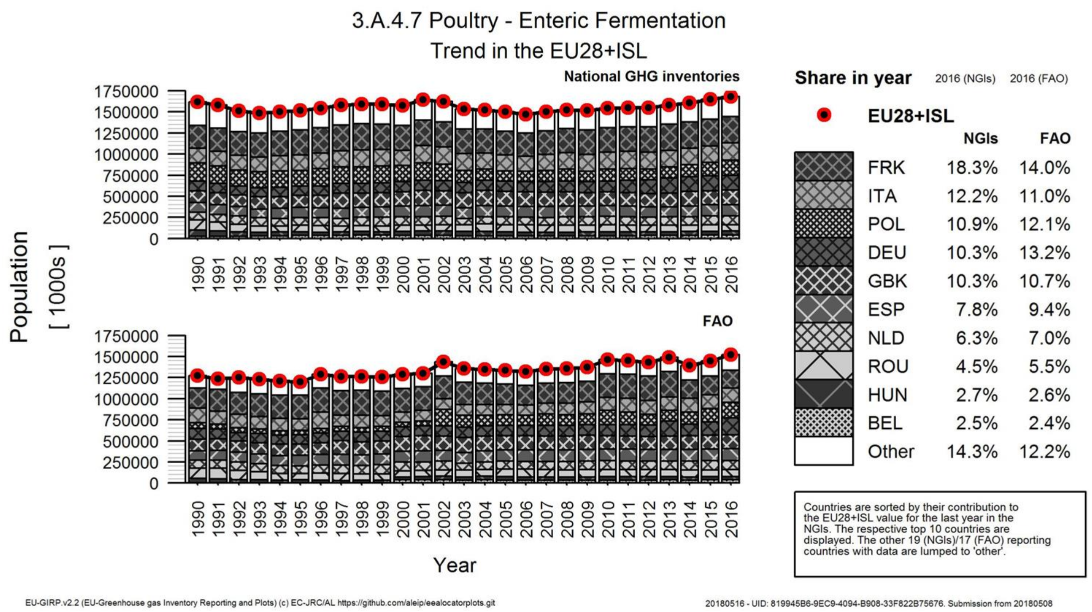
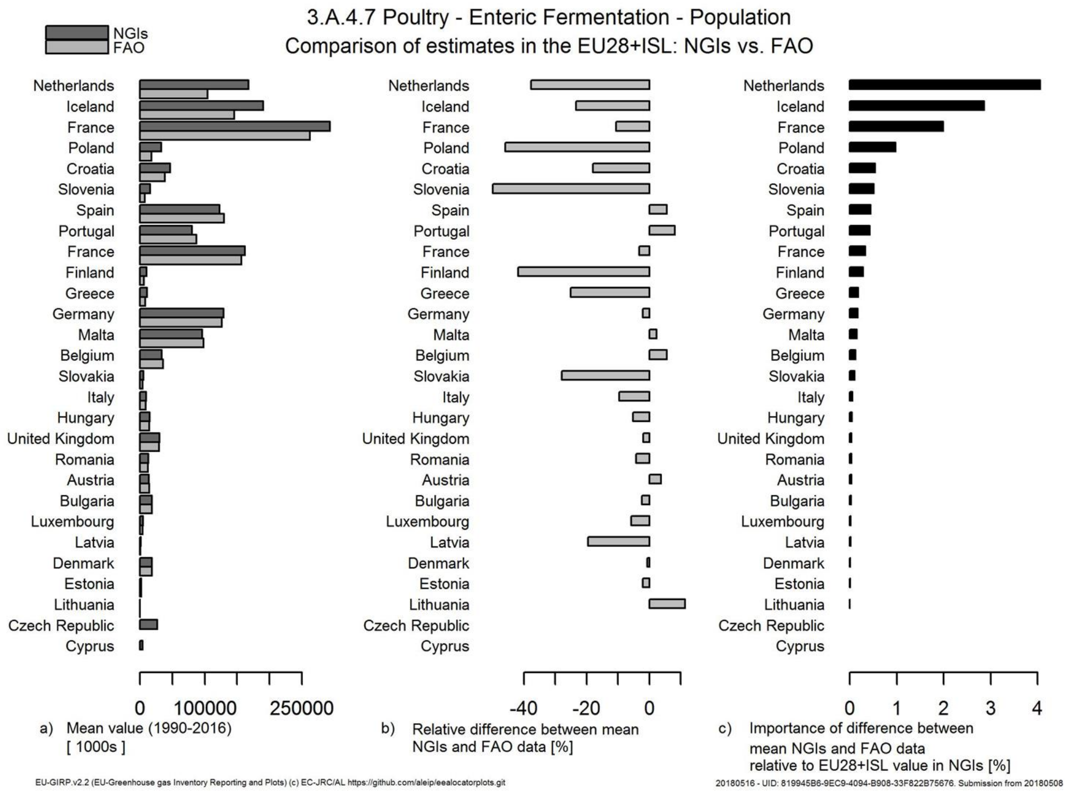


Figure 5.93: 3.A.1: (a) Average Poultry population in the EU28+ISL in the UNFCCC and the FAO, (b) Importance of range of difference in the databases for total EU28+ISL value and (c) Relative difference of mean values by country.



Nitrogen excretion

In addition to population data, nitrogen excretion data is another parameter with a high influence on emissions, notably on N_2O emissions from manure in various emission categories. FAOSTAT calculates N excretion based on default typical animal mass and nitrogen excretion per animal mass unit, while UNFCCC provides national data, calculated with different methodologies. Figure 5.94 through Figure 5.103 compare UNFCCC vs. FAOSTAT data related to N excretion rate for the main livestock categories: dairy cattle, non-dairy cattle, sheep, swine and poultry.

Dairy cattle total N excretion data from FAO are smaller than NIR data for all years. Comparing all years, NIR is larger by 700 kt N/year or -25.1% of the average value in the EU. The three countries with the largest differences in single years are the Netherlands, Germany and France. The largest deviations (FAO minus NIR) are -159 kt N/year (Germany, 2016), corresponding to 6.1% of total EU dairy cattle total n excretion in this year (NIR), -155 kt N/year (Germany, 2015), and -149 kt N/year (Germany, 2014).

Non-dairy cattle total N excretion data from FAO are smaller than NIR data for all years. Comparing all years, NIR is larger by 1081 kt N/year or -31.6% of the average value in the EU. The three countries with the largest differences in single years are France, Ireland and the United Kingdom. The largest deviations (FAO minus NIR) are -433 kt N/year (France, 2001), corresponding to 12% of total EU non-dairy cattle total n excretion in this year (NIR), -424 kt N/year (France, 2000), and -417 kt N/year (France, 2002).

Sheep total N excretion data from FAO are smaller than NIR data for all years. Comparing all years, NIR is larger by 714 kt N/year or -73.3% of the average value in the EU. The three countries with the largest differences in single years are France, Italy and the United Kingdom. The largest deviations (FAO minus NIR) are -170 kt N/year (France, 1990), corresponding to 14% of total EU sheep total n excretion in this year (NIR), -165 kt N/year (France, 1991), and -160 kt N/year (France, 1992).

Swine total N excretion data from FAO are sometimes smaller and sometimes larger than NIR data. Differences are in the range between -10.1% and 13.1%. 10 years showing values that are larger in NIR (on average by 109.9 kt N/year) and 17 years when FAO data are larger (on average by 128 kt N/year). Comparing all years, NIR is smaller by 40 kt N/year or 2.32% of the average value in the EU. The three countries with the largest differences in single years are Germany, Romania and Spain. The largest deviations (FAO minus NIR) are 76 kt N/year (Germany, 1991), corresponding to 3.9% of total EU swine total n excretion in this year (NIR), 69 kt N/year (Germany, 1990), and -62 kt N/year (Romania, 1990).

Poultry total N excretion data from FAO are smaller than NIR data for all years. Comparing all years, NIR is larger by 154 kt N/year or -17.1% of the average value in the EU. The three countries with the largest differences in single years are Poland, Romania and Germany. The largest deviations (FAO minus NIR) are -85 kt N/year (Romania, 1990), corresponding to 8.7% of total EU poultry total n excretion in this year (NIR), -72 kt N/year (Poland, 1994), and -70 kt N/year (Poland, 1991).

Figure 5.94: 3.B.2: Comparison of dairy cattle total nitrogen excretion in the EU28+ISL and range of values reported by countries in the UNFCCC and the FAO.

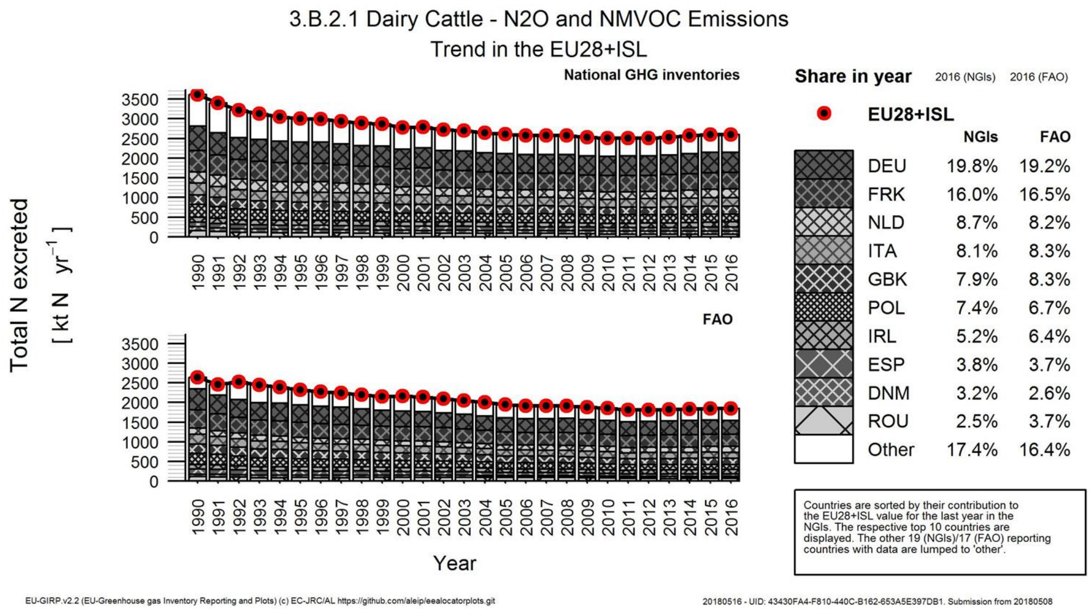


Figure 5.95: 3.B.2: (a) Average Dairy Cattle total nitrogen excretion in the EU28+ISL in the UNFCCC and the FAO, (b) Importance of range of difference in the databases for total EU28+ISL value and (c) Relative difference of mean values by country.

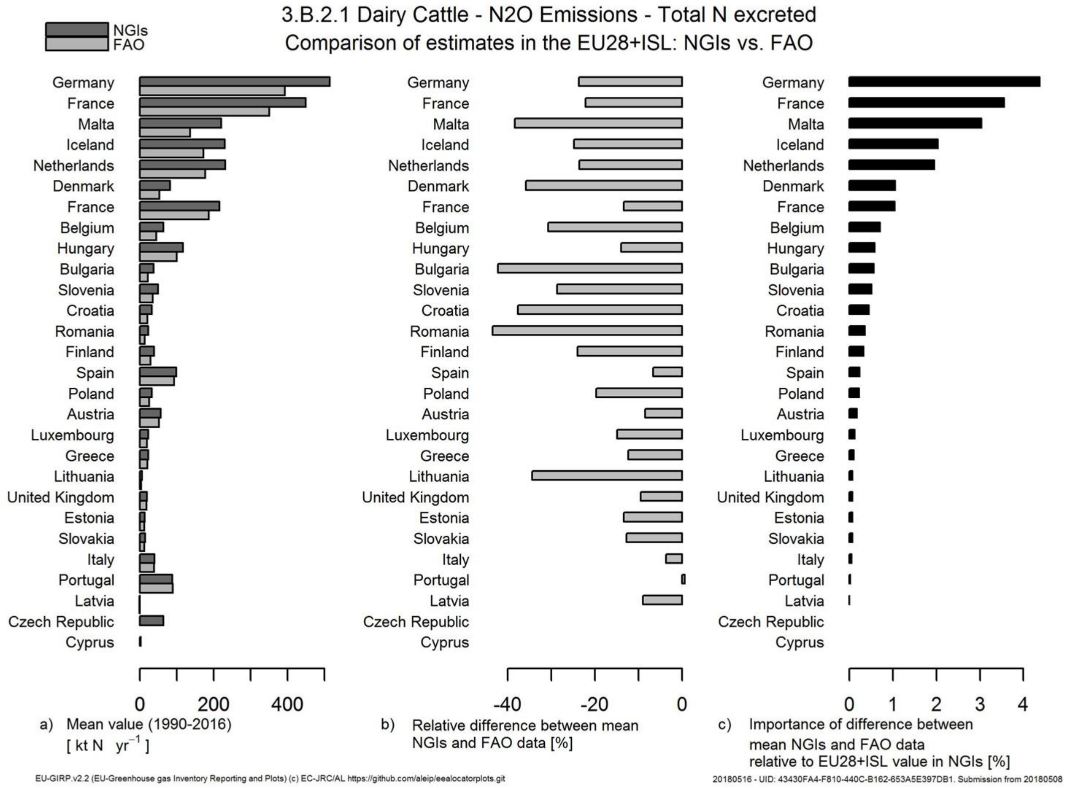


Figure 5.96: 3.B.2: Comparison of non-dairy cattle total nitrogen excretion in the EU28+ISL and range of values reported by countries in the UNFCCC and the FAO.

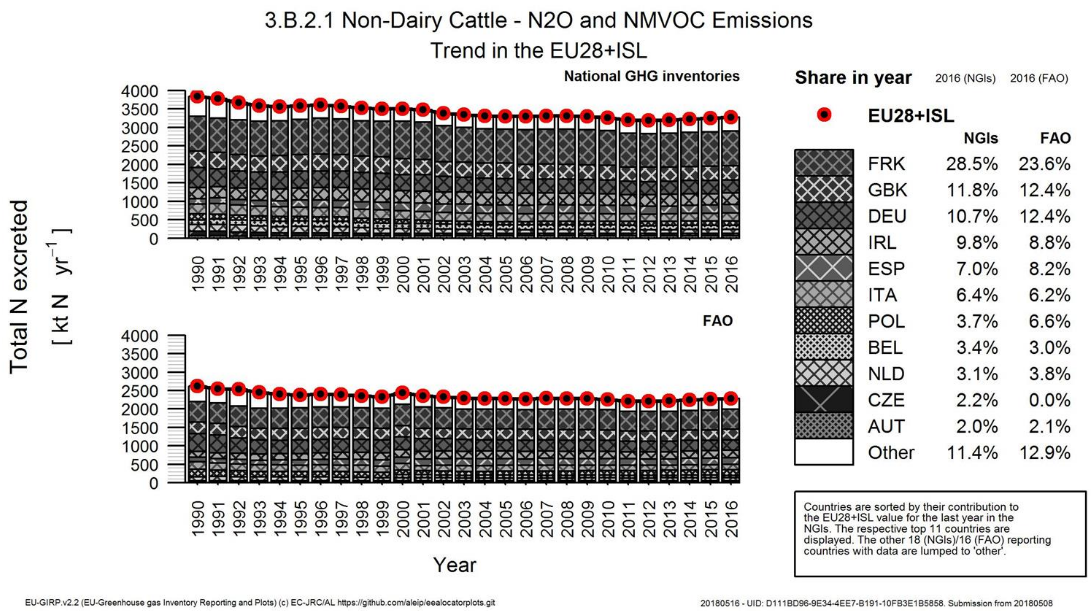


Figure 5.97: 3.B.2: (a) Average Non-Dairy Cattle total nitrogen excretion in the EU28+ISL in the UNFCCC and the FAO, (b) Importance of range of difference in the databases for total EU28+ISL value and (c) Relative difference of mean values by country.

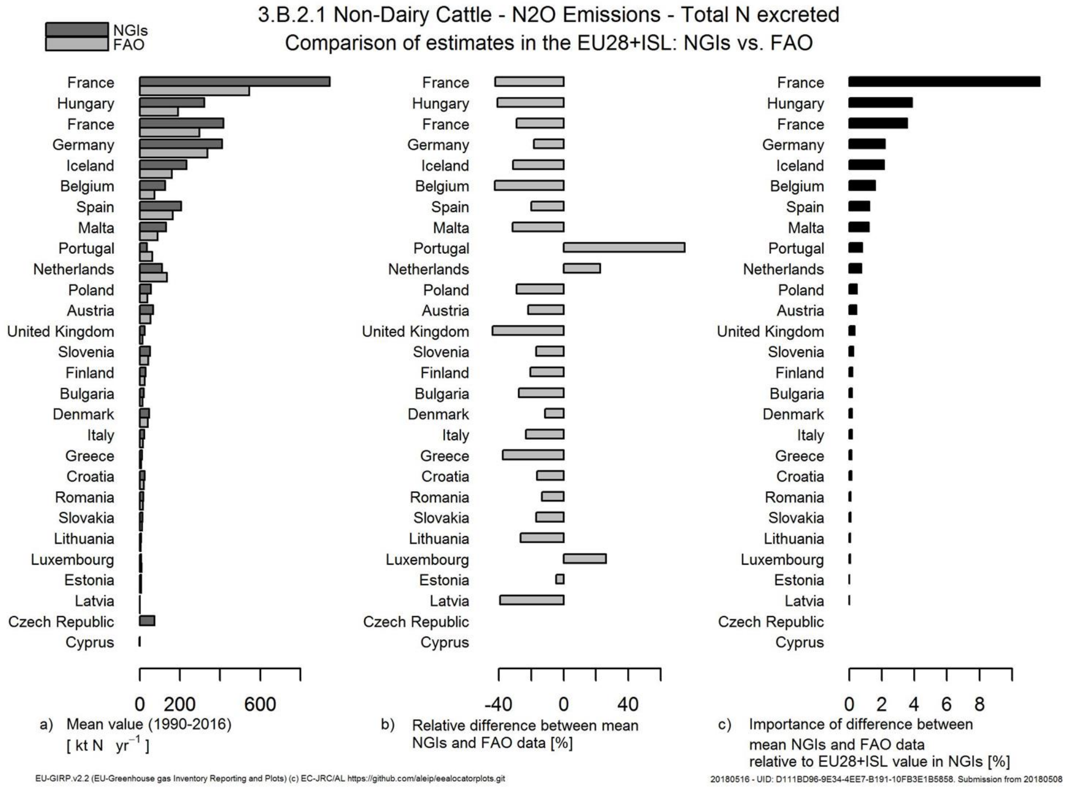


Figure 5.98: 3.B.2: Comparison of sheep total nitrogen excretion in the EU28+ISL and range of values reported by countries in the UNFCCC and the FAO.

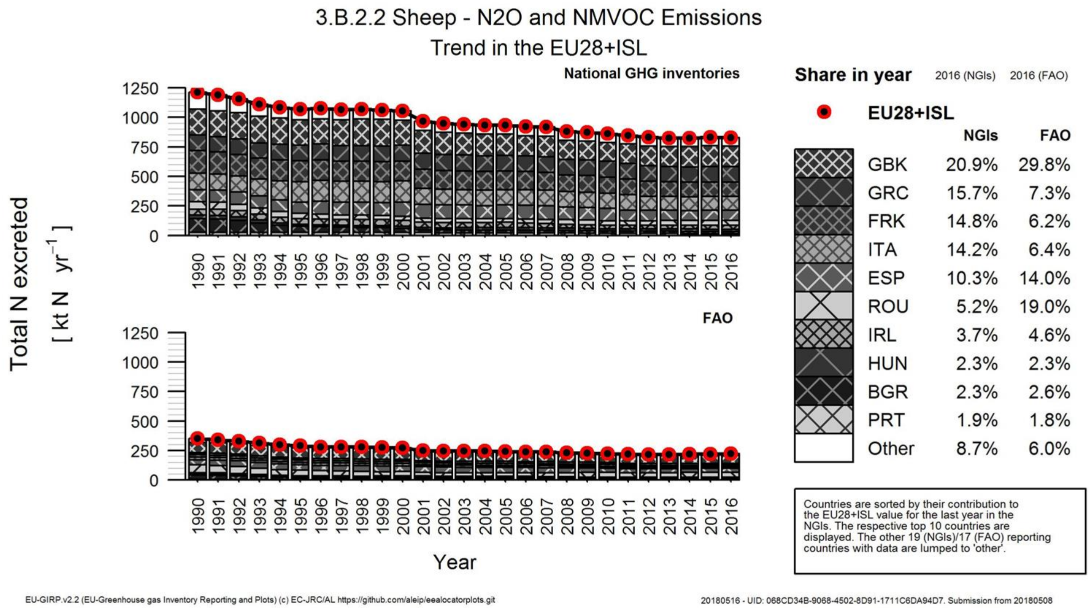


Figure 5.99: 3.B.2: (a) Average Sheep total nitrogen excretion in the EU28+ISL in the UNFCCC and the FAO, (b) Importance of range of difference in the databases for total EU28+ISL value and (c) Relative difference of mean values by country.

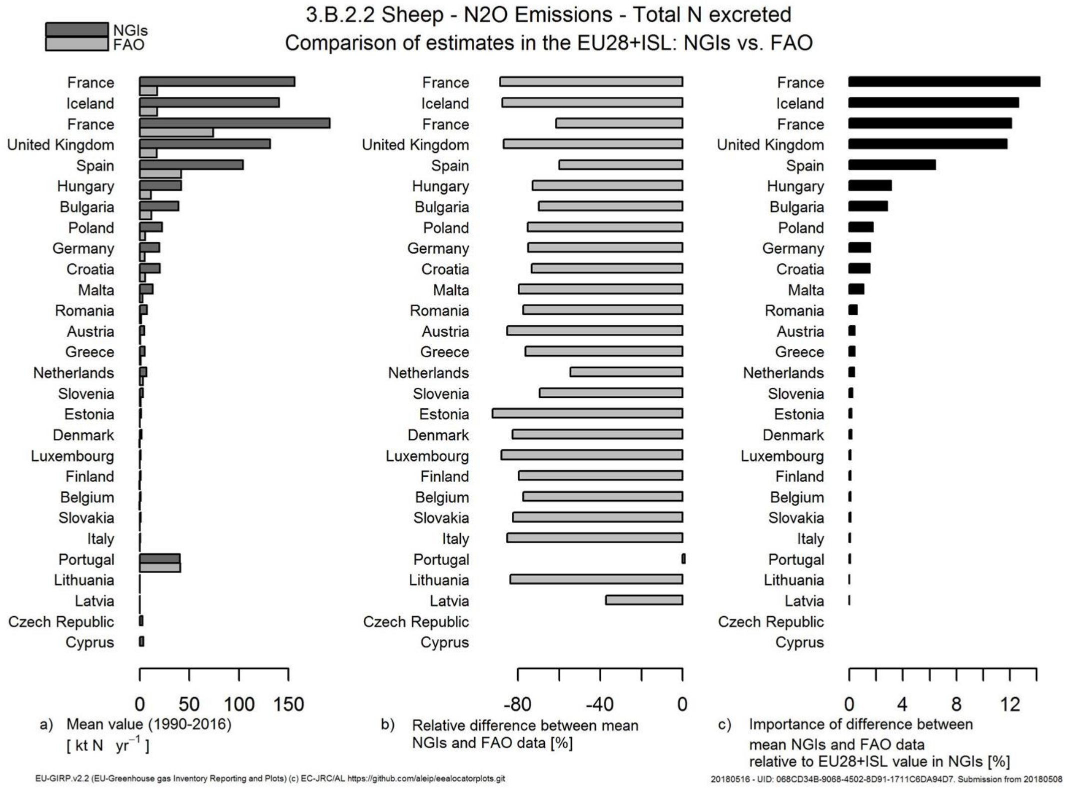


Figure 5.100: 3.B.2: Comparison of swine total nitrogen excretion in the EU28+ISL and range of values reported by countries in the UNFCCC and the FAO.

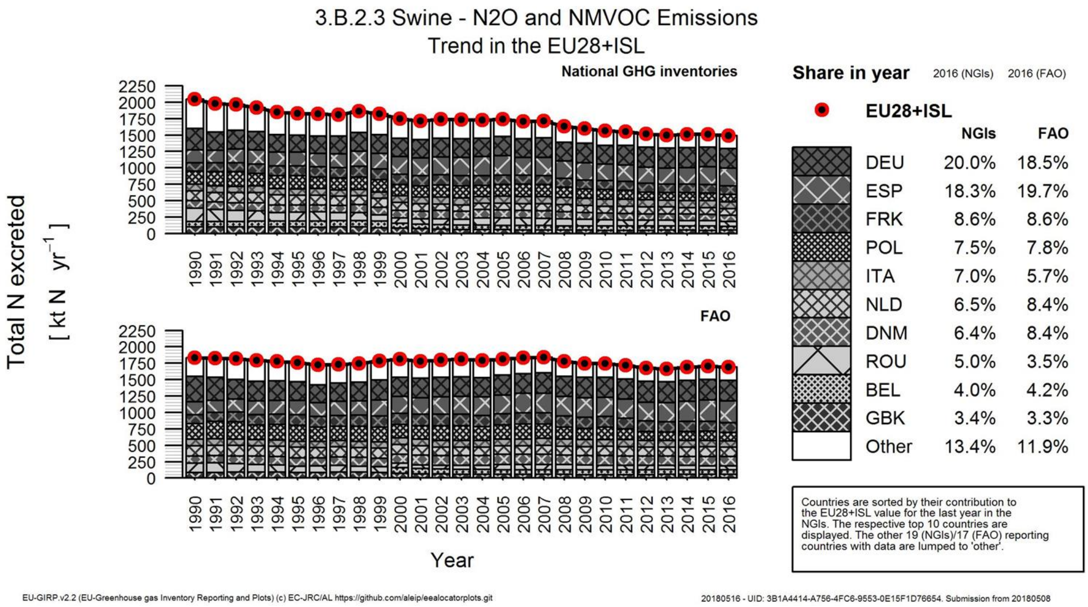


Figure 5.101: 3.B.2: (a) Average Swine total nitrogen excretion in the EU28+ISL in the UNFCCC and the FAO, (b) Importance of range of difference in the databases for total EU28+ISL value and (c) Relative difference of mean values by country.

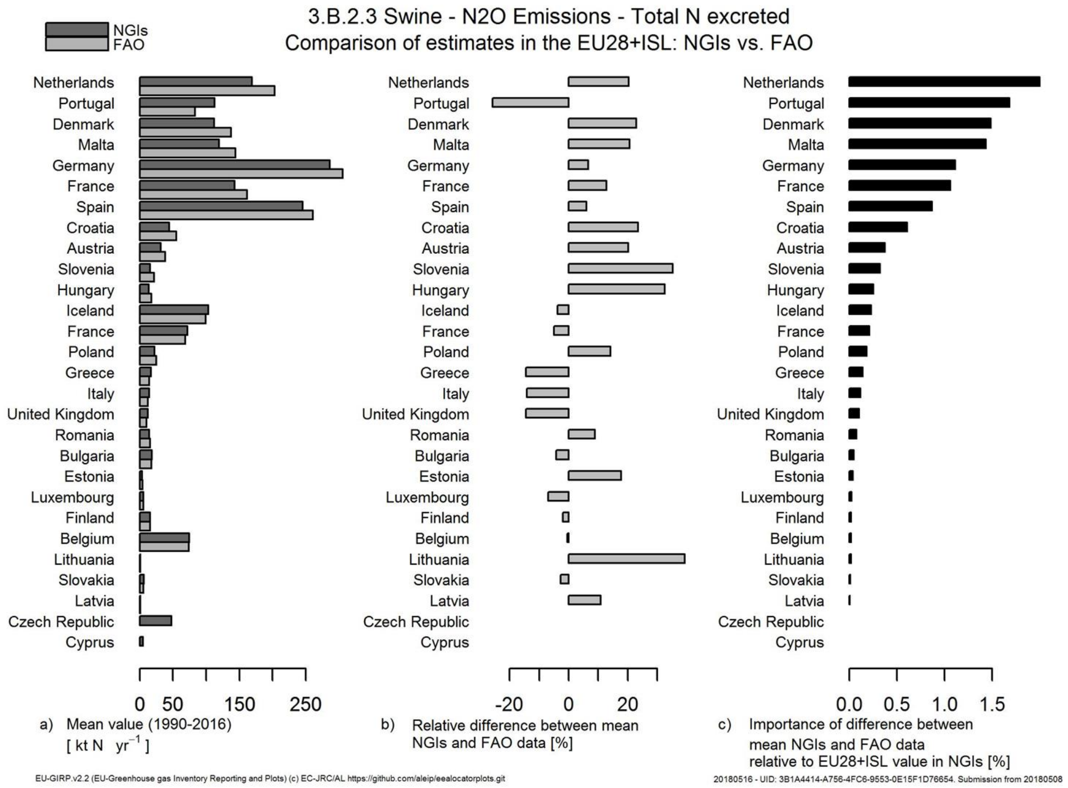


Figure 5.102: 3.B.2: Comparison of poultry total nitrogen excretion in the EU28+ISL and range of values reported by countries in the UNFCCC and the FAO.

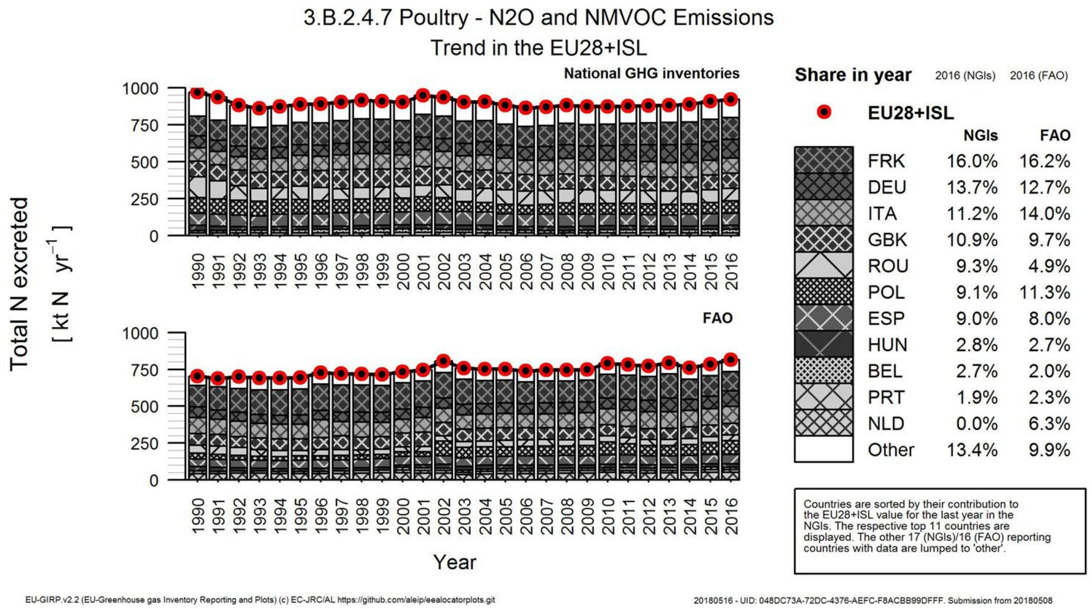
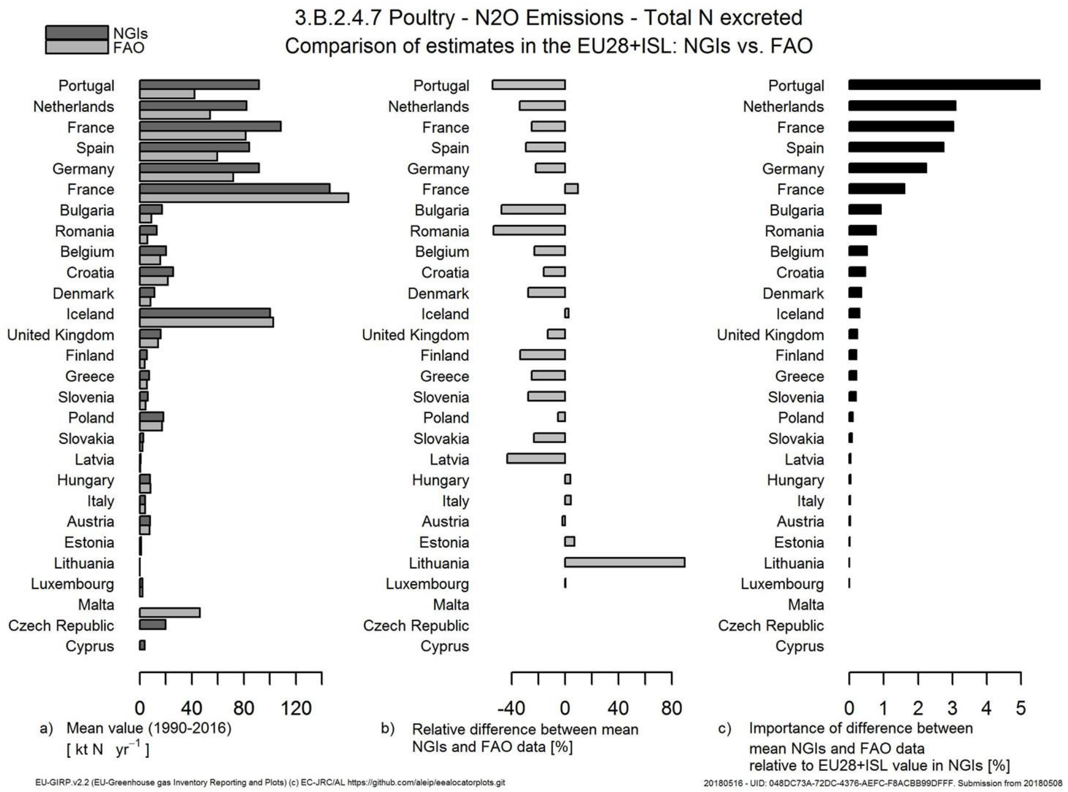


Figure 5.103: 3.B.2: (a) Average Poultry total nitrogen excretion in the EU28+ISL in the UNFCCC and the FAO, (b) Importance of range of difference in the databases for total EU28+ISL value and (c) Relative difference of mean values by country.



Comparing N excretion from the different livestock categories between the two databases, we can see that, for most of them, FAOSTAT presents lower values, being these differences highest for (sheep (-73.4) the EU28+ISL average). Only for swine, approximately half of the countries are reporting higher values in their NIR than FAOSTAT. Individual differences by country for dairy cattle range from -50 to 5%, with a much more defined decrease time trend in the NIR data and differences between databases getting smaller along time for the EU28+ISL totals. For most the countries NIR values are larger, being Greece the only country with larger numbers in FAO (5%). Germany holds the highest difference share in absolute values (4% of total EU28+ISL), followed by France and the Netherlands (3.2 and 3.0%, respectively). Similarly, for N excretion from non-dairy cattle most countries present higher values in the NIR, where data is also (but more smoothly) decreasing in time and decreasing differences with FAO, which shows more stable values. Differences in individual countries range from -40 to 50% (Romania) for the average of the time series. Compared to EU28+ISL totals, France is, by far, responsible for the highest share in the total differences FAO-NIR (10% of the total), followed by United Kingdom (4%) and Ireland (3%). Not only differences for the EU totals but also for individual countries are highest for sheep, always bigger in the NIR database and ranging from nearly 0% in Romania to around 80% in many of the countries. Countries with the highest shares of Nex are also the responsible for the highest shares of total EU differences between databases: France, UK, Italy and Greece (15, 15, 14 and 12% of total EU28+ISL differences, respectively). N excretion from swine also shows a decreasing trend in the UNFCCC database, while FAO data is more stable in time. For the individual countries, differences in the average values along the total period range from -30% in the Czech Republic to 40% in Croatia and Luxemburg. Regarding their contribution to total EU28+ISL differences, Poland is in the first place with 2%, followed by Romania (1.8%). The contribution to the total differences is more equally distributed than in previous livestock categories. Regarding poultry, total N excretion for EU28+ISL is slightly increasing in time in FAO database and more irregularly fluctuating according to NIR data, but it is also lower in FAO, both for EU totals and for most of the countries. Individual country differences range from -40% in Romania and Slovakia to 85% in

Luxemburg. Regarding country contribution to total EU differences, the biggest share corresponds to Romania with 7%, followed by Poland with 3.5%, and United Kingdom with 3%. Only for non-dairy cattle there is one country clearly dominating the differences in EU28+ISL N excretion, while the other livestock categories do not have one only main contributor.

Rice cultivation

Regarding CH_4 emissions from rice cultivation, the related activity data is the rice cultivated area. Figure 5.104 and Figure 5.105 compare rice area of both databases, UNFCCC inventories and FAOSTAT, first total values for all EU-28 countries together, and then differences between databases by country.

Rice harvested area data from FAO are sometimes smaller and sometimes larger than NIR data. Differences are in the range between -4% and 0.4%. 18 years showing values that are larger in NIR (on average by 0.1 thousand km^2 $year^{-1}$) and 9 years when FAO data are larger (on average by 0.0054 thousand km^2 $year^{-1}$). Nevertheless, the data show very similar trends for both datasets. Comparing all years, NIR is larger by 0.051 thousand km^2 $year^{-1}$ or -1.19% of the average value in the EU. The one country with the largest differences in single years are France. The largest deviations (FAO minus NIR) are -0.092 thousand km^2 $year^{-1}$ (France, 2004), corresponding to 2.1% of total EU rice harvested area in this year (NIR), -0.091 thousand km^2 $year^{-1}$ (France, 1990), and NA thousand km^2 $year^{-1}$ (NA, NA).

Figure 5.104: 3.C: Comparison of rice area in the EU28+ISL and range of values reported by countries in the UNFCCC and the FAO.

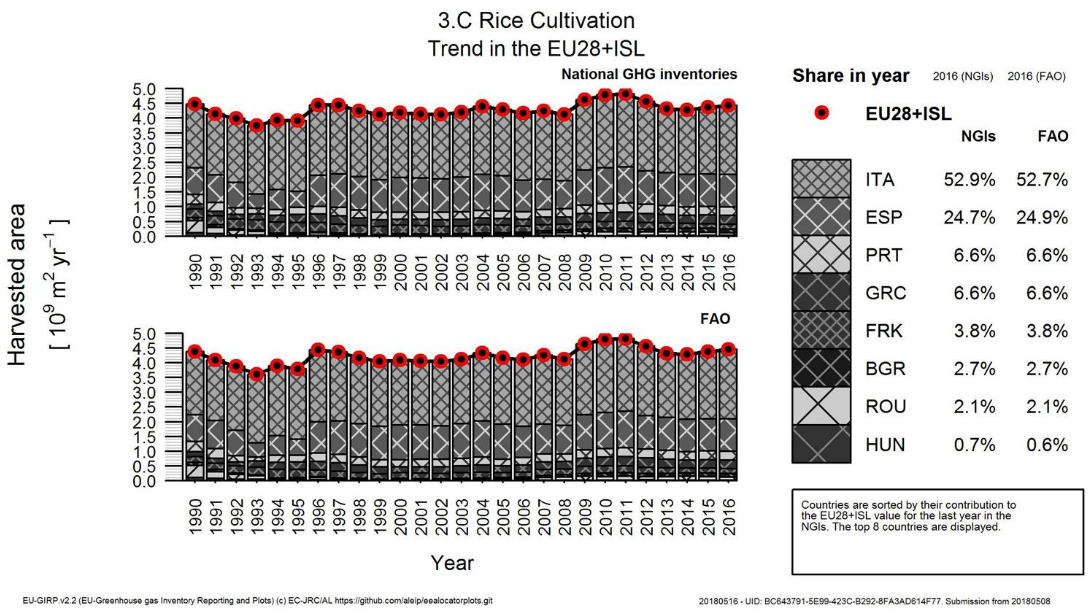
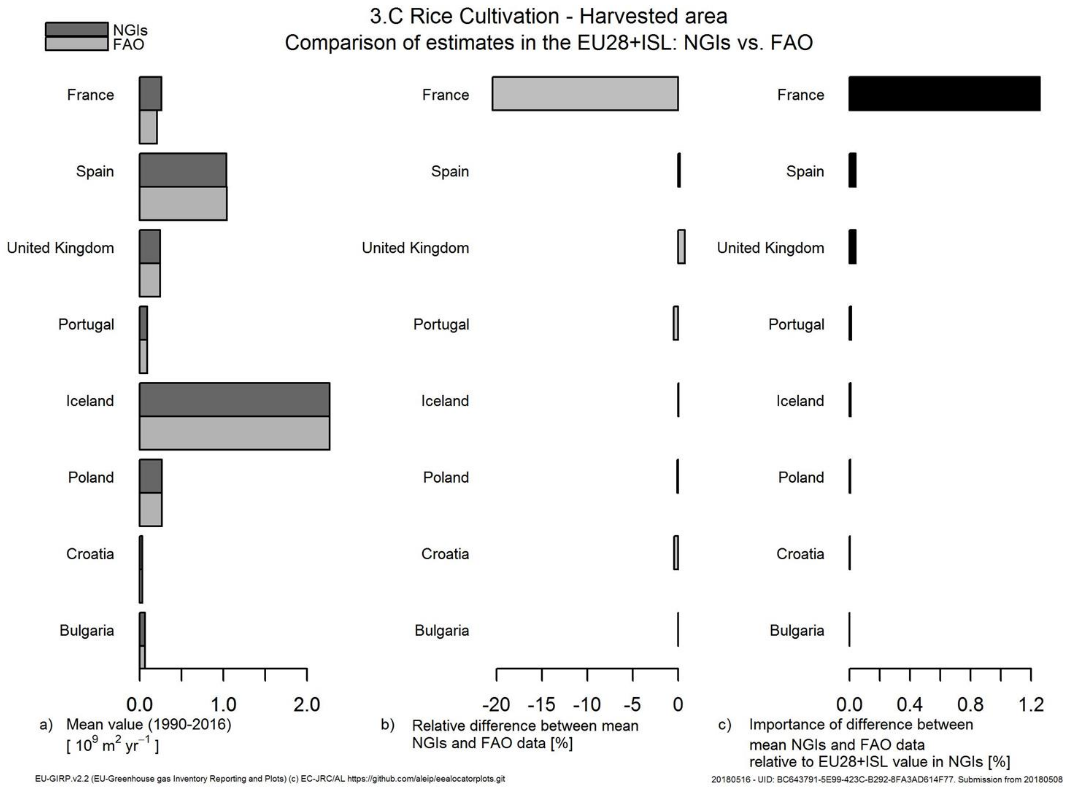


Figure 5.105: 3.C: (a) Average Rice area in the EU28+ISL in the UNFCCC and the FAO, (b) Importance of range of difference in the databases for total EU28+ISL value and (c) Relative difference of mean values by country.



Nitrogen input to agricultural soils

Nitrogen input to agricultural soils is an important factor both direct and indirect N_2O emissions from managed soils. New nitrogen is added with synthetic fertilisers, while other nitrogen sources are recycling nitrogen that comes from livestock and manure management systems, food or other organic waste (compost) or from sewage systems. In the following we compare nitrogen input agricultural soils as mineral fertilisers (Figure 5.106 and Figure 5.107), applied organic fertilisers (Figure 5.108 and Figure 5.109), and crop residues (Figure 5.110 and Figure 5.111).

Figure 5.106: 3.D: Comparison of Inorganic N fertilisers N input in the EU28+ISL and range of values reported by countries in the UNFCCC and the FAO.

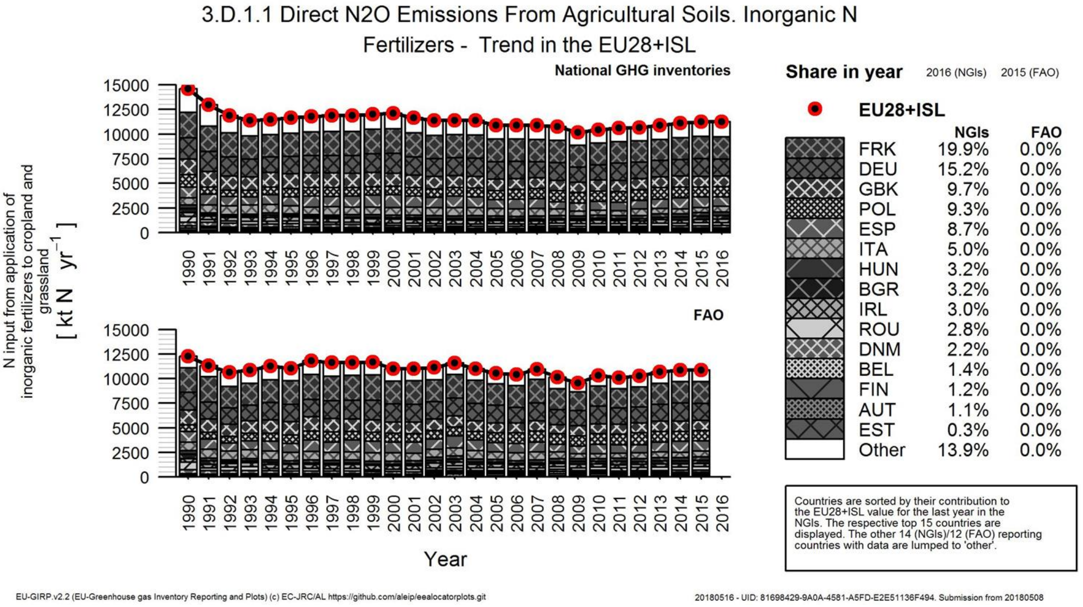


Figure 5.107: 3.D: (a) Average Inorganic N fertilisers N input in the EU28+ISL in the UNFCCC and the FAO, (b) Importance of range of difference in the databases for total EU28+ISL value and (c) Relative difference of mean values by country.

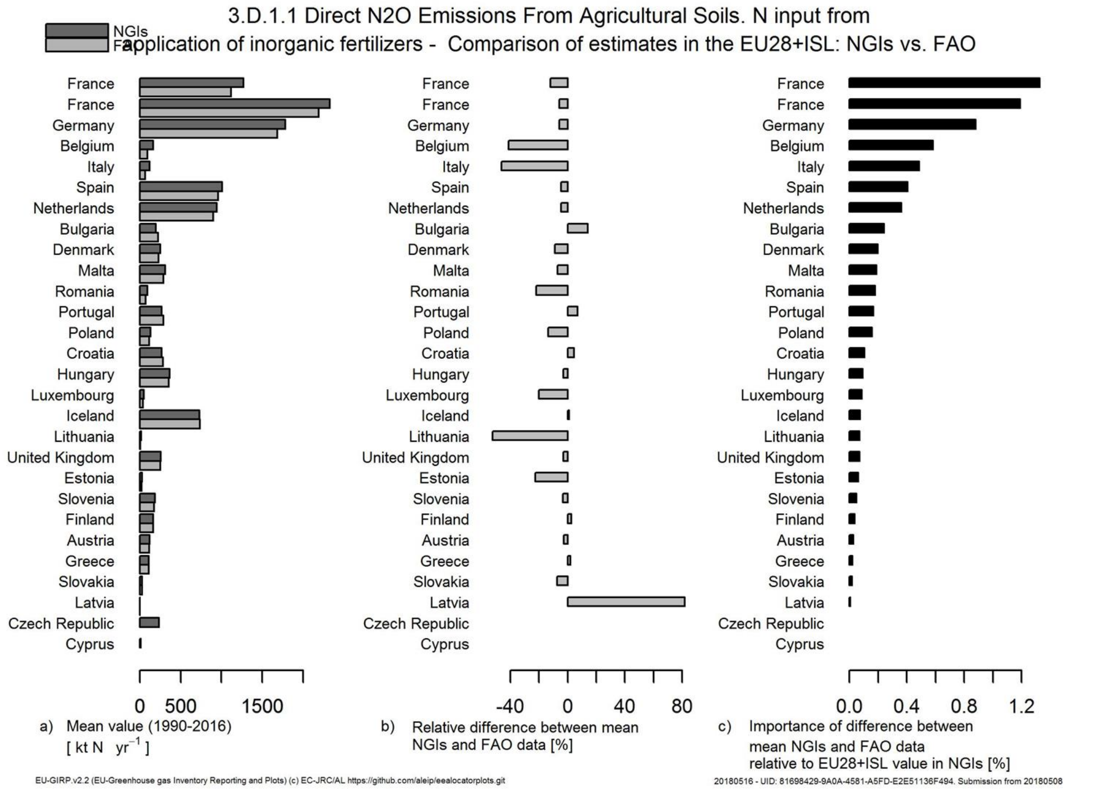


Figure 5.108: 3.D: Comparison of Organic N fertilisers N input in the EU28+ISL and range of values reported by countries in the UNFCCC and the FAO.

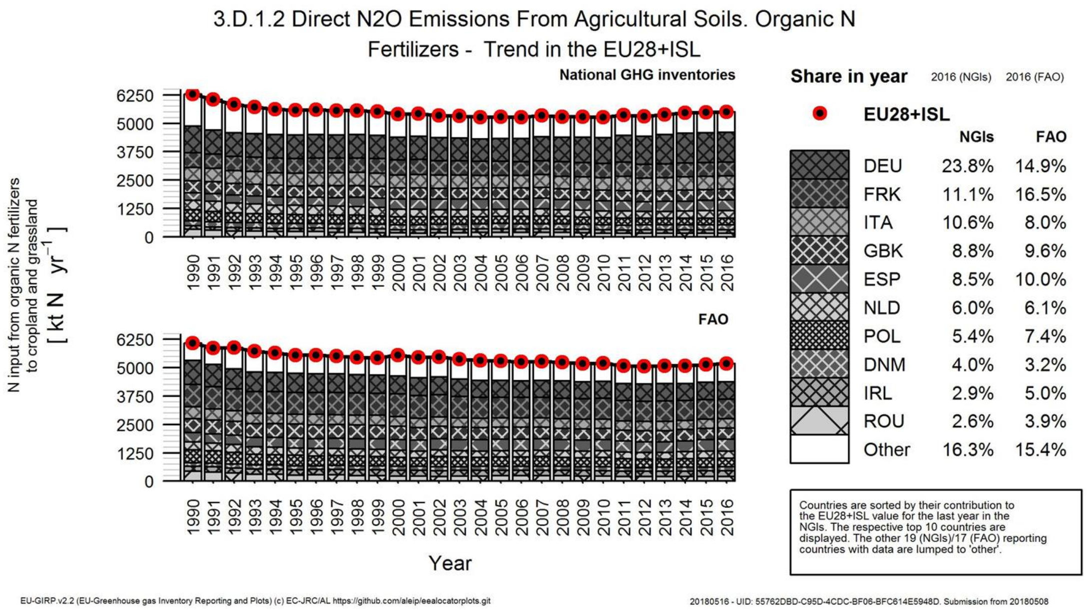


Figure 5.109: 3.D: (a) Average Organic N fertilisers N input in the EU28+ISL in the UNFCCC and the FAO, (b) Importance of range of difference in the databases for total EU28+ISL value and (c) Relative difference of mean values by country.

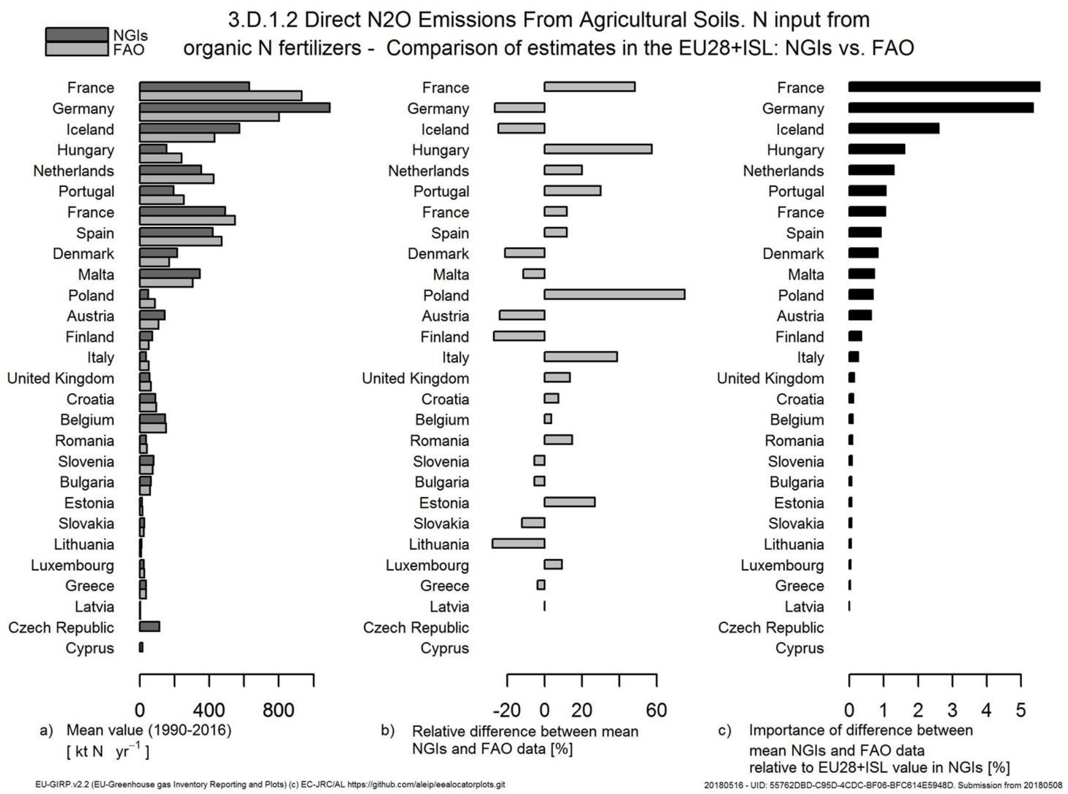


Figure 5.110: 3.D: Comparison of crop residues N input in the EU28+ISL and range of values reported by countries in the UNFCCC and the FAO.

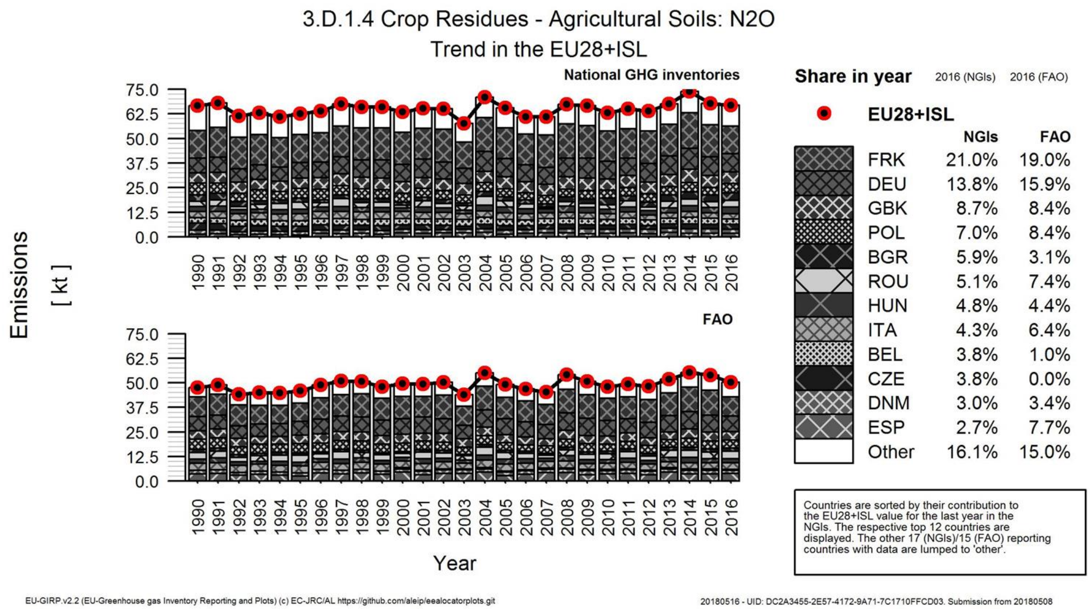
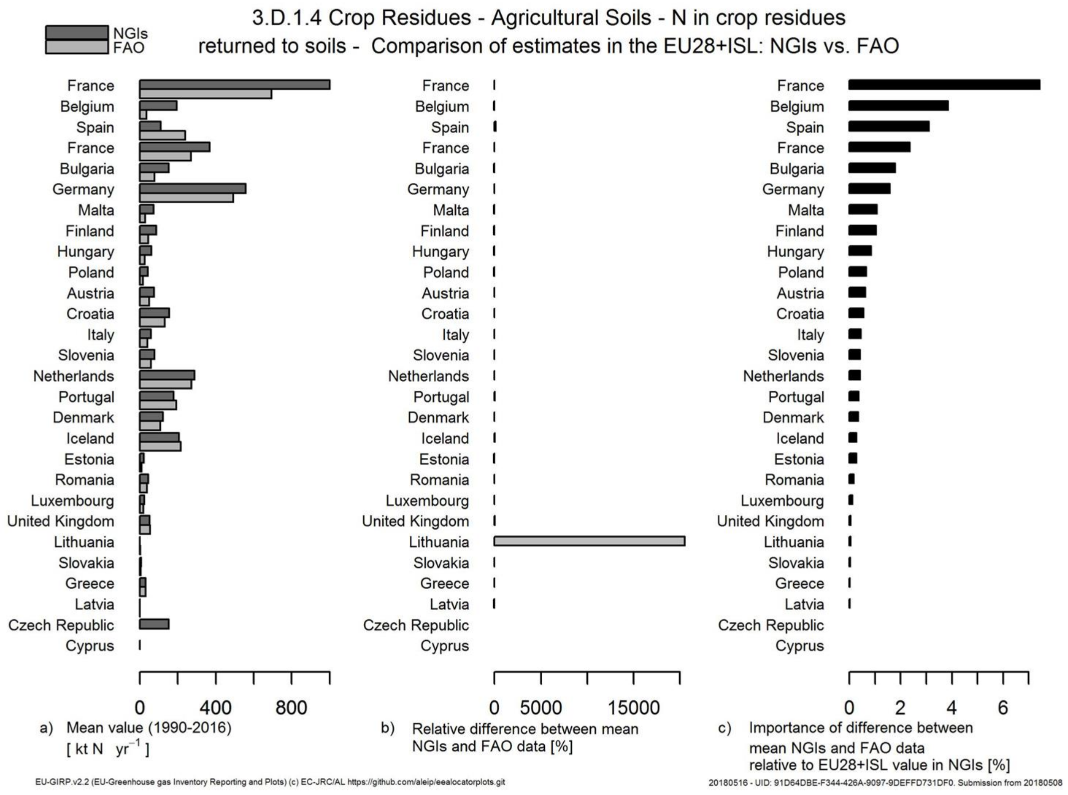


Figure 5.111: 3.D: (a) Average Crop residues N input in the EU28+ISL in the UNFCCC and the FAO, (b) Importance of range of difference in the databases for total EU28+ISL value and (c) Relative difference of mean values by country.



From the three nitrogen sources analysed above, all three present higher total values in the NIR data, but differences are highest in synthetic fertilisers applied. Time trends are quite smooth in the first two cases, with some sudden steps in crop residues applied to soils, which are probably due to climatic reasons and captured by both databases.

Cultivation of histosols

Focusing on the area of cultivated organic soils, we can see in Figure 5.112 and Figure 5.113 that total EU-28 area provided by FAOSTAT is higher than the area reported by countries to UNFCCC, constant in both databases for nearly the whole time series.

Area of cultivated organic soils data from FAO are smaller than NIR data for all years. Comparing all years, NIR is larger by 83855218 ha/year or -93.7% of the average value in the EU. The three countries with the largest differences in single years are the Netherlands, Poland and Estonia. The largest deviations (FAO minus NIR) are -89420425 ha/year (the Netherlands, 1990), corresponding to 95% of total EU area of cultivated organic soils in this year (NIR), -89065902 ha/year (the Netherlands, 1991), and -88711381 ha/year (the Netherlands, 1992).

Figure 5.112: 3.D.1.6: Comparison of histosols area in the EU28+ISL and range of values reported by countries in the UNFCCC and the FAO.

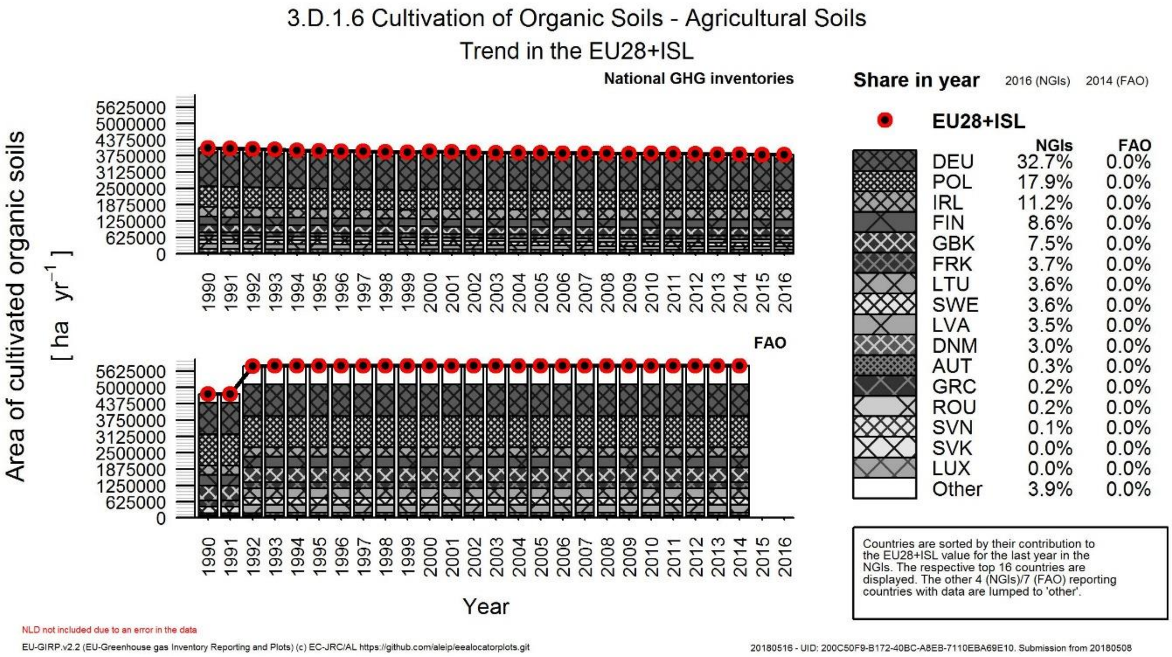
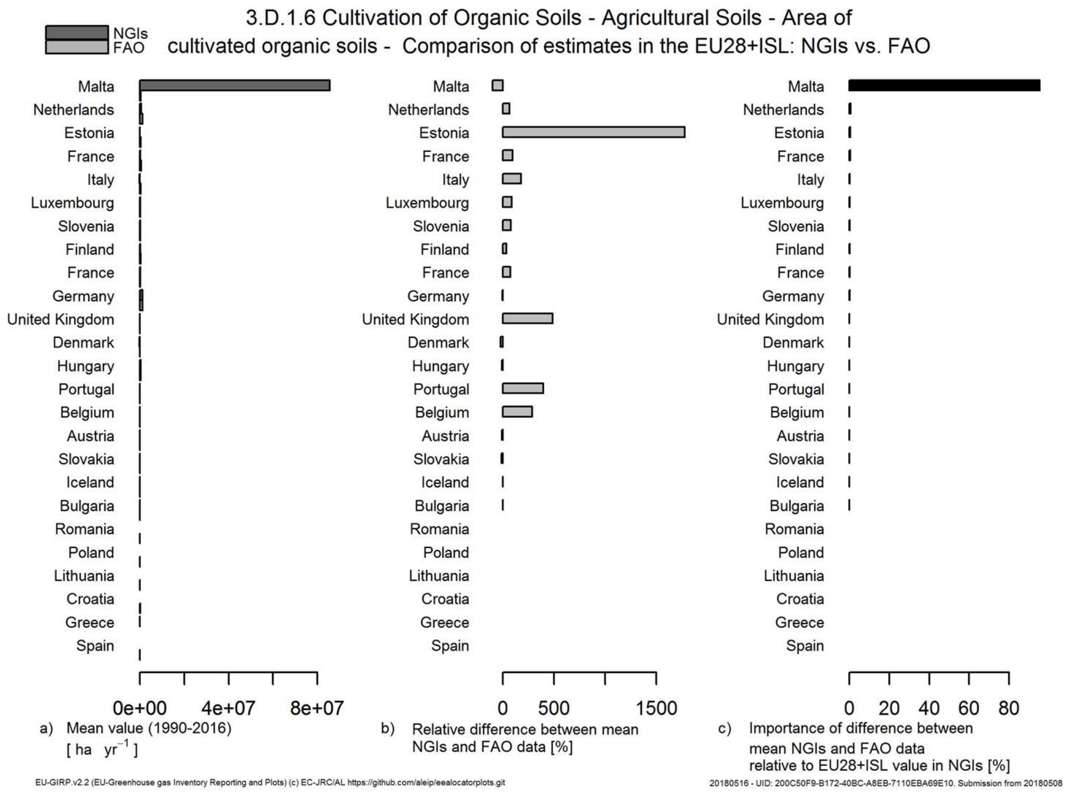


Figure 5.113: 3.D.1.6: (a) Average Histosols area in the EU28+ISL in the UNFCCC and the FAO, (b) Importance of range of difference in the databases for total EU28+ISL value and (c) Relative difference of mean values by country.



An in-depth comparison of the area of cultivated organic soils as reported by the FAO, in the NIRs, and with calculations done at the JRC has been performed by JRC in October 2013.

The FAO (FAO, 2103) provides area of cultivated organic soils on country level. The analysis is based on the Harmonized World Soil Database - HWSD - (FAO/IIASA/ISRIC/ISSCAS/JRC, 2009) and the Global Land Cover data set for the year 2000 (GLC2000).

At JRC the area of cultivated organic soils for the single countries in EU27 has been derived from overlaying the HWSD with the CORINE Land Use/Cover data set - CLC2006 (EEA, 2011) for the year 2006 (for some countries 2000). Both data sets have been resampled to a 1km by 1km raster cell size.

Definition of organic soils as given in IPCC (2006) based on FAO (1998): Soils are organic if they satisfy the requirements 1 and 2, or 1 and 3 below (FAO, 1998):

1. Thickness of 10 cm or more. A horizon less than 20 cm thick must have 12 percent or more organic carbon when mixed to a depth of 20 cm;
2. If the soil is never saturated with water for more than a few days, and contains more than 20 percent (by weight) organic carbon (about 35 percent organic matter);
3. If the soil is subject to water saturation episodes and has either: (i) at least 12 percent (by weight) organic carbon (about 20 percent organic matter) if it has no clay; or (ii) at least 18 percent (by weight) organic carbon (about 30 percent organic matter) if it has 60 percent or more clay; or (iii) an intermediate, proportional amount of organic carbon for intermediate amounts of clay (FAO, 1998).

FAO gave larger area of organic soils cultivated compared to JRC results for all countries except Germany Figure 5.114. This was mainly due to different source data sets for delineation of cropland area and the assumptions regarding the land use classification.

In the JRC approach Soil Typological Units (STU) of the HWSD are defined as 'organic soils'

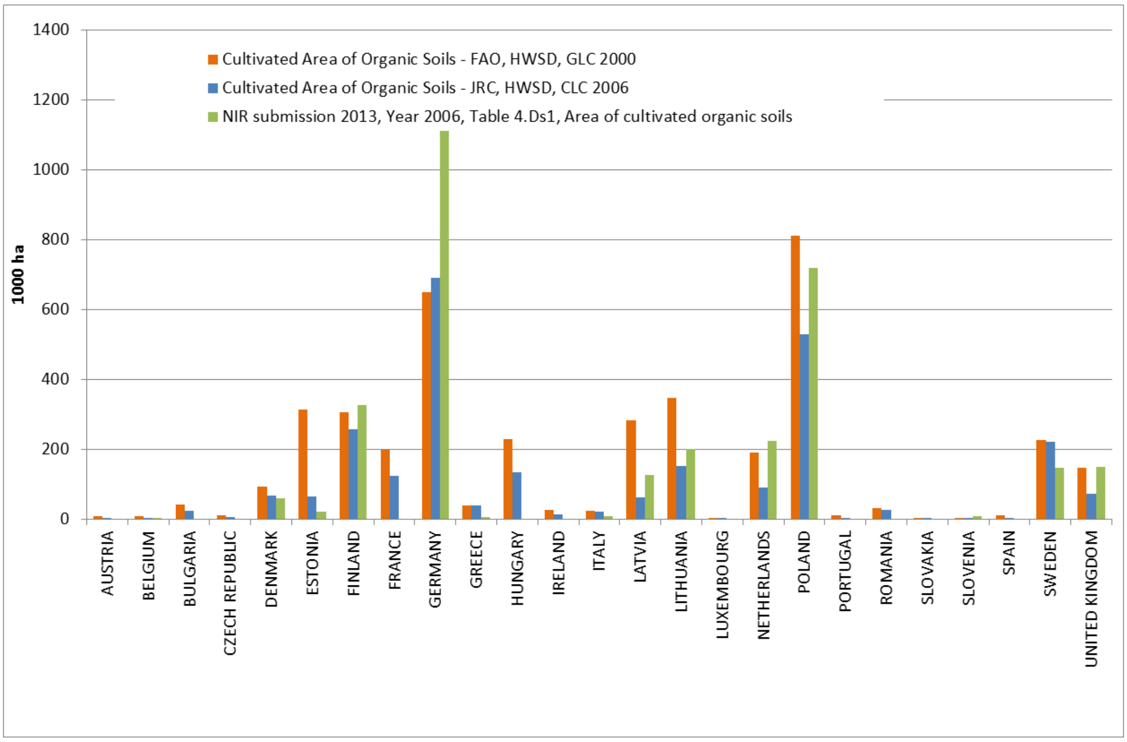
(1) if the topsoil organic carbon content is > 18% or

(2) if the topsoil organic carbon content is higher than the topsoil clay content * 0.1 + 12. All STUs in the EU27 of the HWSD which have been classified as 'organic soils' showed an organic carbon content of >30%, thus de facto only criterion (1) was applied.

To delineate 'cropland area' in the land use/cover map, FAO considers pure cropland classes as well as mixed cropland/other land use classes. For the latter, assumptions were made on the share of cropland within these mixed classes. However, the JRC approach takes assumes that in case of mixed land use classes the probability of the different land uses happening on organic soils are not the same, in contract to the approach of the FAO, which distribute land cover proportionally. As some crops do not grow well on organic soils it might occur that the land uses are not distributed equally on the mineral and organic soil but that 100% of the forest is grown an organic soil and the crops are cultivated only on mineral soils.

In the JRC analysis mixed land use classes are not taken into account as the shares of cropland within these classes are given as ranges in the legend of CORINE. The cropland/other land use shares in the mixed land use classes might also vary between regions. Thus, by excluding mixed land use classes, the estimate of cropland area on organic soils can be considered as conservative compared to the FAO approach.

Figure 5.114: Area of cultivated organic soils based on two studies and the values given in the National Inventory Reports (2013) for the year 2006



Conclusion

Differences in the reported emissions between FAO and UNFCCC databases can be due, as explained before, to diverse activity data or to the methodologies used for the estimation of emissions. If we focus on the emission categories holding the biggest discrepancies between the two databases, different explanations can be found. Emissions reported for category 3.B.2 N_2O emissions from manure management are around 42% larger in the country submissions. This can be explained by estimations of total N excretion data, which are smaller in FAO than in country data for dairy cattle, non-dairy cattle, sheep and poultry for all years (25.1%, 31.6%, 72.7% and 13.1% larger, respectively, as an average of all years for EU total). Only swine shows similar values in the two databases, with numbers which are sometimes higher in the NIRs and sometimes in the FAO database. Many countries use Tier 2 approach, more detailed and using more country specific data than Tier 1 used by FAOSTAT, which can explain differences between databases.

Also emissions in category 3C Rice cultivation were identified as one of the categories with the largest differences in relative terms, in this case showing double values in FAO. Rice area is not always but mostly higher in country submissions (18 years out of 27), with an average difference of only 1.2% for all years and with a different sign than emission differences. Therefore, rice area data cannot explain discrepancies in emissions from rice cultivation. Differences must be due to the consideration of different water regimes (continuously flooded/multiple aeration) and the selection of scaling factors, which are country specific in national submissions but estimated values in FAOSTAT.

For category 3.D.1.6 Cultivation of organic soils, we found that FAO reports 55% larger emissions. Activity data is also larger in FAO for all years, but the difference in areas does not fully explain deviations in emission estimations. Some additional explanation might be that, although countries use mostly Tier 1 approach, some of them apply country specific emission factors.

Regarding category 3.D.2 Indirect N_2O emissions from soils, where FAO reports 24% higher emissions than country submissions, we find that activity data and direct emissions from the application of inorganic fertilisers, organic fertilisers and urine and dung deposited on pastures are very close in both databases. Therefore, differences in activity data cannot explain the differences in indirect emissions, but these are due to the methodologies used in the estimations. Most countries use Tier 1 approach and default emission factor, but many of them use country specific fractions (especially $Frac_{GASM}$ and $Frac_{GASF}$).

5.6 Sector-specific recalculations, including changes in response of to the review process and impact on emission trend

Table 5.62 to Table 5.65 provide information on the contribution of Member States to EU-28+ISL recalculations in sectors 3A (CH_4), 3B (CH_4 and N_2O) and 3D (N_2O) for 1990 and 2016 and main explanations for the largest recalculations in absolute terms.

Table 5.62 3A Enteric fermentation: Contribution of MS to EU-28+ISL recalculations in CH_4 emissions for 1990 and 2016 (difference between latest submission and previous submissions in kt CO_2 equivalents and percent)

	1990		2015		Main explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
Austria	-	-	-	-	NA
Belgium	-	-	9	0.2	Revision of livestock numbers for 2014 and 2015 in Flanders
Bulgaria	0	0.0	6	0.4	Updated milk and wool production of sheep.
Croatia	194	9.8	162	15.8	Technical correction.
Cyprus	-	-	-0	-0.1	Revised population data for swine, horses and mules and asses.
Czech Republic	-	-	-	-	NA
Denmark	0	0.0	0	0.0	NA
Estonia	-	-	1	0.2	Emissions from dairy cattle corrected due to former data errors in protein and fat content of milk.
Finland	-	-	-0	-0.0	NA

	1990		2015		Main explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
France	1 003	2.7	756	2.2	Correction of EF for breeding dairy heifers of more than 2 yrs. Update of animal numbers for overseas territories. Separation of 'horses' and 'mules and asses' from overseas. Update of 2015 animal numbers for several categories. Adjustment of EF for young sheep and goats. Updated EF of CH_4 emissions from enteric fermentation from sows according to MONDFERENT 2 study. Update of pork production for the whole period and milk production for 2015.
Germany	-	-	-25	-0.1	Amongst others: revised animal numbers
Greece	-	-	-189	-4.8	Updated AD.
Hungary	-	-	1	0.1	Revision of feeding characteristics (GE, Ym, DE) for Dairy Cattle. Revised dairy cattle population.
Ireland	-	-	-13	-0.1	Updated EF for some cattle categories. Revised activity data for goats.
Italy	5	0.0	-79	-0.6	Update of methodology by applying Tier 2 for sheep. Updated number of sows.
Latvia	-	-	-	-	NA
Lithuania	32	0.7	-1	-0.0	In order to increase consistency of used methodologies for calculation of emissions from enteric fermentation, the gross energy intake and emission factor of swine and non-dairy cattle for the period 1990-2015 has been recalculated considering the number of animals in subcategories. Livestock population data in non-dairy, sheep, swine, horses, goats and fur bearing animals categories were updated.
Luxembourg	-	-	-0	-0.0	NA
Malta	-1	-2.0	-0	-0.5	Recalculations were due to the revision of livestock populations (cattle, swine, poultry, sheep and goats)
Netherlands	4	0.0	-2	-0.0	Recalculations on faecal N digestibility developed for NH_3 were also considered in the Tier 3 model for CH_4 from enteric fermentation in mature dairy cattle.
Poland	-	-	-	-	NA
Portugal	0	0.0	2	0.1	Revision of 2014 and 2015 animal numbers for poultry, rabbits, horses, mules & asses, according to the results of the last Farm Structure Survey (2016) published by INE.
Romania	-	-	-	-	NA
Slovakia	-	-	-	-	NA
Slovenia	-0	-0.0	3	0.3	Emissions from rabbit production were added (previously not reported). New information on growth rate in fattening cattle was included. Revised data on milk production were taken into account (2015 only).
Spain	-981	-6.9	-396	-2.7	Application of new zootechnical document for sheep. Error corrected to avoid double counting of emissions from horses. Updated animal numbers for goats in 2015
Sweden	-10	-0.3	-4	-0.1	Revised population statistics from the Swedish board of Agriculture./Updated EF for calves.
United Kingdom	-2 027	-7.2	-2 153	-8.9	Revised livestock numbers and implementation of Tier 3 model for cattle and sheep with more detailed categorisation and CS parameters and country and system and country and system-specific information on housing and feeding practices.
EU28	**-1 782**	**-0.7**	**-1 921**	**-1.0**	
Iceland	1	0.2	2	0.8	Emission factors updated to 2006 IPCC Guidelines.
United Kingdom (KP)	-2 027	-7.2	-2 153	-8.9	Revised livestock numbers and implementation of Tier 3 model for cattle and sheep with more detailed categorisation and CS parameters and country and system

	1990		2015		Main explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
					and country and system-specific information on housing and feeding practices.
EU28+ISL	-1 781	-0.7	-1 918	-1.0	

Table 5.63 3B Manure Management: Contribution of MS to EU-28+ISL recalculations in CH_4 emissions for 1990 and 2016 (difference between latest submission and previous submissions in kt CO_2 equivalents and percent)

	1990		2015		Main explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
Austria	0	0.0	0	0.1	Revised amounts of digested manure and energy crops used in biogas plants. Revised Tier 1 calculations for chicken and horses
Belgium	4	0.3	7	0.6	Revision of livestock numbers for 2014 and 2015 in Flanders, correction of solid/liquid manure repartition of calves in Brussels and Wallonia.
Bulgaria	0	0.0	-3	-2.4	New data for feeding of cattle
Croatia	87	26.5	100	28.9	Technical correction
Cyprus	-42	-37.5	-84	-61.4	New Tier 2 methodology for the calculation of CH_4 emissions from swine manure. Revised population data for horses, mules and asses.
Czech Republic	-57	-3.2	-44	-5.7	New region specific default value for swine manure. Corrected Nex of sheep. Revised population data for poultry. Error corrected in weighted value of methane emission factor.
Denmark	0	0.0	15	0.8	Updated number of animals.
Estonia	-	-	0	0.1	2015 emissions from rabbit recalculated to update of rabbit population. Emissions from poultry recalculated due to population update. For dairy cattle, errors corrected in milk protein and fat content data.
Finland	-	-	-1	-0.3	Fur animal numbers updated (2015). Correction of calf weight.
France	-1 768	-32.8	-1 931	-31.1	Improved characterisation of manure management systems. Update of animal numbers and average annual temperature and implementation of full N-cycle balance in overseas territories. Separation of 'horses' and 'mules and asses' from overseas. Update of 2015 animal numbers for several categories. For cattle, revised shares of manure managed in the different systems (more solid, less slurry). For swine, revised VS within the MONDFERENT II project, and also for young sheep and goats. Update of pork production.
Germany	-	-	-12	-0.2	Revised models
Greece	-	-	-22	-3.3	Updated AD.
Hungary	-	-	-9	-1.3	Revision of AWMS data (data update + reallocation of anaerobic digested manure to the AWMS in line with the on-farm storage), feeding characteristics for Dairy Cattle (GE->VS, Nex). Revised dairy cattle population.
Ireland	64	4.8	73	5.6	Revised housing days for sheep and horses. Revised CH_4 EF for some cattle categories. Updated GE and DE intake values for swine, according to current feeding practices.
Italy	-	-	118	4.0	Updated Ym from storage of dairy cattle and swine categories. Updated housing distribution for dairy cattle, changing liquid/slurry and solid shares. Based on new manure storage system data, CH_4 emission factors for swine have been updated. Revised number of sows.
Latvia	-0	-0.0	-0	-0.0	Entering of data in CRF with more precise amounts of decimal places.

	1990		2015		Main explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
Lithuania	44	7.0	11	4.2	Recalculations of methane EF for non-dairy and swine have been made due to recalculated animal population, distribution in subcategories and updated GE indicators.
Luxembourg	-	-	0	0.0	NA
Malta	0	1.4	0	9.8	Recalculations were due to the revision of livestock populations (cattle, swine, poultry, sheep and goats) and the improvement of rabbit manure management emissions methodology to tier 2
Netherlands	-367	-6.3	-585	-13.0	Updated MCF and B0 CS values, based on more recent literature
Poland	-	-	-	-	NA
Portugal	141	20.9	127	21.4	Revision of the share of the manure of cattle, sheep, goats and equidae, managed in each type of storage system ; revision of the MCF used for manure storage in tank systems.
Romania	-	-	-1	-0.1	Results a difference due to of transcription errors.
Slovakia	1	0.2	2	1.6	New AWMS percentages for dairy cattle were implemented. Due to implementation of digesters methane emissions increased.
Slovenia	0	0.1	5	1.8	Emissions from rabbit production were added (previously not reported). Emissions from other chicken for 2000-2015 have been included (previously not reported by mistake). New information on growth rate in fattening cattle was included. Revised statistical data on milk production were taken into account (2015 only). Based on new farm structure data for 2016 estimates for manure management systems were corrected also for 2014 and 2015.
Spain	18	0.3	-1 522	-18.0	Revised values of VS for sheep and poultry, based on the zootechnical document. New rules for the distribution of manure along MMS for pigs and goats.
Sweden	-	-	1	0.3	Revised population statistics from the Swedish board of Agriculture. Revised population statistics for turkeys.
United Kingdom	419	9.4	788	22.4	Revision of livestock numbers. For cattle and sheep, CS VS excretion values, calculated with a Tier 2 approach, based on GE from Tier 3 enteric CH_4 model. In addition, for cattle, reallocation of manure along MMS and revision of MCF for crusted slurry storage. For poultry, revisions to allocation of the default VS and B0 values.
EU28	-1 457	-2.7	-2 968	-6.6	
Iceland	2	4.7	2	4.8	Emission factors updated to 2006 IPCC Guidelines.
United Kingdom (KP)	419	9.4	788	22.4	Revision of livestock numbers. For cattle and sheep, CS VS excretion values, calculated with a Tier 2 approach, based on GE from Tier 3 enteric CH_4 model. In addition, for cattle, reallocation of manure along MMS and revision of MCF for crusted slurry storage. For poultry, revisions to allocation of the default VS and B0 values.
EU28+ISL	-1 454	-2.7	-2 966	-6.6	

Table 5.64 3B Manure Management: Contribution of MS to EU-28+ISL recalculations in N_2O emissions for 1990 and 2016 (difference between latest submission and previous submissions in kt CO_2 equivalents and percent)

	1990		2015		Main explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
Austria	-	-	-0	-0.1	Revised amounts of digested manure and energy crops used in biogas plants.
Belgium	-40	-4.1	-43	-5.8	Revision of livestock numbers for 2014 and 2015 in Flanders, correction of solid/liquid manure repartition of calves in Flanders and Wallonia. Flanders: update NH_3-model complete time series (impact on indirect emissions). Revision of EF for direct N_2O emissions from liquid manure storage, FracGASM and N for leaching.
Bulgaria	63	5.3	12	2.6	New data for feeding of cattle
Croatia	38	11.7	21	14.2	Technical correction
Cyprus	0	0.0	-0	-0.1	Revised population data for horses, mules and asses (affecting direct and indirect emissions).
Czech Republic	-839	-34.1	-181	-18.0	Corrected share of manure managed in 'dry lot' and 'solid storage'. New region specific default value for swine manure. Corrected Nex of sheep. Revised population data for poultry.
Denmark	0	0.0	7	0.9	Updated number of animals.
Estonia	-	-	-1	-0.9	2015 emissions from rabbit recalculated to update of rabbit population. Emissions from poultry recalculated due to population update. For dairy cattle, errors corrected in milk protein and fat content data.
Finland	-	-	-0	-0.0	NA
France	609	25.9	789	42.4	Improved characterisation of manure management systems. Update of animal numbers and average annual temperature and implementation of full N-cycle balance in overseas territories. Separation of 'horses' and 'mules and asses' from overseas. Update of 2015 animal numbers for several categories. For cattle, revised shares of manure managed in the different systems (more solid, less slurry). Update of Nex for sheep and goats based on MONDFERENT II. Update of pork production.
Germany	-1	-0.0	-3	-0.1	Amongst others: revised animal numbers and revised N-models
Greece	9	2.7	-15	-4.8	Updated AD and update of Nex values for dairy cattle.
Hungary	5	0.5	15	3.3	Revision of AWMS data (data update + reallocation of anaerobic digested manure to the AWMS in line with the on-farm storage), feeding characteristics for Dairy Cattle (GE->VS, Nex) and indirect emissions (NH_3-N and NO_x-N volatilization losses as well as leaching and run-off). Revised dairy cattle population.
Ireland	19	3.9	14	2.9	Change in N excretion for other cattle, now based on a Tier 2 method, and revised housing days for sheep and horses.
Italy	4	0.1	-26	-1.2	Update of NH_3 and NO_x emissions from housing and storage that involves changes in FracGASMS. Based on new data on MMS, emission factors of NH_3 from housing and storage also updated. NO_x emissions from storage updated according to Tier 2 methodology from EMEP/EEA Guidebook 2016. NH_3 emissions from digesters biogas facilities have been estimated and subtracted from manure management category, allocated in anaerobic digestion in 5B2.Distribution of N excreted between liquid/slurry and solid has been revised.

	1990		2015		Main explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
Latvia	-12	-4.1	-6	-6.6	For 2018 submission, recalculations of emissions from manure management for period 1990-2016 are done based on implementation of revised nitrogen excretion value for fur animals, taking into account the fact, that most of fur animals in Latvia were minks (98% of the total fur-animals in 2016) . Previously IPCC default N excretion value 8.34 kg N year -1 was used. New value introduced for the 2018 submission is 4.60 kg N year-1 according to EMEP/EEA 2016 . Recalculations also are done for the estimation of indirect nitrous oxide emissions from manure management, according to updating of Tier 2 methodology assumptions to calculate N that is lost due to volatilisation of NH_3 and NO_x from the livestock buildings and manure storage facilities.
Lithuania	7	1.2	2	0.8	N excretion rates were recalculated due to updated animal numbers in subcategories. N_2O emissions have been recalculated due to recalculation of N excretion rates.
Luxembourg	6	15.0	3	9.0	Change of nitrogen excretion factors for dairy cows.
Malta	0	1.9	0	4.1	Recalculations were due to the revision of livestock populations (cattle, swine, poultry, sheep and goats) and an improvement in the rabbit manure management emissions methodology to tier 2
Netherlands	-4	-0.5	1	0.1	Updated Nex of cattle categories
Poland	-	-	-33	-1.6	Corrected Nex for other cattle
Portugal	22	8.7	-17	-9.1	Revision of the share of the manure of cattle, sheep, goats and equidae, managed in each type of storage system ; revision of the EF used for manure storage in tank systems.
Romania	-	-	-	-	NA
Slovakia	12	2.5	3	1.9	New AWMS percentages for dairy cattle were implemented. Due to implementation of digesters N_2O emissions decreased. Nex correction was performed in poultry category. Average body weight was changed in turkey category, high average body weight was corrected.
Slovenia	4	2.8	3	3.0	Emissions from rabbit production were added (previously not reported). Revised statistical data on milk production were taken into account (2015 only). Based on new farm structure data for 2016 estimates for manure management systems were corrected also for 2014 and 2015. N excretion in sheep and goats was corrected for the entire period.
Spain	94	6.7	88	5.0	Application of zootechnical document of reference for sheep and poultry. Application of manure management system usage (MS%) for white swine and goats.
Sweden	2	0.4	2	0.5	Revised population statistics from the Swedish board of Agriculture./Indirect emissions from NO_x are now included.
United Kingdom	1 738	98.3	1 398	95.2	New model implemented for cattle and sheep with revised estimates of N excretion based on diet and production characteristics; full N-balance approach implemented for manure management including all N losses (NH_3, N_2O, NO, N2, leached N), additions (N added in bedding for livestock housing) and transfers (immobilisation, mineralisation); CS EF for N_2O from deep litter systems implemented.
EU28	1 737	5.9	2 033	9.7	
Iceland	0	0.1	-0	-0.2	Minor adjustments

	1990		2015		Main explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
United Kingdom (KP)	1 738	98.3	1 398	95.2	New model implemented for cattle and sheep sectors with revised estimates of N excretion based on diet and production characteristics; full N-balance approach implemented for manure management including all N losses (NH_3, N_2O, NO, N2, leached N), additions (N added in bedding for livestock housing) and transfers (immobilisation, mineralisation); CS EF for N_2O from deep litter systems implemented.
EU28+ISL	1 737	5.9	2 033	9.7	

Table 5.65 3D Agricultural Soils: Contribution of MS to EU-28+ISL recalculations in N_2O emissions for 1990 and 2016 (difference between latest submission and previous submissions in kt CO_2 equivalents and percent)

	1990		2015		Main explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
Austria	-0	-0.0	7	0.3	Updated land-use data within LULUCF sector (3.D.1..5), revision of Austria's air emission inventory (N-flow model), correction of an error in the calculation of NO-N losses from sewage sludge application and revised activity data for urea application (3.D.2)
Belgium	59	1.3	89	2.7	Flanders: update NH_3-model complete time series (impact on indirect emissions soils), update number of animals 2014-2015 (impact on direct and indirect) and update area cropland remaining cropland. Revision of N excretion factors, FracGASM and FracGASF. Wallonia: revision of N manure applied to soils (related to new NH_3 methodology).
Bulgaria	279	5.3	319	8.9	Revised data on fertiliser consumption, revised emission factor for urine and dung deposited by grazing animals, updated FracGASF according to EMEP/EEA Guidebook 2016, revised AD of manure applied to soils due to changes in category 3B.
Croatia	41	3.0	37	3.9	Correction of error
Cyprus	-15	-9.7	-10	-7.6	Consideration of volatilisation losses for the estimation of emissions from animal manure applied to soils. Revised activity data for sewage sludge applied to soils. Estimation of emissions from other organic fertilisers applied to soils for the first time. Estimation of emissions from the incorporation of crop residues other than wheat; mistake corrected for emissions from the incorporation of wheat residues.
Czech Republic	-266	-4.6	-101	-2.9	New data on sewage sludge applied to soils for 1990-2001. Calculation of emissions from mineralisation of soil organic matter now based only on cropland remaining cropland. Removed indirect N_2O emissions from manure management in the calculation of manure N available for application. Revised cattle weight.
Denmark	42	0.8	72	1.9	Revised activity data for inorganic N fertilisers (2009-2015). New data on sewage and industrial sludge leading to recalculations in N_2O emissions from sludge and in N_2O emissions from atmospheric deposition due to increase in NH_3 emissions from sludge.
Estonia	-5	-0.4	5	0.8	Updated activity data under the manure management subcategory; corrections of omission errors of milk and protein data and correction of one calculation; corrections in calculations implemented under the crop residues subcategory; data on areas of organic soils cultivated were updated in the framework of the NFI (see chapter LULUCF); starting to report N_2O emissions from mineralization associated with loss/gain of soil organic matter. Please see Chapters 5.4.12 and 5.5.6.
Finland	0	0.0	12	0.3	Fur animal numbers updated for 2015. Cultivation of organic soil areas updated for the whole time series.

	1990		2015		Main explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
France	39	0.1	-171	-0.5	Updated activity data for synthetic fertilisers applied. Update of manure N applied to soils following changes in 3B category; recalculation of manure excreted on pastures following updated Nex for sheep and goats. Revised method for the calculation of N in crop residues (rapeseed, cabbage, potatoes). Updated area of cultivated histosols. Correction of an error in the calculation of FracGAS for grazing, updated NH_3 emission factors for synthetic fertilisers, revised characterisation of cattle manure. Updated quantities of N applied to soils lead also to changes in N leaching.
Germany	-183	-0.6	-299	-1.1	Amongst others: revised animal numbers and N-models
Greece	11	0.2	-235	-7.3	Emissions from manure application recalculated due to updated AD and updated Nex in dairy cattle.
Hungary	-102	-2.8	-16	-0.5	Revision of animal manure N applied to soils (FAM) due to the revision of the N balance (N2 consideration). Revision of N input from compost (FON), and crop residues (FCR). Revision of volatilization losses (FracGASM) due to the recalculations in the UNECE/LRTAP reporting.
Ireland	-713	-10.9	-558	-9.2	Implementation of CS EFs for inorganic fertilisers (by fertiliser type) and for urine and dung deposited by grazing animals (cattle). Adjustments to housing time for sheep and horses. Revision in the estimation of emissions and removals in 4.B and 4.C, affecting emissions due to the cultivation of organic soils and to the mineralisation associated with the loss/gain of organic matter.
Italy	-533	-4.9	-526	-5.9	Updated FracLEACH-(H) based on CS method. Updated NH_3 and NO_x emissions from manure spreading and from sewage sludge, other organic fertilisers and from synthetic fertilisers lead to new FracGASM and FracGASF. Amount of animal manure N applied is affected by changes in 3.B. Part of nitrogen lost through N-NH_3 in digesters was subtracted to the share of N left from housing and storage. Amount of N supplied by bedding changes as a result of new distribution of N excreted by MMS. Update of AD on sewage sludge and number of sows.
Latvia	254	11.1	-62	-3.7	1) Implementation of emission factor 8.2 (kg N_2O-N ha-1yr-1) for organic soils in grasslands to reach consistent reporting of emissions with LULUCF sector, it is consider to use emission factor for temperate climate, deep drained, nutrient-rich grasslands ; 2) implementation of country specific values for DRY matter in crop residues for pulses, fodder roots, green feed, perennial grass, rape, vegetable and flax according to national studies ; 3) updating values of crop residues removal according to expert judgement; 4) updating values of organic soils area.

	1990		2015		Main explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
Lithuania	-2	-0.0	29	1.2	IFA has updated inorganic N fertiliser consumption for 2014 and provided data on inorganic N fertilisers consumption for 2015 only in September of 2017, therefore data for 2014 and 2015 was recalculated. Due to recalculation made in CRF 3.B.2 Manure management category, emission from 3.D.1.2.a Animal manure applied to soils and 3.D.1.3 Urine and dung deposited by grazing animals were also recalculated. Recalculation of 3.D.1.4 Crop residue category was made due to revision of parameters used for the FCR estimation, where incorrect value of FracRENEW was used for mixed dried pulses (0.2 instead 1), as well the ratio of below ground residues to harvested yield of crop (R BG(T)) was omitted from the calculation for annual, perennial grasses and meadows. For some crops Statistics Lithuania has updated data on crops harvests. Also “Non-N-fixing crops” and “Root and tuber crops” categories were recalculated in accordance with 2006 IPCC Guidelines. Recalculations for 3.D.1.5 Mineralization/Immobilization associated with Loss/Gain of soil organic matter for the 1990-2015 period were made due to recalculations made in LULUCF sector. For the 2004 and 2015 notation key NO was used as there was no carbon loss in mineral soils during these years. Due to recalculations of Cropland and Grassland organic soils area made in LULUCF sector, emissions from 3.D.1.6 Cultivation of organic soils was recalculated. Due to recalculations made in 3.D.1 Direct N_2O emissions from managed soils category (Chapter 5.6.1.5) recalculation has been made in 3.D.2 Indirect N_2O emissions from managed soils atmospheric deposition and N leaching and run-off from managed soil categories.
Luxembourg	53	28.2	52	35.9	Revision of available N applied to soils by subtracting volatile N and N2 in MMS.
Malta	-0	-0.8	-1	-3.7	Recalculations were due to the revision of livestock populations (cattle, swine, poultry, sheep and goats) and improvement of rabbit manure management emissions methodology to tier 2 affecting the rate of N from animal manure. In addition, agricultural land areas were revised, crop area was updated and N application was revised.
Netherlands	69	0.7	163	3.0	Adjustments in NH_3 emissions from manure management in the N-flow approach, leading to differences to the N available for application, influencing direct and indirect N_2O emissions. Follow-up crops added to the calculation of crop residues. Updated area of cultivated organic soils. Updated activity data for sewage sludge applied to soils.
Poland	-	-	-36	-0.3	Corrected Nex for other cattle
Portugal	-0	-0.0	-3	-0.1	Revision of the 2015 values for apparent consumption of inorganic N fertilisers (total amount and by type of fertiliser) updated by the National Statistical Institute (INE); Revision of the 2014 and 2015 animal numbers for poultry, rabbits, horses, mules & asses, according to the results of the last Farm Structure Survey (2016); revision of the share of the manure of cattle, sheep, goats and equidae, in each type of management system including deposited in pasture.
Romania	-	-	-	-	NA
Slovakia	-532	-18.3	-455	-28.0	The changes in agriculture soils connected with the changes in manure management. Categories 3.D.1.2.a and 3.D.1.4 were recalculated due to methodological changes.

	1990		2015		Main explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
Slovenia	6	1.4	0	0.0	Emissions from rabbit production were added (previously not reported). Revised statistical data on milk production were taken into account (2015 only). Based on new farm structure data for 2016 estimates for manure management systems were corrected also for 2014 and 2015. N excretion in sheep and goats was corrected for the entire period. New estimates on loss/gain of soil organic matter were introduced. New estimates of indirect N_2O emissions due to volatilization of N compounds from the use of synthetic fertilisers (new NH_3 emission factors for urea, CAN and other mineral fertilisers).
Spain	280	2.9	398	3.9	Updated Nex values, implementation of new rules for the distribution of manure along MMS. New values of Nex for 'other poultry' (turkey), based on EMEP 2016.
Sweden	24	0.7	-29	-0.9	Included N-losses as nitrogen gas (N2) during storage./Revised time series from Statistics Sweden, the Swedish board of Agriculture and the Swedish University of Agricultural Sciences./Rounding of the stable period.
United Kingdom	-3 193	-19.0	-3 107	-21.6	Revisions to fertiliser use and crop activity data based on fuller access to and analysis of British Survey of Fertiliser Practice; Revision to CS EF for mineral fertilisers - now spatially sensitive; revision to N applied to soil as livestock manure as a result of the implementation of the full N-flow model; revisions to N excretion by grazing cattle and sheep. Use of harvest index approach for cereals and oilseed crops and use of CS values for crop residue ratios and N contents. CS value for NH_3 and NO volatilised and for N leached as a result of the full N-flow model.
EU28	-4 387	-2.2	-4 423	-2.7	
Iceland	-21	-9.3	-19	-9.1	Changed so it is consistent with CLRTAP methodology. Instead of using FracGASM from IPCC2006 to estimate N volatilised as NH_3 and NO2, this is now summing the NH_3 and NO2 emissions estimated with EMEP/EEA methodology for Manure to soils and Grazing animals
United Kingdom (KP)	-3 193	-19.0	-3 107	-21.6	Revisions to fertiliser use and crop activity data based on fuller access to and analysis of British Survey of Fertiliser Practice; Revision to CS EF for mineral fertilisers - now spatially sensitive; revision to N applied to soil as livestock manure as a result of the implementation of the full N-flow model; revisions to N excretion by grazing cattle and sheep. Use of harvest index approach for cereals and oilseed crops and use of CS values for crop residue ratios and N contents. CS value for NH_3 and NO volatilised and for N leached as a result of the full N-flow model.
EU28+ISL	-4 408	-2.2	-4 442	-2.7	

6 LULUCF (CRF SECTOR 4)

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. This variety is well recognized as a value in terms of biodiversity and culture, but may represent a challenge when compiling a greenhouse gas (GHG) inventory.

Land use, Land-use change and Forestry (LULUCF) covers anthropogenic GHG emissions, and CO_2 removals that result from land management practices. The sign of the impact of these practices on the carbon stock depends of several factors, but it is well know that, while certain patterns prevent the release of the carbon, or enhance the carbon sink, others stimulate the release of the carbon that is naturally stored in the pools.

With more than three-quarters of the European Union (EU) territory covered by forests and agricultural lands, EU‘s environmental and agricultural policies have had for many years a paramount impact on the current European landscape.

In particular, over the last years, the Common Agricultural Policy, and the rural development programs, have stimulated less intensive agricultural practices, and have implemented measurements towards sustainability and enhancement of rural environments. Furthermore, with the aim of protecting ecosystems and enhance their services, the EU environmental policy (e.g. Natura 2000 network) has resulted in an increase of the area under conservation regime and it has contributed to preserve the biodiversity and landscapes.

Overall, throughout the reporting period (1990-2016) the resulting trend from these policies is a decrease of the arable lands that is compensated by an increase of forests, and to a lesser extent, by urban areas. This is itself one of the main drivers of the final carbon balance in the LULUCF sector. However, of utmost importance is also the fact at the EU level felling accounts for only about two thirds of the net annual wood increment, which explain the significant build-up of biomass over time (i.e. carbon removal) in the forests.

6.1 Overview of the sector

Complying with relevant EU provisions (i.e. Regulation No 525/2013), LULUCF sector of the EU GHG inventory is a compilation of the inventories submitted by individual Member States (MS). Submissions by MS in 2018 are used as the primary source of data and information, unless otherwise specified and referenced in the text.

This chapter provides the general trends of GHG emissions and CO_2 removals from LULUCF at EU level, including information from Iceland. It provides general information on the methods used by the individual national inventories, and describes the efforts carried out to harmonize and improve the quality of the inventories. More detailed information can be found in individual national inventory reports (NIR) and common reporting format tables (CRF) submitted by MS and Iceland.

In particular, this chapter includes: an overview of LULUCF sector and overall trends, the contribution of land use changes, the completeness of the sector in the individual inventories, the key categories analysis of the EU GHG inventory, general methodological information used to derive GHG emissions by sources and removals by sinks, the trends of net emissions or removals, and activity data for each land use category, specific methodological information for relevant categories; and an overview of cross-cutting issues including uncertainties, QA/QC procedures, time series consistency, recalculations and verification.

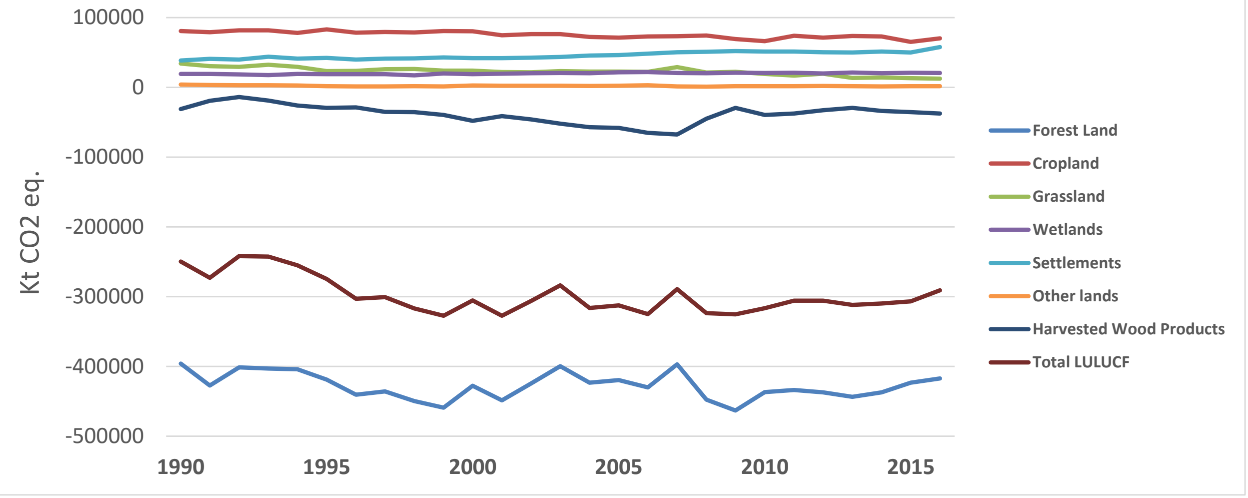
6.1.1 Trends by land use categories

The LULUCF sector within the EU GHG inventory results in a net carbon sink from higher removals by sinks than emissions by sources. In terms of land use categories the only net carbon sinks are represented by Forest land and by Harvested Wood Products. Cropland is the largest source of emissions, and Grasslands, along with the other land use categories, represents a small source of emissions.

In 2016, the LULUCF sector of the EU MS and ISL results in a total net sink of 314.000 kt CO_2, which corresponds to an increase of about 15% as compared to the net carbon sink reported for the year 1990 (Table 6. 1). Harvested Wood Products carbon pool in 2016 is reported as a net carbon sink of about -38.235 kt CO_2. Emissions of CH_4 and N_2O offset about 7% of total annual carbon removals.

Within the EU, few MS also reported in the CFR table 4, under the category "Other", additional emissions of GHG. For instance, France reports CO_2 and CH_4 emissions from Reservoir of Petit-Saut in French Guiana, and biogenic NMVOC emissions from managed forest.

Figure 6.1 Sector 4 LULUCF: EU and ISL GHG net emissions (+) / removals (-) for 1990–2016, in CO_2 eq. (kt).



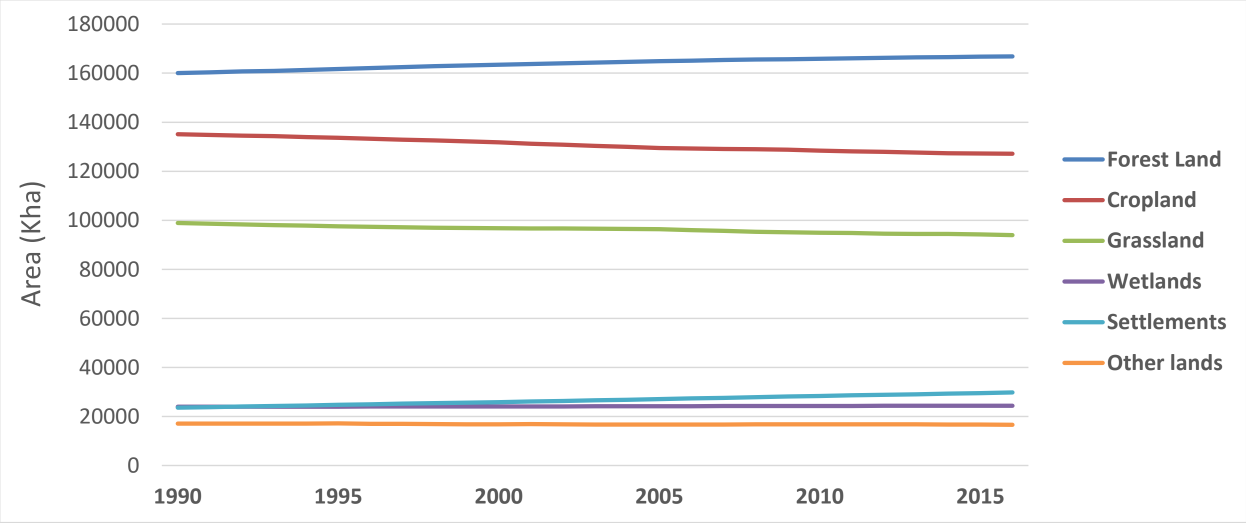
Source: MS and ISL submissions 2018, CRF Table10s1

The overall trend of the LULUCF sector since 1990 is largely affected by the Forest Land category. An increase of the forest carbon sink took place during the 90s mainly due to forest area expansion and to an increase of net forest increment, which has been followed by a slight decline attributable to a general increase in harvest rates. In the late 2000s harvest rate decreased (mainly due to the economic crisis) and the sink increased again. Inter-annual variations are mainly related with natural disturbance events, for instance, major wind storms in central-western Europe (e.g. 2000, 2005, 2007 and 2009) and wildfires (e.g.1990, 2003, 2005, 2007 and 2016) in Mediterranean countries. However, in some specific years the methods implemented by MS to derive carbon stock changes had also an impact in the EU trend. For instance, the decrease of the forest carbon sink in 2002 is due to a drop in the carbon sink reported by Germany in the subcategory 4A1, which takes place in a single year due to the stock-difference method used. It resulted in a reduction by half of its net carbon sink.

The total reported area of the different land use categories in 2016 by EU MS and Iceland is about 459.000 kha. The trend on these categories (Figure 6. 2) confirms the trends known from other EU statistics (e.g. Eurostat), however, absolute numbers may slightly differ due to different definitions used under each dataset.

The changes in total areas reported under the land use categories for 2016 as compared to 1990 are: Settlements (+26%), Croplands (-6%), Forest land (+4%), Grassland (-5%), Wetlands (2%), Other lands (-3%).

Figure 6. 2 Total area for each of the land use categories (kha), as reported in EU MS and ISL in 2016.



Although, as shown above, the LULUCF sector results in a net carbon sink at the level of EU and Iceland, the LULUCF sector reported by individual inventories ranges from a net source (e.g. Denmark, Netherlands, Ireland) to a small sink (e.g. Latvia, Belgium) or a large sinks (e.g. France, Spain, Sweden).

Compared to 1990, for 2016, individual inventories report either a significant increase in the carbon sink or a substantial reduction. Changes are driven by the harvested rates and natural disturbances events.

Table 6. 1 Sector 4 LULUCF: MS' contributions to net CO_2 removals in 2016 (CRF table 4)

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016	
	1990	2015	2016		kt CO2	%	kt CO2	%
Austria	-12 150	-4 603	-4 368	1.4%	7 782	64%	236	5%
Belgium	-2 445	-1 337	-1 311	0.4%	1 135	46%	26	2%
Bulgaria	-15 094	-6 964	-7 173	2.3%	7 921	52%	-209	-3%
Croatia	-6 654	-5 496	-5 539	1.8%	1 114	17%	-44	-1%
Cyprus	-268	-567	67	0.0%	335	125%	634	112%
Czech Republic	-6 647	-6 591	-5 397	1.7%	1 250	19%	1 193	18%
Denmark	4 745	4 130	5 320	-1.7%	575	12%	1 189	29%
Estonia	-1 546	-2 277	-2 746	0.9%	-1 200	-78%	-469	-21%
Finland	-16 829	-30 945	-29 247	9.3%	-12 418	-74%	1 698	5%
France	-30 066	-45 077	-40 917	13.0%	-10 850	-36%	4 160	9%
Germany	-33 018	-16 097	-16 204	5.2%	16 814	51%	-107	-1%
Greece	-2 188	-3 718	-3 357	1.1%	-1 169	-53%	361	10%
Hungary	-2 584	-5 433	-4 329	1.4%	-1 744	-67%	1 105	20%
Ireland	5 790	4 333	4 250	-1.4%	-1 540	-27%	-83	-2%
Italy	-5 349	-36 173	-31 078	9.9%	-25 729	-481%	5 095	14%
Latvia	-11 751	-357	-1 996	0.6%	9 755	83%	-1 639	-459%
Lithuania	-5 197	-6 313	-8 626	2.7%	-3 430	-66%	-2 313	-37%
Luxembourg	27	-420	-504	0.2%	-531	-1964%	-84	-20%
Malta	3	3	3	0.0%	0	15%	0	7%
Netherlands	6 048	6 528	6 544	-2.1%	496	8%	16	0%
Poland	-27 831	-28 362	-29 219	9.3%	-1 388	-5%	-857	-3%
Portugal	278	-8 973	-6 263	2.0%	-6 541	-2354%	2 710	30%
Romania	-21 923	-25 370	-26 311	8.4%	-4 388	-20%	-941	-4%
Slovakia	-9 652	-6 799	-6 916	2.2%	2 737	28%	-116	-2%
Slovenia	-4 264	-5 012	-5 025	1.6%	-761	-18%	-13	0%
Spain	-40 031	-42 513	-41 201	13.1%	-1 169	-3%	1 312	3%
Sweden	-37 674	-46 525	-44 620	14.2%	-6 946	-18%	1 906	4%
United Kingdom	-4 377	-16 570	-16 026	5.1%	-11 649	-266%	544	3%
EU-28	**-280 647**	**-337 499**	**-322 187**	**103%**	**-41 541**	**-15%**	**15 312**	**5%**
Iceland	7 665	7 931	7 910	-2.5%	246	3%	-21	0%
United Kingdom (KP)	-4 395	-16 562	-16 020	5.1%	-11 625	-264%	542	3%
EU-28 + ISL	**-273 000**	**-329 560**	**-314 272**	**100%**	**-41 271**	**-15%**	**15 288**	**5%**

At EU level, in the year 2016 the LULUCF sector offsets about 7% of the total emissions from other sectors ("Total without LULUCF"), with significant differences among MS (Table 6. 2, column a).

Forest Land category is the most important driver in the LULUCF sector, offsetting itself about 10% of total emissions from other sectors. In 2016 this category resulted, in terms of CO_2 equivalent, a net sink for all the MS with the exception of Cyprus and Denmark (Table 6. 2, column b). The most significant contributors to the total net sink reported for Europe under the category 4A are France, Germany and Sweden (Table 6. 2, column c).

Table 6. 2 Sector 4 LULUCF: Contribution of Sector 4 (column a) and category 4A (column b) to total MS emissions (CO_2 eq. without LULUCF); and MS contribution to total EU category 4A (column c)

Member States	LULUCF over total inventory excluding LULUCF	Category 4A over total inventory excluding LULUCF	MS contribution to total EU category 4A
	(a)	*(b)*	*(c)*
Austria	-5.3%	-5.4%	1.0%
Belgium	-1.0%	-2.7%	0.8%
Bulgaria	-11.1%	-10.0%	1.4%
Croatia	-22.3%	-22.8%	1.3%
Cyprus	0.9%	3.7%	-0.1%
Czech Republic	-4.1%	-3.5%	1.1%
Denmark	10.8%	1.8%	-0.2%
Estonia	-13.9%	-16.0%	0.8%
Finland	-46.1%	-58.1%	8.2%
France	-8.0%	-12.3%	13.5%
Germany	-1.6%	-6.3%	13.8%
Greece	-3.6%	-2.3%	0.5%
Hungary	-6.9%	-7.4%	1.1%
Ireland	8.0%	-5.9%	0.9%
Italy	-7.0%	-8.4%	8.6%
Latvia	-8.2%	-26.3%	0.7%
Lithuania	-42.0%	-54.1%	2.6%
Luxembourg	-4.9%	-5.6%	0.1%
Malta	0.2%	0.0%	0.0%
Netherlands	3.4%	-1.2%	0.5%
Poland	-7.1%	-9.2%	8.8%
Portugal	-8.0%	-12.1%	2.0%
Romania	-21.6%	-21.2%	5.7%
Slovakia	-16.7%	-11.4%	1.1%
Slovenia	-28.2%	-29.0%	1.2%
Spain	-12.5%	-11.4%	8.9%
Sweden	-81.2%	-78.0%	9.9%
United Kingdom	-3.0%	-4.9%	5.7%
EU 28	**-7.0%**	**-9.7%**	**100%**
Iceland	218.9%	-6.9%	0.1%

Source: MS submissions 2018, CRF Table10s1

6.1.2 Contribution of land use changes

The conversion of lands at the level of EU and ISL for the year 2016 results in a net source of 31.102 kt CO_2 (Table 6. 3). Land use changes represent 9% of the total reported land area in EU and ISL. The carbon sink resulting from conversions to Forest Land and Grassland is balanced by emissions from conversions to Cropland and Settlements.

Table 6. 3 Contribution of land use changes in 2016 for EU +ISL, in terms of area (columns a-b) and net CO_2eq. (Columns c-d) (As aggregation of data from CRF Table 4.)

Land conversions	**a) land area (Kha)**	**b) % of area of the corresponding category[1]**	**c) Emissions (+) and removals (-) (Kt CO_2eq.)**	**d) % of net emissions of the corresponding category[1,2]**
4A2. Land converted to Forest Land	7439	4%	-48709	12%
4B2. Land converted to Cropland	10908	9%	46063	68%
4C2. Land converted to Grassland	13347	14%	-23992	241%
4D2. Land converted to Wetlands	1158	5%	3531	21%
4E2. Land converted to Settlements	6555	22%	54315	95%
4F2. Land converted to Other Land	1126	7%	-106	100%
Total land use changes	**40533**	**9%**	**31102**	**28%**

[1] The corresponding category is 4A (Forest land) for 4A2, 4B (Cropland) for 4B2, etc.

[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 4A2)/(abs 4A1+ abs 4A2) x 100.

On average, for the year 2016, from total area under conversion, 33% is reported as converted to Grassland, 27% as converted to Cropland, 18% as converted to Forest land, 16% as converted to Settlements, and 3% as converted to Wetlands and Other lands.

6.1.3 Completeness of the sector

Table 6. 4 shows the current coverage status of reporting, in terms of quantitative estimates, for each of the land use sub-categories taken from the individual inventories submitted in the year 2018.

This table along with Table 6. 5 aims to provide an overview of the completeness status. Empty cells should not be directly associated with an incomplete reporting as in many cases the expected carbon stock changes are assumed in balance in line with the IPCC guidelines, or none methods exist for their estimation (such pools are marked in grey in table 6.5 to facilitate the assessment of the completeness).

It should also be noted that under the subcategories "land converted to" there are a wide range on methods and completeness status; for instance, a pools can be a source in forest converted to cropland, and a sink in grassland converted to cropland. This large variety cannot be displayed in these tables given the length that would be required for the tables. However, such information is provided in following sections. See for instance tables on implied emission factors.

The three main land uses categories, Forest Land, Cropland and Grassland, including their sub-categories, are mostly completed. However, under certain subcategories of other land uses, there are still some gaps that are largely associated with the lack of IPCC methods for estimating GHG emissions (e.g. Flooded land remaining flooded land, under Wetlands), the assumption of equilibrium under Tier 1 methods, or the implementation of the *insignificance* provision in accordance with the Decision 24 CP/19 (e.g. for living woody biomass under Grassland remaining Grassland). Finally, lack of quantitative estimates often also associates with the absence of lands being converted to certain subcategories or the lack of organic soils.

Thus, any judge on completeness would require a comprehensive case by case assessment.

Table 6. 4 Sector 4 LULUCF: Coverage of CO_2 emissions and removals for each of the LULUCF sub-categories for the year 2016, as derived from individual 2018 GHGI submissions

MS	Reporting category												
	Forest land		Cropland		Grassland		Wetland		Settlements		Other land		HWP
	4.A.1. F-F	4.A.2. L-F	4.B.1. C-C	4.B.2. L-C	4.C.1. G-G	4.C.2. L-G	4.D.1. W-W	4.D.2. L-W	4.E.1. S-S	4.E.2. L-S	4.F.1. O-O	5.F.2. L-O	
Austria	R	R	R	E	E	E		E		E		E	R
Belgium	R	R	E	E	R	R		R		E			E
Bulgaria	R	R	E	E		R		E		E		R	R
Croatia	R	R	E	E	E	R		E		E			R
Cyprus	E	R	R	R	R	R		R		E		E	E
Czech Republic	R	R	E	E	R	R		E		E			R
Denmark	E	E	E	E	E	E	E	R		E			R
Estonia	R	R	E	E	E	R	E	E		E		E	R
Finland	R	R	E	E	E	E	E	E		E			R
France	R	R	R	E	R	R		E	E	E		E	R
Germany	R	R	E	E	E	R	E	E	E	E			R
Greece	R	R	R	E	E	R		E		E		E	E
Hungary	R	R	R	E	E	R	E	R		E		E	R
Ireland	R	R	R		E	E	E	E		E		E	R
Italy	R	R	E	E	R	R				E			E
Latvia	R	R	E	R	E	E	E		R	E			R
Lithuania	R	R	R	E		R	E	E		E		E	R
Luxembourg	R	R	E	E		R		E		E		E	
Malta			R	E	R	R				E		E	
Netherlands	R	R	E	E	E	E	R	E	E	E		E	E
Poland	R	R	E	E	E	R	E	E	R	E			R
Portugal	R	R	R	E	R	E		E		E		R	R
Romania	R	R	R	E	R	E		E		E		E	R
Slovakia	R	R	R	E		R				E		E	R
Slovenia	R	R	R	E		E		E	R	E		E	R
Spain	R	R	R	E		R	E	R		E		E	R
Sweden	R	R	E	E	R	E	E		R	E		R	R
United Kingdom	R	R	E	E	R	R	E	E	E	E			R
Iceland	R	R	E	E	E	E	R	E		E			R

R = Carbon stock changes in the pool result in net Removals;
E = Carbon stocks change in the pool results in net Emissions;
Empty cells = Quantitative estimates were included elsewhere, or no quantitative estimates are provided in line with Tier 1 assumption, the provision of insignificance, because no land use changes took place, or due to the lack of IPCC methods.

Overall, the reporting of Wetlands, Settlements and Other lands categories is associated with lower tiers methods in comparison to the main land use categories. And more specifically, carbon stock changes in “land remaining in the same category” are often assumed in equilibrium for these land use categories, although carbon stock changes are estimated and reported whenever a land use change is identified.

Table 6. 5 shows with more detail the completeness reporting on carbon stock changes by carbon pools, for the three most important land use categories as reported this year in individual

submissions.Compared to the previous years, several MS have increased the number of carbon pools estimated and reported (e.g. Cyprus and France).

As for table 6.4, empty cells in table 6.5 represent carbon pools which are not reported with quantitative estimates (e.g. based on Tier 1 assumptions, demonstrating the insignificance of the resulting carbon stock changes, because the lack of IPCC methods, of because the absence of organic soils). For few specific cases, where empty cells are associated with incompleteness issue, information on the ongoing efforts to prepare estimates for the affected pools is included in the individual submissions.

Table 6. 5 Sector 4 LULUCF: Quantitative estimates of carbon stock changes on carbon pools for the most important land use subcategories for the year 2016.

MS	Reporting category																																
	Forest land								Cropland								Grassland							
	4.A.1. F-F				4.A.2. L-F				4.B.1. C-C				4.B.2. L-C				4.C.1. G-G				4.C.2. L-G			
	LB	DOM	SOCmin	SOCorg	LB	DOM	SOCmin	SOCorg	LB	DOM	SOCmin	SOCorg	LB	DOM	SOCmin	SOCorg	LB	DOM	SOCmin	SOCorg	LB	DOM	SOCmin	SOCorg
Austria	R	E	E		E	R	R		E		R		R	R	E				R	E	E	E	R	
Belgium	R		R		E	R	R		E		E	E	E	R	E				R	E	E	E	R	
Bulgaria	R	E	E		E	R	E		R		E		E		E						E		R	
Croatia	R				E		R		R		R	E	R		E					E	E		R	
Cyprus	R		E		E	R	R		E				R		R		R				R	R	R	
Czech Rep.	R				E	R	R		R		E		E	R	E				R		E	E	R	
Denmark	R	R		R	R	R	R	E	R		R	E	R	R	E		E			E	E	E	R	E
Estonia	R	E	R	R	E	R	R	E	E		E	E	E	R	E	E	R			E	R	E	R	E
Finland	R		R	R	E		R	E	E		R	E	E	R	E	E	R			E	E		R	E
France	R	R			E	R	R		R		R		E	R	E		R		E		E	E	R	
Germany	R	R	R	R	E	R	E	E	R			E	E	R	E	E	R		E	E	R	E	R	E
Greece	R				E				E			E	E		E		E				E	E	R	
Hungary	R			R	E	R	R		R		R		E	R	E				E		E	E	R	
Ireland	E	E		R	E	R		E	E		R								R	E	E	E		E
Italy	R	E			E	R			R			E	E		E		R	R		E			R	
Latvia	R	E		R	E	R		E	E	E		E			E	R	R	E		E				E
Lithuania	R	E			E	R	R		E		R		E		E						R		R	
Luxembourg	R				E	R	R		R		R		E	R	E						E	E	R	
Malta									E		R		R		E		R		R				R	
Netherlands	R	E			E		E	E				E	E	R	E	E	R		R	E	E	E	R	E
Poland	R		R	R	E		R	E	E		E	E			E				E	E	R		R	
Portugal	R	R	R		E	R	R		E		R		E	R	E				R		E	E	E	
Romania	R			R	E	R	R		E	E	R	E	E	R	E		R			R	E	E	R	
Slovakia	R				E	R	R		E		R		E		E						E	E	R	

MS	Reporting category																							
	Forest land								Cropland								Grassland							
	4.A.1. F-F				4.A.2. L-F				4.B.1. C-C				4.B.2. L-C				4.C.1. G-G				4.C.2. L-G			
	LB	DOM	SOCmin	SOCorg	LB	DOM	SOCmin	SOCorg	LB	DOM	SOCmin	SOCorg	LB	DOM	SOCmin	SOCorg	LB	DOM	SOCmin	SOCorg	LB	DOM	SOCmin	SOCorg
Slovenia	R	R			E		E		E		E	E	R	R	E						E	E	R	
Spain	R				E	R	R		E		R		R	R	E						E	E	R	
Sweden	R	R	R	R	E	R	E	E	E	R	E	E	E	R	E	E	R	R	R	E	E	E	R	E
UK	R	E	R	E	E	R	E	E	R		E	E	E		E	E	E		R		E	E	R	E
Iceland	R			R	E	R	R	E			R	E	E		R	E	R	R	R	E	R	R	R	E

Pools: DOM – dead organic matter, LB – living biomass, SOCmin – soil organic carbon in mineral soils, SOCorg – soil organic carbon in organic soils.
R: net Removal;
E: net Emission;
Empty cells: Quantitative estimates were included elsewhere, or no quantitative estimates are provided in line with Tier 1 assumption (grey cells indicate carbon pools for which the IPCC tier 1 methods assume the net carbon stock changes in equilibrium), the provision of insignificance, or because the pool is not present (i.e. absence of organic sols under certain land use categories). Only in few cases the lack of quantitative estimates associates with incompleteness. See more details in following sections.

Source: MS and Iceland submissions 2018, CRF table 4A-4C

6.1.4 Data and methods

This section provides an overview of the information on methods and data used by MS and Iceland for reporting on emissions by sources and removals by sinks from the three main land use categories. More detailed information regarding methodological issues is included as an annex to this report, and a complete description can be found in individual national inventory reports, which are considered also part of this submission.

Given the heterogeneity among MS in terms of ecological and socio-economic conditions, there is not a common definition of land use categories. Methods used to estimate GHG emissions and CO_2 removals from the LULUCF sector also differ among MS and land use categories. The underlying assumption of the EU GHG inventory is that the implementation of country-specific definitions and methods that reflect and capture specific national circumstances (as long as they are in accordance with IPCC) is likely to result in more accurate GHG estimates than the implementation of a single EU wide approach.

Table 6. 6 is a summary of relevant information on methodologies applied for each individual carbon pool under the three main land use categories of the LULUCF sector as included this year in individual GHG inventories.

Usually, for reporting "lands remaining in the same category", a single data source is used, which facilitate the categorization of the methodologies under a single tier method. By contrast, multiple data sources are often used to derive emissions from “land converted to” which prevents the categorization of the methods under a single Tier. For instance, for estimating carbon stock changes in living biomass from forest land converted to cropland, MS may implement country-specific values for forest land and default factors for cropland.

Furthermore, because the categorization of methods under a single tier for “land converted to” depends also on the categories involved in the conversion (i.e. different approaches and data sources are often used for forest converted to grassland and for cropland converted to grassland), Table 6. 6 is intended to show only a summary of information on methods and carbon stock changes factors used by individual MS and Iceland.

Finally, because of different underlying methods applied by each MS and Iceland, and due to their own national circumstances, the comparison of absolute levels, or trends, of emissions across them should be done carefully to avoid erroneous interpretations. Indeed, in some cases, large differences may be attributable to the different estimating methodologies. For example, (i) the gain-loss and stock-difference methods may lead to different trends in the short term or (ii) the resulting implied carbon stock change factors may be significantly affected by new areas entering in a given category.

Table 6. 6 Summary of methods and carbon stock change factors used by MS to calculate CO_2 emissions and removals of different carbon pools in the LULUCF sector, as reported in the GHGI 2018 submissions.

MS	Forest land								Cropland								Grassland							
	FL-FL				L-FL				CL-CL				L-CL				GL-GL				L-GL			
	LB	DOM (1)	SOC Min	SOC Org (2)	LB	DOM	SOC Min	SOC Org (2)	LB (3)	DOM	SOC Min (4)	SOC Org (2)	LB (5)	DOM	SOC Min	SOC Org (2)	LB	DOM	SOC Min (4)	SOC Org (2)	LB	DOM	SOC Min	SOC Org (2)
AT	CS	CS,CS	CS	NO	CS	CS	CS	NO	CS	D	CS	NO	CS,CS	CS	CS	NO	D	D	CS	CS	CS	CS	CS	NO
BE	CS	CS,CS	CS	NO	CS	D	CS	NO	CS	D	CS	D	CS,NO	CS	CS	NO	D	D	CS	D	CS	CS	CS	NO
BG	CS	D,D	D	NO	CS	CS	CS	NO	D	D	CS	NO	CS,CS	NO	CS	NO	D	D	NO	NO	CS	NO	CS	NO
CY	CS	D,D	D	NO	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
CZ	CS	D,D	D	NO	CS	D	CS	NO	D	D	CS,D	NO	CS,D	CS	CS	NO	D	D	CS,D	NO	CS	CS	CS	NO
DE	CS	CS,CS	CS	CS	CS	CS	CS	CS	NO	D	NO	CS	CS,CS	CS	CS	CS	CS	D	CS	CS	CS	CS	CS	CS
DK	CS	CS,CS	D	CS	CS	CS	CS	CS	CS	D	CS	CS	CS,CS	CS	CS	CS	CS	D	NO	CS	CS	CS	CS	CS
EE	CS	CS,D	CS	CS	CS	CS	CS	CS	CS	D	CS,D	D	CS,CS	CS	CS	CS	CS	CS	CS,D	CS	CS	CS	CS	CS
ES	CS	D,D	D	NO	CS	CS	CS	NO	CS	D	CS,D	NO	CS,CS	CS	CS	NO	D	D	NE	NO	CS	CS	CS	NO
FI	CS	CS,CS	CS	CS	CS	CS	CS	CS	CS	D	CS	CS	CS,CS	CS	CS	CS	CS	D	NO	CS	CS	CS	CS	CS
FR	CS	CS,D	D	NO	CS	CS	CS	CS	D	D	CS	NO	CS,NO	CS	CS	NO	D	D	NO	NO	CS	CS	CS	CS
GR	CS	D,D	D	NO	CS	D	NO	NO	CS	D	NE	D	CS,CS	CS	CS	NO	D	D	NO	NO	NO	NO	CS	NO
HR	CS	D,D	D	NO	CS	D	CS	NO	D	D	CS,D	CS	CS,CS	NO	CS	NO	D	D	NO	CS	CS	NO	CS	NO
HU	CS	D,D	D	CS	CS	CS	CS	NO	CS	D	CD,D	NO	CS,D	CS	CS	NO	D	D	CS,D	NO	CS	CS	CS	NO
IE	CS	CS,CS	D	CS	CS	CS	NO	CS	CS	D	CS,D	NO	NO,NO	NO	NO	NO	D	D	CS,D	CS	CS	CS	NO	CS
IT	CS	CS,CS	D	NO	CS	CS	CS	NO	CS	NO	NO	D	NO,D	NO	CS	NO	CS	CS	NO	NO	CS	NO	CS	NO
LT	CS	CS,D	D	D	CS	D	NO	D	D	D	CS,D	D	NO,CS	D	CS	D	NO	NO	NO	D	NO	NO	CS	D
LU	CS	D,D	D	NO	CS	D	CS	NO	CS	D	CS,D	NO	CS,CS	CS	CS	NO	D	D	NO	NO	CS	CS	CS	NO
LV	CS	CS,D	D	D	CS	CS	NO	CS	CS	CS	NO	D	NO,NO	NO	CS	D	CS	CS	NO	D	NO	NO	CS	D
MT	CS	D,D	D	NO	NO	NO	NO	NO	D	D	NO	NO	NO,NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
NL	CS	CS,D	D	NE	CS	D	CS	CS	NE	D	NO	CS	CS,CS	CS	CS	CS	D	D	NO	CS	CS	CS	CS	CS

MS	Forest land								Cropland								Grassland							
	FL-FL				L-FL				CL-CL				L-CL				GL-GL				L-GL			
	LB	DOM (1)	SOC Min	SOC Org (2)	LB	DOM	SOC Min	SOC Org (2)	LB (3)	DOM	SOC Min (4)	SOC Org (2)	LB (5)	DOM	SOC Min	SOC Org (2)	LB	DOM	SOC Min (4)	SOC Org (2)	LB	DOM	SOC Min	SOC Org (2)
PL	CS	D,D	D	D	CS	D	D	D	D	D	D,D	D	NO	NO	D	NO	D	D	D,D	D	CS	NO	D	NO
PT	CS	CS,CS	CS	NO	CS	CS	CS	NO	CS	D	CS	NO	CS,CS	CS	CS	NO	D	D	CS	NO	CS	CS	CS	NO
RO	CS	D,D	D	D	CS	CS	CS	NO	CS	CS	CS	CS	CS,CS	CS	CS	NO	CS	D	NO	D	CS	CS	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	CS
SK	CS	D,D	D	NO	CS	CS	CS	NO	D	D	CS,D	NO	CS,CS,	CS	CS	NO	D	D	NO	NO	CS	CS	CS	NO
SV	CS	CS,D	D	NO	CS	D	CS	NO	D	D	CS,D	D	CS,CS	CS	CS	NO	D	D	NO	NO	CS	CS	CS	NO
UK	CS	CS,CS	CS	CS	CS	CS	CS	CS	D	D	CS	CS	CS,CS	CS	CS	CS	D	D	CS	CS	CS	CS	CS	CS
IS	CS	D,D	D	D	CS	CS	CS	D	D	D	NE	D	CS,CS	CS	CS	D	CS	CS	CS	D	CS	CS	CS	D

Source: submissions 2018, CRF table 4A-4C

(D: default; CS: country-specific; NA: not applicable; NE: not estimated; NO: not occurring). Grey heading means that for these carbon pools IPCC TIER 1 allows to assume no net change in C stock.

"CS" country-specific data, associated either with IPCC method tier 2 or country-specific method tier 3, if data are highly disaggregated or derivate using models. Note that sometimes not all parameters involved in the estimation are truly "CS" (e.g. root/shoot ratio and BEF are often taken from IPCC guidelines). However it is expected that if "CS" is reported in table 6.6, 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).

"NE" means either country assumes insignificant emission/removal or not enough data is available for the 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: dead wood and litter respectively.

(2) for SOCorg any notation key used under carbon stock changes, if areas of organic soils are reported, should, in principle, be seen as NE. D refers to the use of IPCC default emissions factors

(3) for LB carbon stock change in CL-CL is assumed only for perennial woody crops. Biomass of annual crops is generally assumed in balance.

(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 factors" (see 2006 IPCC GL 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 LB under L – CL, "conversion to cropland", the 2 notation keys used mean: first one refers to FL-CL and second to GL-CL.

6.1.5 Key categories

The following LULUCF subcategories of the EU GHG inventory were identified to be key categories (Table 6. 7) for the trend (T) and the level assessment (L).

Table 6. 7 Key category analysis for the EU (LULUCF sector excerpt)

Source category gas	kt CO_2 equ.		Trend	Level	
	1990	2016		1990	2016
4.A.1 Forest Land: Land Use (CO_2)	-363025	-375593	T	L	L
4.A.2 Forest Land: Land Use (CO_2)	-41859	-48953	T	L	L
4.B.1 Cropland: Land Use (CO_2)	23832	21446	T	L	L
4.B.2 Cropland: Land Use (CO_2)	49775	42693	T	L	L
4.C.1 Grassland: Land Use (CO_2)	48139	33566	0	L	L
4.C.2 Grassland: Land Use (CO_2)	-18260	-24195	0	L	L
4.D.1 Wetlands: Land Use (CO_2)	12622	13392	T	L	L
4.E.2 Settlements: Land Use (CO_2)	33433	50196	T	L	L
4.G Harvested Wood Products: Wood product (CO_2)	-31306	-38235	0	L	L

6.2 Categories and methodological issues

6.2.1 Forest land (CRF 4A)

6.2.1.1 Overview of the Forest land category

Forest land category is the main land use category in the LULUCF sector. It represents about 36% of the total area reported by EU MS and Iceland. According to the information provided in individual submissions, total forest area increased from 160.086 kha in 1990 to 166.838 kha in 2016, which represents an increase of 4%. About 5% of the total forest area is represented by lands under conversion to forest land. This trend, which is also reflected in different official statistics of the EU, is given by the expansion of forests due to decreasing grazing pressure and agricultural activities, which promoted natural forest expansion, but also due to the promotion of national afforestation programs (including grant-aid).

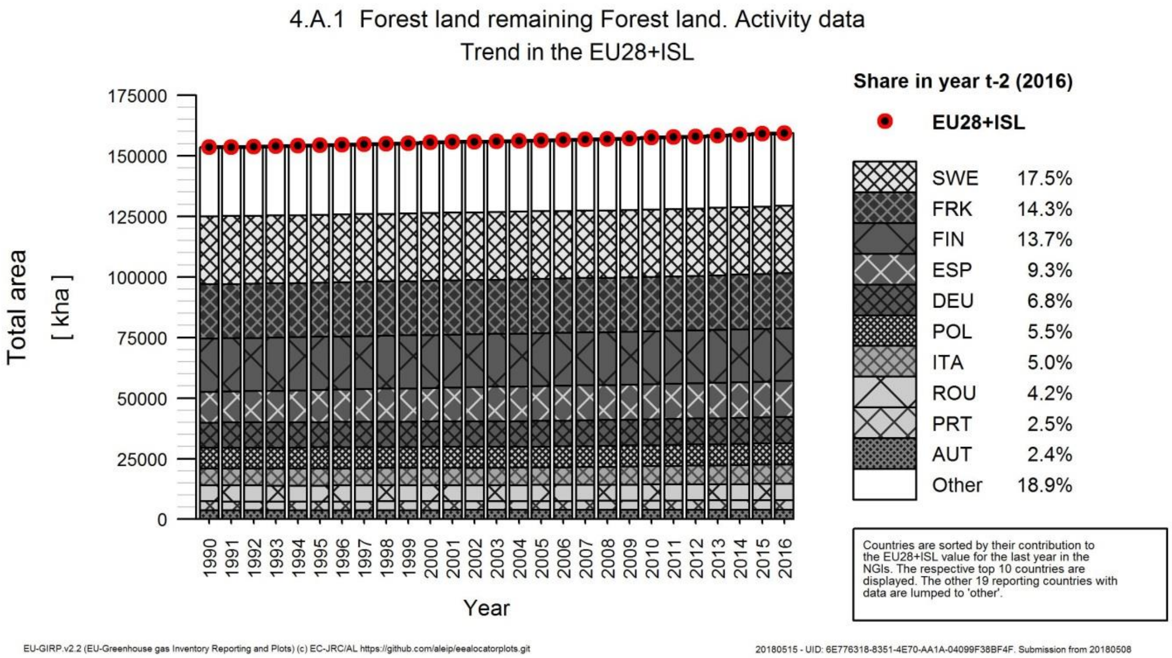
The largest forest area is reported by Sweden, France and Finland, which together report about 45% of the total forest area at EU level. Deforestation does not appear to be a major issue in Europe, nevertheless, the absolute area under conversion from forest is well compensated by new planting areas and by natural forest expansion.

6.2.1.2 Forest Land remaining Forest Land (CRF 4A1)

Overview of Forest Land remaining Forest Land category

The area of Forest Land remaining Forest Land, reported for the year 2016 at the EU level and Iceland slightly increased by 4% as compared with 1990. However, at the level of individuals submissions there are significant differences. For instance, UK reports an increase of about 34% while Netherlands reports a decrease of about 11% respect to the year 1990. The major contributors, in terms of area, for this subcategory are Sweden, France and Finland (Figure 6. 3)

Figure 6. 3 Trend of activity data in subcategory 4A1 “Forest land remaining Forest Land” in EU MS and Iceland (kha, 1990-2016)



For the year 2016, the total land area reported under the sub category 4.A1 reached 159.400 Kha out of which about 80% corresponds to the 10 MS with the higher contribution.

In terms of GHG emissions the category 4.A1 resulted in a net sink of -375.593 kt CO_2, increasing by 3% as compared in 1990. The major contributors are Germany, France, and Sweden (Table 6. 8).

Table 6. 8 4A1 Forest Land remaining Forest Land: MS and Iceland' contributions to net CO_2 emissions(+)/removals (-) (CRF table 4)

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016	
	1990	2015	2016		kt CO2	%	kt CO2	%
Austria	-7 849	-2 579	-2 579	0.7%	5 271	67%	1	0%
Belgium	-2 508	-2 774	-2 768	0.7%	-260	-10%	6	0%
Bulgaria	-13 755	-5 352	-5 328	1.4%	8 427	61%	24	0%
Croatia	-6 695	-5 336	-5 332	1.4%	1 364	20%	5	0%
Cyprus	-82	-275	352	-0.1%	434	527%	627	228%
Czech Republic	-4 822	-5 522	-4 071	1.1%	752	16%	1 452	26%
Denmark	-554	-318	703	-0.2%	1 257	227%	1 021	321%
Estonia	-3 160	-2 758	-2 892	0.8%	268	8%	-134	-5%
Finland	-22 632	-38 285	-35 770	9.5%	-13 138	-58%	2 515	7%
France	-35 894	-54 267	-50 684	13.5%	-14 790	-41%	3 583	7%
Germany	-70 327	-53 534	-53 618	14.3%	16 709	24%	-84	0%
Greece	-1 142	-2 065	-2 055	0.5%	-913	-80%	10	0%
Hungary	-2 971	-3 917	-3 141	0.8%	-170	-6%	776	20%
Ireland	-2 720	-135	-183	0.0%	2 536	93%	-49	-36%
Italy	-15 002	-33 009	-30 251	8.1%	-15 249	-102%	2 757	8%
Latvia	-18 018	-2 307	-3 599	1.0%	14 419	80%	-1 293	-56%
Lithuania	-7 365	-8 130	-10 340	2.8%	-2 975	-40%	-2 210	-27%
Luxembourg	66	-378	-474	0.1%	-540	-819%	-96	-25%
Malta	NO,NA	NO,NA	NO,NA	-	-	-	-	-
Netherlands	-1 844	-1 610	-1 626	0.4%	218	12%	-17	-1%
Poland	-34 000	-27 992	-34 005	9.1%	-6	0%	-6 014	-21%
Portugal	-4 146	-8 079	-6 001	1.6%	-1 855	-45%	2 078	26%
Romania	-21 162	-18 589	-19 671	5.2%	1 491	7%	-1 082	-6%
Slovakia	-6 413	-4 502	-4 302	1.1%	2 111	33%	200	4%
Slovenia	-4 215	-4 845	-4 914	1.3%	-699	-17%	-69	-1%
Spain	-20 260	-27 562	-27 784	7.4%	-7 524	-37%	-221	-1%
Sweden	-38 816	-40 787	-41 453	11.0%	-2 638	-7%	-667	-2%
United Kingdom	-16 708	-23 914	-23 733	6.3%	-7 024	-42%	181	1%
EU-28	**-362 995**	**-378 821**	**-375 521**	**100%**	**-12 526**	**-3%**	**3 300**	**1%**
Iceland	-16	-34	-35	0.0%	-20	-126%	-2	-5%
United Kingdom (KP)	-16 723	-23 951	-23 769	6.3%	-7 047	-42%	181	1%
EU-28 + ISL	**-363 025**	**-378 892**	**-375 593**	**100%**	**-12 568**	**-3%**	**3 299**	**1%**

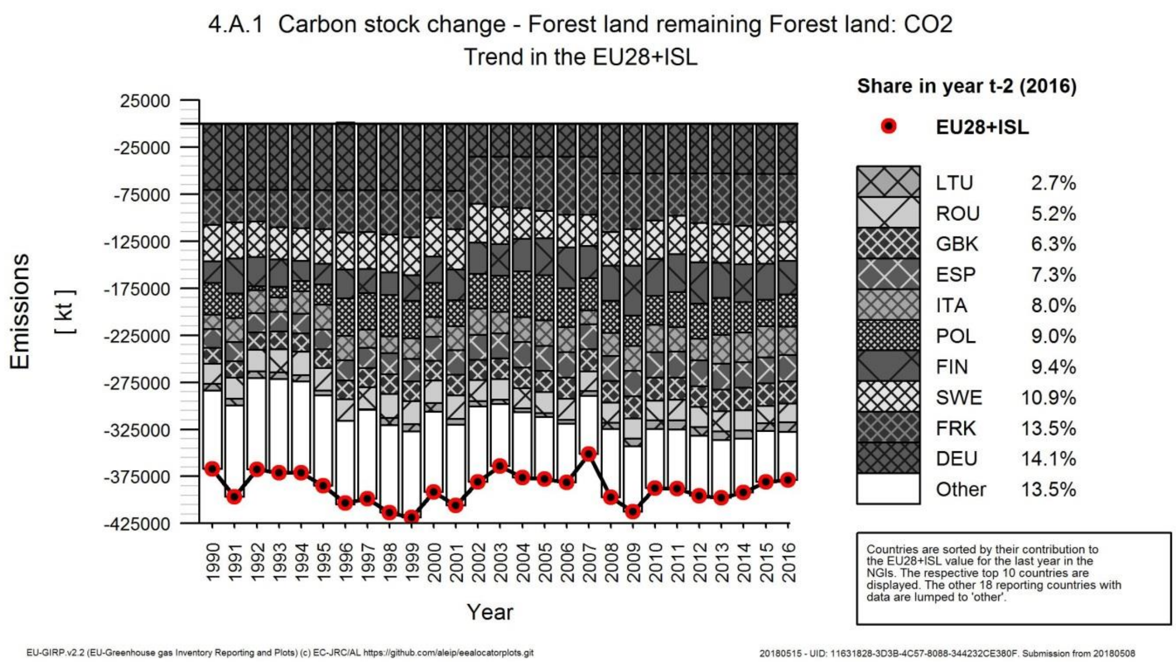
For the year 2016, not all individual submissions report a net sink of carbon in Forest Land remaining Forest Land.

The largest change in absolute terms reported as compared with 1990 corresponds to a significant decrease of the carbon sink reported by Germany due to changes in harvesting rates. In other cases, for the period 1990-2016, this category has shifted between a net source and a net sink of carbon, as occurred in Denmark due to the age distribution of the forests.

A particular case is given by Malta that having 0.072 Kha of forest does not report the carbon stock changes in this land use category following a recommendation of the ERT. Indeed, the ERT noted that the use of IPCC factors, which are not suited for Malta's conditions, results in the absurd estimate of an indefinite net carbon accumulation across time, while carbon pools have physical limits to the amount of carbon stock they may store.

In a good match with the share in total areas, the 10 MS with the largest contribution to the total net carbon sink account for about 85% of the EU removals (Figure 6. 4).

Figure 6. 4 Trend of emissions (+)/removals (-) in subcategory 4A1 "Forest land remaining Forest Land" in EU MS and Iceland (kt CO_2, 1990-2016)



Inter-annual variations in this subcategory are closely related with natural disturbances that mostly affect direct GHG emissions in forests areas. In this respect, wildfires, in southern European countries, and windstorms, in several European countries, resulted in a significant source of GHG emissions for specific years that are reflected in the trend at EU level.

The CO_2 emissions from biomass burning are, in many cases, implicitly included in CRF table 4.A as a loss of carbon stock, while related non-CO_2 emissions are reported in CRF table 4(V). Estimation of emissions from forest fires is made with Tier 1 method in case of small emissions or with higher tiers where such annual emissions have a significant share within the overall budget (e.g. Portugal, Spain).

Windstorms (mainly in central Europe) in specific years affected a large amount of forest areas. However, given that the biomass affected by storms is either treated as salvage logging or enters into the dead organic matter carbon pool, emissions peaks due to storms are often not so visible in the GHG inventories. Other type of disturbances generally have a much localized effects and low magnitude. In general, they are difficult to quantify in terms of biomass loss (e.g. insect outbreaks), and therefore they are practically not explicitly mentioned in the individual national inventory reports but reflected in long term in the national forest inventories.

The largest inter-annual variability in GHG estimates that affect the EU trend are due to:

- Forest fires (e.g. Portugal in 1990, 2003 and 2005; Italy in 1990, 1993 and 2007).

- Windstorms (e.g. France in 2000 and 2009, and Denmark in 2000, Sweden in 2005);

Or they are attributed to the estimation method:

- For instance, Germany uses the stock-difference method between subsequent forest inventories. This method is accurate for estimating carbon stock changes over a time period but it may results in discontinuities in trends, i.e. “steps” in single years (e.g. 2002), because the significant decrease of the sink, which occurred over a period since the previous forest inventory, is counted in a single year when carbon stocks of the more recent inventory are integrated in the calculation.

Methodological issues for Forest Land remaining Forest Land category

Forest land definitions are reported by all individual submissions (Table 6. 9; Table 6. 10). The consistency of these definitions with the land representation system is ensured within the national inventories in terms of time and space. The forest definitions among MS, slightly differ in terms of quantitative parameters (i.e. crown cover, tree height and minimum land area). In general, these forest definitions are consistent with definitions used under other international processes (e.g. Global Forest Resources Assessments FRA (FAO)). For forest administrative purposes, lands without tree cover, may be included or not within forest land, thus, additional qualitative criteria complement the forest definitions provided (i.e. treatment of forest roads, nurseries, willow crops, etc.).

Few MS have changed their forest definition since 1990, but recalculations of the whole time series ensured the consistency on activity data. For example, Denmark changed from a questionnaire based forestry information system to NFI but implemented methods for ensuring the consistency of the time series (i.e. reassessment of base year data based on earth observation information).

The overall effect of different forest definitions on carbon stock changes at EU level is difficult to assess as it depends on several factors (i.e. land fragmentation, land use change frequency, transition period, land registry systems, GHG estimation methodology, etc.), but it is likely to be small.

Table 6. 9 Quantitative thresholds used to define forests as selected by individual MS and Iceland

Member State	Crown cover (%)	Height (m)	Area (ha)	Minimal width (m)
Austria	30	2	0.05	10
Belgium	20	5	0.5	-
Bulgaria	10	5	0.1	10
Croatia	10	2	0.1	-
Cyprus	10	5	0.3	-
Czech Republic	30	2	0.05	-
Denmark	10	5	0.5	20
Estonia	30	2	0.5	-
Finland	10	5	0.25 (0.5) for Southern (Northern) Finland	20
France	10	5	0.5	20
Germany	10	5	0.1	-
Greece	25	2	0.3	-

Member State	Crown cover (%)	Height (m)	Area (ha)	Minimal width (m)
Hungary	30	5	0.5	-
Ireland	20	5	0.1	20
Italy	10	5	0.5	-
Latvia	20	5	0.1	20
Lithuania	30	5	0.1	10
Luxembourg	10	5	0.5	-
Netherlands	20	5	0.5	30
Malta	30	5	1	-
Poland	10	2	0.1	10
Portugal	10	5	0.5	20
Romania	10	5	0.25	20
Slovakia	20	5	0.3	20
Slovenia	10	5	0.25	-
Spain	20	3	1.0	25
Sweden	10	5	0.5	10
United Kingdom	20	2	0.1	20
Iceland	10	2	0.5	20

Table 6. 10 Additional qualitative criteria used to define forests as selected by individual MS and Iceland.

Member State	Forest land definition
Austria	Permanently unstocked basal areas that are directly connected with forest in terms of space and forestry enterprise and contribute directly to its management (such as forestal hauling systems, wood storage places, forest glades, forest roads) also represent forests. 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. Rows of trees (except shelter belts for wind protection) and areas with woody plants in a park structure are not forest land.
Belgium	This category includes all land with woody vegetation consistent with thresholds used to define forest land as described in paragraph 6.1 of the NIR. It also includes systems with vegetation that currently fall below, but are expected to exceed, the threshold of the forest land category.
Bulgaria	Areas of natural forest regeneration outside urban areas with a size of more than 0.1 ha also represent “forest”. Forests are also: areas which are in a process of recovering and are still under the parameters, but it is expected to reach forest crown cover over 10% and tree height 5 meters; areas, which as the result of anthropogenic factors or natural reasons are temporarily deforested, but will be reforested; protective forest belts, as well as tree lines with an area over 0.1 ha and width over 10 meters; cork oak stands. City parks with trees, forest shelter belts, and single row trees do not fall under the category “forests.
Croatia	Forest includes land under forest management (forest land without tree cover): Productive forest land without tree cover, non-productive forest land without tree cover, barren wooded land (e.g. forest roads wider than 3 meters, quarries)

Member State	**Forest land definition**
Cyprus	Forests include forest roads, cleared tracts, firebreaks and other small open areas within the forest as well as reforested areas or burnt areas or other areas that temporarily have low plant cover due to human intervention or natural causes, but it does not include municipal parks and gardens.
Czech Republic	Forests excludes the areas of permanently unstocked cadastral forest land, such as forest roads, forest nurseries and land under power transmission lines.
Denmark	Temporarily non-wooded areas, fire breaks and other small open areas, that are an integrated part of the forest, are also included. Christmas trees are also included.
Estonia	All temporarily unstocked forest areas and regeneration areas which have yet to reach a crown density of 30 per cent and a tree height of 2 meters are also included as forest, as are areas which are temporarily unstocked as a result of human intervention such as harvesting, or natural causes (fires, etc.) but which are expected to revert to forest.
Finland	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	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 Forest land are met. 5% of France's European forests are unmanaged on lands such as strong slopes or used for loisir, esthétique, cultural or military. Also, 40% of France's dependencies Forest land is considered as unmanaged.
Germany	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	No additional criteria are used.
Hungary	Forest land (includes FL-FL, L-FL sub-categories) includes areas covered by trees, as well as roads and other areas that are under forest management but that are not covered by trees.
Ireland	All public and private plantation forests. Includes recently clear felled areas. Tree grown for fruits or flowers, and shrub species (furze, rhododendron) are excluded. Includes open areas within forest boundaries.
Italy	Forest roads, cleared tracts, firebreaks and other open areas within the forest as well as protected forest areas are included in forest. Plantations, mainly poplars, characterized by short rotation coppice system and used for energy crops are included and also other plantation as chestnut and cork oak, have been included in forest land.
Latvia	Young natural stands and all plantations established for the forestry purposes, which have to reach a crown density of 20 % or tree height of 5 m are considered under forest land; as well as the areas normally forming part of the forest area, which are temporarily unstocked as a result of human intervention or natural causes, but which are expected to revert to forest.
Lithuania	Tree lines up to 10 meters of width in fields, at roadsides, water bodies, in living areas and cemeteries or planted at the railways protection zones as well as single trees and bushes, parks planted and grown by man in urban and rural areas are not defined as forests.
Malta	No additional criteria are used.
Luxemburg	Permanently unstocked basal areas that are directly connected with forest in terms of space and forestry enterprise and contribute directly to its management (such as forestal hauling systems, wood storage places, forest glades, forest roads) also represent forests. 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 (except shelter belts for wind protection) and areas with woody plants in a park structure are not forest land.

Member State	Forest land definition
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 areas)
Poland	Young stands and all plantations that have yet to reach a crown density of 10 percent or a tree height of 2 m are included under forest. Areas normally forming part of the forest area that are temporarily un-stocked as a result of human intervention, such as harvesting or natural causes such as wind-throw, but which are expected to revert to forest are also included.
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.
Romania	It comprises deciduous forest, coniferous forest, mixt forests, clear-cut areas and nurseries, as defined by presence of deciduous trees, coniferous trees, deciduous and resinous trees, dead trees, clear-cuts and forest nursery.
Slovakia	This category includes the land covered by all tree species serving for the fulfilment of forest functions and the lands on which the forest stands were temporarily removed with aim of their regeneration or establishment of forest nurseries or forest seed plantation.
Slovenia	It includes abandoned agricultural land with natural expansion of forest. Abandoned agricultural land on area more than 0.5 ha, which have been abandoned for more than 20 years, with minimal tree height 5.00 m and have a tree crown cover between up to 75 % are defined as forests.
Spain	Any land having woody vegetation with no agricultural use/activities fulfilling the threshold of forest and any other land which is expected achieve these parameters (including for “dehesa” where tree cover meet the thresholds)
Sweden	Land which hosts a potential yield of stem-wood exceeding one cubic meter per hectare and year. Meanwhile, the Land which hosts a potential yield of stem-wood lower than one cubic metre per hectare and year are classified as mire (under Wetlands). Permanent forest roads (width>5m) are not considered as forest land. All country forests are considered managed.
United Kingdom	Forestry statistics definition used for GHG inventory includes integral open space and felled areas that are awaiting restocking.
Iceland	All forested lands, not belonging to Settlement, that is presently covered with trees or woody vegetation that reach the defined thresholds. Natural birch woodland is included in the IFR national forest inventory (NFI). In the NFI the natural birch woodland is defined as one of the two predefined strata to be sampled. The other stratum is the cultivated forest consisting of tree plantation, direct seeding or natural regeneration originating from cultivated forest.

National forest inventories provide fundamental data inputs for both, areas (forest land and conversions to and from forest land) and for the estimation of carbon stock changes in various pools. Nevertheless, this information in some case is also taken from forest management plan databases (especially, information used to derive activity data and emissions for the base year, e.g. Slovakia).

Data collection in national forest inventories is typically based on repeated measurements in permanent sampling plots, but the sampling design differs among MS in terms of spatial density and frequency of field surveys (e.g. Austria 3 years, Spain 10 years, Lithuania 5 years).

In the last years, the EU MS have made considerable efforts to adjust their forest inventories to the specific requirements of UNFCCC/KP reporting, but also there were some steps toward a slight harmonization at European scale (e.g. COST E43 Action)[63].

Given that annual data are barely available for this sector, efforts have been made also to adjust the timing of inventory cycles to the timeline of first commitment period of the Kyoto Protocol. To meet

[63] http://www.metla.fi/eu/cost/e43

reporting requirements of the time series, annual values are usually obtained by interpolation and extrapolation of available data sets. The main data source for forest land area, the national forest inventories, are in many instances complemented with auxiliary information in the form of national statistics (i.e. surveys) or remotely sensed products (i.e. satellite images, aerial photographs) including their derivatives products such as Corine Land Cover maps.

Furthermore, MS usually have disaggregated forest land areas in various subdivisions according to available datasets. Breakdown criteria differ across MS, although they are consistent across time series: forest type (e.g. broadleaved/coniferous; evergreen/deciduous; species based classification – beech, oak, pine, spruce, etc.); by climate (e.g. temperate moist or temperate dry,); by soil and site type (e.g. lowlands, mountains), administrative or geographical boundaries, and management type (e.g. coppice, high stands).

For Forest land category, definitions of carbon pools are reported by most of the MS (Table 6. 11). Among them, there are slight variations. The impact on the estimates of such variability, even if difficult to assess in quantitative terms, is considered small.

For instance, forest inventories define above-ground biomass carbon pool according to the threshold of minimal diameter (i.e. DBH– diameter at breast height) of sampled trees as ranging from 0 to 7,5 cm. Concerning the below-ground biomass, the information on what exactly is included on this carbon pool is sparse. Dead wood mostly differs in terms of decay time and thresholds of diameters and height/length of wood pieces included in the pool. Litter is either independently assessed or included with soils. In soils organic matter, carbon stock changes are computed according to various soil depths. Usually, carbon stock in understory biomass is only accounted in principle for estimating forest fires emissions (although such information is often not transparently reported in the NIR).

Table 6. 11 Explicit information on forest carbon pools definitions as reported by EU MS and Iceland.

MS	Description
	Aboveground biomass
Austria	All living biomass (DBH > 5cm) above the soil including stem, stump, branches, seeds, bark and foliage (foliage only of evergreen trees). At ARD sites and LUC from and to forests all forest biomass (shrubs, forest understory) with a DBH > 0 cm to 5 cm is also taken under consideration.
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	Living trees with a height over 1.3 m, under different recording 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 1.35 m, i.e. those trees that are measured in NFIs, including the stem wood, stem bark, living and dead branches, cones, needles/foliage. Understory is counted only to estimate the emission from forest fire.
France	Trees with DBH over 7.5 cm.
Germany	Trees with DBH over 7 cm.
Greece	Trees with DBH over 10 cm, but in cases of degraded forests (e.g. oak) and coppices (e.g. Castanea) the threshold is 4.6 cm. The trees in the sample area under the minimum diameter are not considered. Understory biomass is considered for GHG emissions from wildfires.
Hungary	The total biomass above the stump, including all branches and bark, of trees taller than two meters.
Lithuania	Above ground biomass refers to all living biomass above the soil including stem, stump, bark, branches, seeds and foliage.
Ireland	Modeled individual cycle of living biomass (but not the understory and annual/perennial non woody vegetation).
Italy	Trees with DBH over 3 cm.
Lithuania	Above ground biomass refers to all living biomass above the soil including stem, stump, bark, branches, seeds and foliage.
Luxemburg	Diameter of 4 cm at 3.5 m of the total height (average value)
Portugal	Living biomass above the soil, including: stems, stumps, branches, bark and foliage, and forest understory (only for estimation of emissions from forest fires).
Slovakia	Merchantable volume, defined as tree stem and branch volume under bark with a minimum diameter threshold of 7 cm.
Slovenia	Volume over bark of all living trees more than 9.99 cm in diameter at breast height (1.3 m). Includes the stem from ground to a top diameter of 6.99 cm, and also branches to a minimum diameter of 6.99 cm.
Spain	Trees with DBH over 7.5 cm at the ground level are 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).
United Kingdom	Modeled living woody biomass (complete individual cycle of trees, it does not include understory and annual/perennial non woody vegetation).
	Belowground biomass
Austria	All living biomass of live roots with a diameter > 2 mm.
Ireland, United Kingdom	Fine roots pool is simulated within integrates models.
Belgium	Diameter of estimated roots > 5 mm.

MS	Description
Denmark	Stumps from harvested trees within a year from the measurement are measured.
France	Fine roots are included with the soil organic matter.
Finland	Stumps and roots down to a minimum diameter of 1cm.
Hungary	The total biomass of the above trees minus their above-ground biomass.
Czech Republic, Italy, Poland, Spain	Applies a country specific “root- to-shoot” factor.
Lithuania	Below-ground biomass refers to all living biomass of live roots.
Portugal	Living biomass of belowground biomass (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.
Dead Organic Matter - Dead wood	
Austria	All non-living woody biomass not contained in the litter or soil, standing on the ground, without roots, as they are already considered as part of the litter or soil.
Belgium	Dead wood as measured by NFI, namely standing dead trees and fallen logs and branches. A dead tree is considered as fallen when it tilts at a vertical angle equal or superior to 45°. Dead trees above 20 cm of circumference are measured, under 20 cm are estimated visually.
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	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.
Ireland, United Kingdom	Pool is simulated by models.
Italy	The amount of carbon in dead wood is estimated from the aboveground carbon amount with an expansion factor.
Greece	Dead wood that remains on site after fire is assumed to fully decompose in 10 years.
Lithuania	Dead wood includes total standing and lying volume of dead tree stems.
Slovakia	The dead wood carbon pool contains dead trees from standing, stumps, coarse lying dead wood and small-sized lying dead wood not included in litter or soil carbon pools.
Slovenia	Dead wood content is all non-living woody biomass not contained in the litter, either standing, lying on the ground. According to definition from NFI 2007, dead wood in Slovenia includes: dead trees (DBH > 10 cm); stumps (D > 10 cm and H > 20 cm); snags (D > 10 cm and H > 50 cm); coarse woody debris (D > 10 cm and L > 50 cm).
Sweden	Dead wood is defined as fallen dead wood, snags or stumps including coarse and smaller roots down to a minimum “root diameter” of 2 mm. Dead wood of fallen dead wood or snags should have a minimum “stem diameter” of 100 mm and a length of at least 1.3 m.
Iceland	dead wood meeting the minimum criteria of 10 cm in diameter and 1 m in length
Dead Organic Matter – Litter	
Austria	All non-living biomass lying dead in various states of decomposition above the mineral or organic soil.
Austria, Ireland, United Kingdom	Litter is simulated by models.
Denmark	Non-living biomass which is not included in other classes, under various status of decomposition

MS	Description
	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). Biomass of ground vegetation (e.g. moss-, lichen-shrub- and twig vegetation) is not included in the living biomass, but it is included when the litter input to the soil is estimated.
France	Non-living dead wood lying on soil with maximum 7.5 cm diameter, dead leaves, humic and fumic layers, fine roots.
Germany	Dead organic cover with a fraction < 20 mm.
Italy	The amount of carbon in litter is estimated from the aboveground carbon amount with linear relations.
Portugal	Non-living biomass on top of mineral soil, in various stages of decomposition (include fumic, humic) (considered only in forest fires).
Slovakia	The litter pool definition used in the inventory includes all non-living biomass with a size less than the minimum diameter defined for dead wood (1 cm). The small-sized lying dead wood (diameter between 1 and 7 cm), in various states of decomposition above the mineral soil are not a part of litter, because they are included in dead wood. The litter includes the surface organic layer (L, F, H horizons) as usually defined in soil profile description and classification. Live fine roots above the mineral or organic soil (of less than the minimum diameter limit chosen for below-ground biomass) are included in litter.
Slovenia	The carbon stock in Ol, Of and Oh sub horizon. Volume of roots and coarse fragments (soil skeleton > 2 mm) is not included.
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 and b) coarse litter with "wood stem diameter" between 10-100 mm.
Soil Organic Carbon	
Austria	All organic matter in mineral and organic soils (including peat) to a soil depth of 50 cm (forests, LUC from and to forests) or to a soil depth of 30 cm (all other land uses and LUC).
Austria, Finland, United Kingdom Ireland	Pool is simulated by models (undefined depth or dimensions).
Belgium, France, Germany, Italy, Luxemburg, Portugal	Organic carbon in 0-30 cm top soil.
Bulgaria	Organic carbon in 0-40 cm top soil, includes also the C stock of the litter layer (humus layer).
Croatia	Organic carbon in 0-40 cm top soil.
Czech Republic	Soil organic carbon in 0-30 cm, including the upper organic horizon.
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 Histosols).
Hungary	The soil carbon stocks were determined from humus content (Hu) values (Filep, 1999) that were measured for the uppermost 30 cm of the soil.
Slovakia	Organic carbon in the mineral soils 0-20 cm.
Slovenia	Carbon stock in mineral part of soil (SOM) in 0–40 cm soil depth.
Spain	Organic carbon in the mineral soils down to 30 cm.
Estonia, 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.

When assessing inventory completeness, it should be noted that what is not reported under a pool, is reported under another one (e.g. fine roots are reported either as litter or as soil organic matter), so that no bias in the overall estimation are expected to occur.

Individual submissions of GHG inventories follow 2006 IPCC GL for estimating the carbon stock changes in forest carbon pools. For living biomass, methodologies are based either on the “stock difference” or “gain-loss” methods (Table 6. 12). Table 6. 12 Methodologies used by MS and Iceland for estimating carbon stock changes in Living Biomass.

Member State	**Estimation method**
Austria	Gain-loss
Belgium	Stock-difference
Bulgaria	Stock-difference
Croatia	Gain-loss
Cyprus	Gain-loss
Czech Republic	Gain-loss
Denmark	Stock-difference
Estonia	Stock-difference
Finland	Gain-loss
France	Gain-loss
Germany	Stock-difference
Greece	Stock-difference
Hungary	Stock-difference
Ireland	Gain-loss
Italy	Gain-loss
Latvia	Gain-loss
Lithuania	Stock-difference
Luxemburg	Gain-loss
Malta	Gain-loss
Netherlands	Gain-loss
Poland	Gain-loss
Portugal	Gain-loss
Romania	Gain-loss
Slovakia	Gain-loss
Slovenia	Stock-difference
Spain	Stock-difference
Sweden	Stock-difference
UK	Gain-loss
Iceland	Gain-loss

Data sources for the estimation of carbon stock changes in living biomass also differ among national inventories, upon data availability. Nowadays, national forest inventories represent the primary source of information for most of MS, while others rely on forestry statistics and yield tables. In addition, forest fire statistics complement both data sources. Data collection and data analysis programs are ongoing in most of the MS to further improve the completeness and accuracy of the estimates, primarily of carbon stock changes.

The implied carbon stock change factors reported for net carbon stock changes in living biomass for 2016 range from 1.40 to -0.23 T C ha^{-1} among MS and Iceland (Table 6. 13). Generally, low values of IEF are shown by countries with most intensive forest exploitation or with less favorable climatic conditions (i.e. lower growth and also more losses by natural disturbances); while higher values are for countries where planting is the main instrument to ensure forest regrowth.

Table 6. 13 Implied carbon stock change factors for living biomass pool in 4A1 (t C ha-1 year-1) reported in individual GHGI 2018.

Member State	Net carbon stock change factor in living biomass t C/ha	
	1990	2016
AUT	0.77	0.31
BEL	0.44	0.58
BGR	1.07	0.40
HRV	0.79	0.63
CYP	0.08	-0.23
CZE	0.51	0.43
DNM	0.37	0.13
EST	0.27	0.25
FIN	0.34	0.34
FRK	0.46	0.64
DEU	1.43	1.03
GRC	0.10	0.17
HUN	0.47	0.45
IRL	2.14	-0.20
ITA	0.55	1.01
LVA	1.62	0.19
LTU	0.96	1.30
LUX	-0.23	1.40
MLT	NA	NA
NLD	1.32	1.15
POL	1.04	0.97
PRT	0.40	0.57
ROU	0.89	0.82
SVK	0.97	0.60
SVN	1.18	1.23
ESP	0.44	0.51
SWE	0.35	0.34
GBK	1.17	1.17
ISL	0.05	0.11

Changes of organic carbon stored in mineral soils and dead organic matter are mostly reported by applying Tier 1 method, which assumes for this land use subcategory that these carbon pools are in equilibrium and therefore no net carbon stock changes occur. In these cases, the notation key NO (or NE) is used in the corresponding CRF table (see also Table 6. 5 and Table 6. 6 on completeness).

When they are estimated, MS mainly rely on data collected in the course of the national forest inventories, however, it should be noted that the widespread use of the Tier 1 method is due to the lack of appropriate data (and the high costs associated with systems that would allow a proper collection of data) or to the very high uncertainty of the existing data.

Nevertheless, and increasing number of MS document on the ongoing efforts to estimate emissions and removals from dead organic matter and mineral soils, and more MS as compared with previous submissions report quantitative estimates for these pools during the last year using country-specific approaches.

When data is available, these are either directly used for estimating carbon stock change by using stock difference or gain-loss methods, or integrated in models. But depending on the available datasets in individual countries, carbon stock changes in dead organic matter are often disaggregated between dead wood (DW) and litter (LT). However, some MS include the estimates within soil organic carbon (e.g. Finland).

Finally, particularities are given by France and Luxembourg that report carbon stock changes in dead organic matter only for part of the time-series.

France, in line with the IPCC, reports this carbon stock changes since 1999 as a result of the significant carbon inputs that entered into the pool after some windstorms event that affected dramatically the forest area in that year. By other hand, Luxembourg uses the stock-difference method, which has resulted in a measured increase of dead wood between two consecutive NFI period between 2000 and 2010, for year before and after the Tier 1 assumption of equilibrium was used.

Table 6. 14 Implied carbon stock change factors in DOM carbon pool in 4A1 (t C ha-1 yr-1) reported in individual GHGI 2018.

Member States	Net carbon stock change in dead wood per area (t C/ha)		Net carbon stock change in litter per area (t C/ha)	
	1990	2016	1990	2016
AUT	0.02	0.06	NE,IE	NE,IE
BEL	NO	NO	NO	NO
BGR	0.00	0.03	0.00	0.04
HRV	NO	NO	NO	NO
CYP	NO	NO	NO	NO
CZE	NO	NO	NO	NO
DNM	0.01	-0.09	-0.01	-0.32
EST	0.02	0.01	NO	NO
FIN	IE	IE	IE	IE
FRK	NE	-0.03	NE	NE
DEU	0.04	-0.05	-0.01	-0.01
GRC	NA,NO	NO,NA	NA,NO	NO,NA
HUN	NO	NO	NO	NO
IRL	IE	IE	-0.16	0.59
ITA	0.02	0.01	0.03	0.01
LVA	0.05	0.20	NA	NA
LTU	0.07	0.06	NO	NO
LUX	NO	NO	NO	NO
MLT	NA	NA	NA	NA
NLD	0.08	0.23	NO	NO
POL	NO	NO	NO	NO
PRT	IE	IE	0.00	0.00
ROU	NO	NO	NO	NO
SVK	NO	NO	NO	NO
SVN	0.00	0.00	NO	NO
ESP	NA	NA	NA	NA
SWE	0.04	0.07	-0.10	-0.14
GBK	IE	IE	0.55	0.45
ISL	NE,IE	NE,IE	NE	NE

Carbon stock changes in mineral soils under forest land remaining forest land in this submission are quantitatively estimated by 11 MS, generally as a small net sink of carbon (with the exception of Austria, Cyprus and Bulgaria) (Table 6. 15).

Most of the MS report absence or insignificant areas of organic soils under this land use subcategory. However, when organic soils are presented, this are reported, in most of the cases, as resulting in a net source of emissions. 12 MS reports CO_2 emissions from organic soils associated with managed forests (e.g. drainage of soils to establish plantations), and only UK reports a sink from organic soils in this category, justified in its national inventory report.

Finally, in the case of Netherlands, it was justified that forests are not actively drained, but that forest on organic soils are mainly forest with a nature purpose and not a production purpose. Therefore the Netherlands uses notation key NO.

Table 6. 15 Implied carbon stock change factors in mineral and organic soils in 4A1 (t C ha-1 yr-1) reported in individuals GHGI 2018.

Member States	Net carbon stock change in mineral soils per area (t C/ha)		Net carbon stock change in organic soils per area (t C/ha)	
	1990	2016	1990	2016
AUT	-0.19	-0.18	NO	NO
BEL	0.53	0.53	NO	NO
BGR	0.00	-0.06	NO	NO
HRV	NO	NO	NO	NO
CYP	0.08	-0.20	NO	NO
CZE	NO	NO	NO	NO
DNM	NA	NA	-1.95	-1.30
EST	0.16	0.16	-0.19	-0.19
FIN	0.13	0.24	-0.55	-0.25
FRK	NE	NE	NO	NO
DEU	0.41	0.41	-2.10	-2.24
GRC	NA,NO	NO,NA	NA,NO	NO,NA
HUN	NO	NO	-2.60	-2.60
IRL	NO	NO	-0.55	-0.45
ITA	NA,NO	NO,NA	NO	NO
LVA	NA	NA	-0.52	-0.52
LTU	NE	NE	IE	IE
LUX	NO	NO	NO	NO
MLT	NA	NA	NO	NO
NLD	NO	NO	NO	NO
POL	0.05	0.11	-0.68	-0.68
PRT	0.02	0.00	NO	NO
ROU	NO	NO	-0.68	-0.68
SVK	NO	NO	NO	NO
SVN	NO	NO	NO	NO
ESP	NA	NA	NO	NO
SWE	0.16	0.20	-0.34	-0.32
GBK	0.20	0.36	-0.11	0.88
ISL	NE	NE	-0.37	-0.37

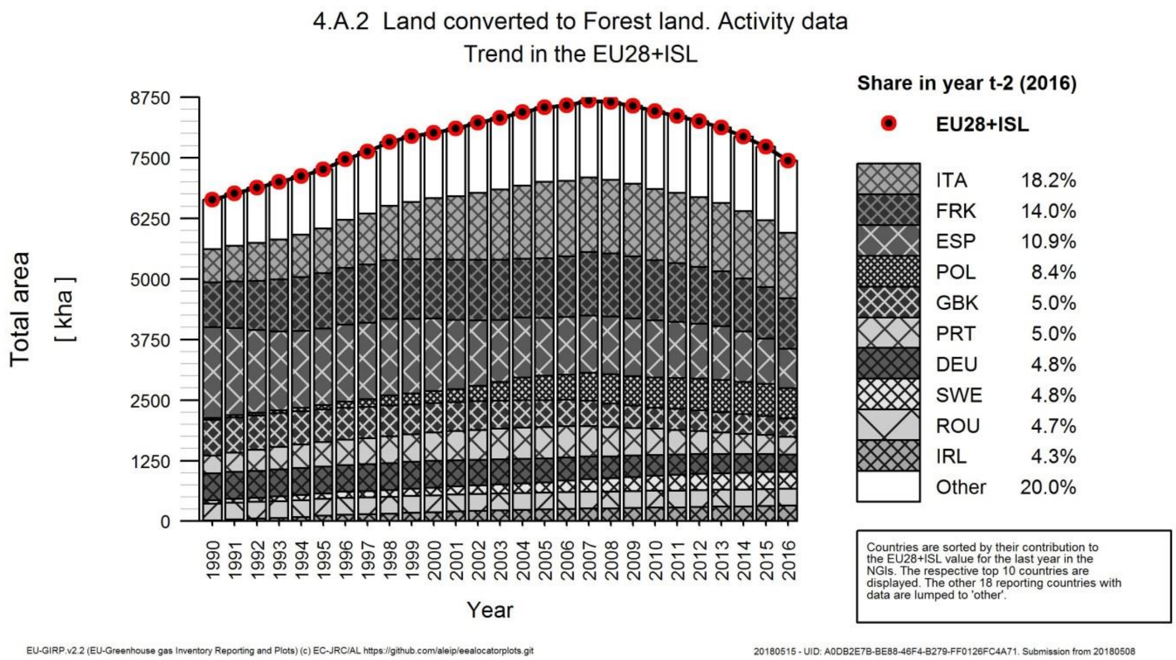
6.2.1.3 Land converted to Forest Land (CRF 4A2)

Overview of Land converted to Forest Land category

In this submission, the area reported under this subcategory represents 4% of the total Forest Land area reported at the level of EU and Iceland. This subcategory has increased by 12% as compared with 1990 (Figure 6. 5), from 6.634 Kha in 1990 to 7.439 Kha in 2016. Most of the new forest areas take place from Grasslands and Cropland areas, and although within the overall category they have a low share in terms of areas, they contribute by 12% to the total carbon sink of the European forest.

In term of areas, Italy, France and Spain together contribute with about 40% of the total areas of land being converted to forest land.

Figure 6. 5 Trend of activity data in subcategory 4A2 "Land converted to Forest Land" in EU MS and Iceland (kha, 1990-2016)



This subcategory has been always reported as a net carbon sink at the level of EU and Iceland. In this submission, it reaches 48.953 Kt CO_2, which represents an increase of 17% as compared with 1990, and a decrease of 5% compared with in previous year. This trend in removals is well associated with the trend on areas (Figure 6. 6; Table 6. 16).

Nevertheless, some MS (i.e. Ireland and Netherlands) have reported this subcategory as a net source of emissions for the first years of the time series or as a very small sink. This fact is explained by the emissions caused during the preparatory practices of soils previous to afforestation or reforestation activities. The absence of such emissions is associated with natural expansion of forest areas.

Table 6. 16 4A2 Land converted to Forest Land: MS and Iceland' contributions to net CO_2 emissions (+)/removals (-) (CRF table 4)

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016	
	1990	2015	2016		kt CO2	%	kt CO2	%
Austria	-3 043	-1 747	-1 741	3.6%	1 302	43%	6	0%
Belgium	-8	-424	-463	0.9%	-455	-5961%	-39	-9%
Bulgaria	-510	-742	-768	1.6%	-258	-51%	-27	-4%
Croatia	-29	-122	-220	0.4%	-191	-665%	-97	-80%
Cyprus	-13	-47	-43	0.1%	-30	-238%	5	10%
Czech Republic	-327	-498	-503	1.0%	-176	-54%	-5	-1%
Denmark	-31	494	157	-0.3%	188	608%	-337	-68%
Estonia	-12	-230	-257	0.5%	-245	-2113%	-27	-12%
Finland	-1	-357	-332	0.7%	-331	-25432%	25	7%
France	-4 615	-6 746	-6 496	13.3%	-1 881	-41%	250	4%
Germany	-5 215	-4 393	-4 222	8.6%	993	19%	171	4%
Greece	NE,NO	-104	-103	0.2%	-103	-∞	1	1%
Hungary	-310	-1 493	-1 441	2.9%	-1 132	-365%	52	3%
Ireland	27	-3 691	-3 692	7.5%	-3 720	-13647%	-2	0%
Italy	-2 633	-6 215	-5 829	11.9%	-3 197	-121%	386	6%
Latvia	-3	-196	-194	0.4%	-190	-5882%	3	1%
Lithuania	-792	-976	-995	2.0%	-203	-26%	-19	-2%
Luxembourg	-306	-101	-86	0.2%	219	72%	15	15%
Malta	NO	NO	NO	-	-	-	-	-
Netherlands	32	-623	-646	1.3%	-678	-2127%	-23	-4%
Poland	-141	-2 697	-2 514	5.1%	-2 373	-1681%	183	7%
Portugal	-2 155	-3 003	-2 495	5.1%	-340	-16%	508	17%
Romania	-3 873	-4 248	-4 248	8.7%	-376	-10%	0	0%
Slovakia	-2 210	-391	-394	0.8%	1 816	82%	-3	-1%
Slovenia	61	-249	-228	0.5%	-289	-475%	21	8%
Spain	-15 073	-10 674	-9 507	19.4%	5 566	37%	1 167	11%
Sweden	70	-1 263	-1 120	2.3%	-1 190	-1703%	142	11%
United Kingdom	-700	-246	-279	0.6%	421	60%	-34	-14%
EU-28	**-41 809**	**-50 983**	**-48 661**	**99%**	**-6 852**	**-16%**	**2 322**	**5%**
Iceland	-27	-282	-291	0.6%	-264	-974%	-9	-3%
United Kingdom (KP)	-723	-247	-281	0.6%	442	61%	-34	-14%
EU-28 + ISL	**-41 859**	**-51 266**	**-48 953**	**100%**	**-7 094**	**-17%**	**2 313**	**5%**

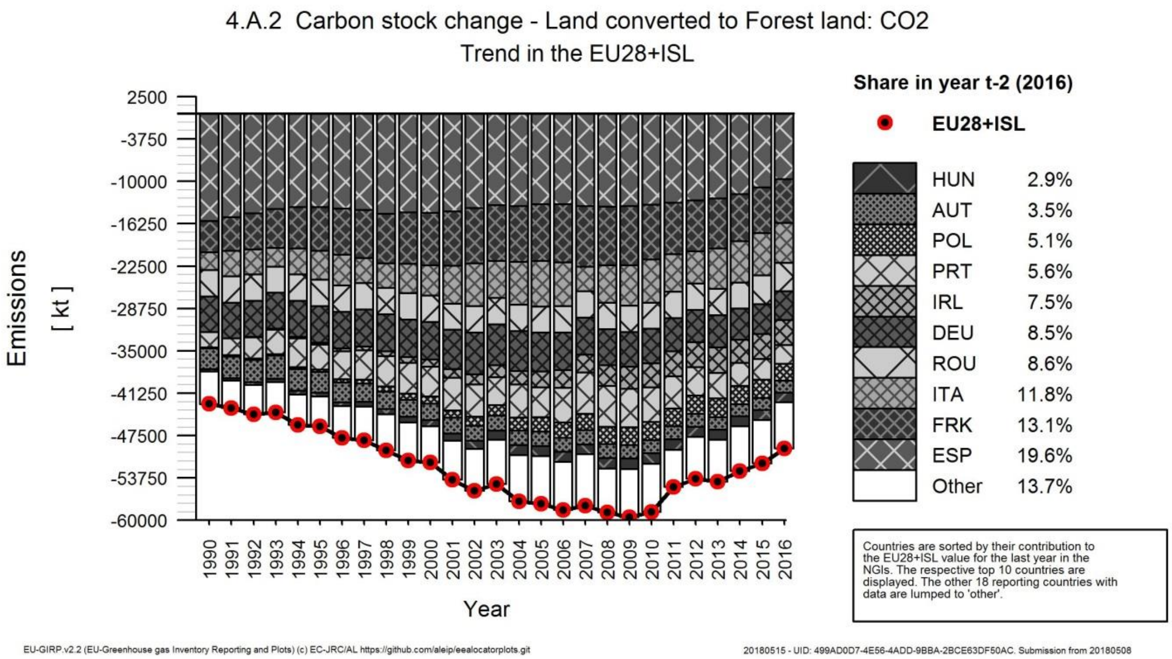
As shown in Table 6. 16, in this year, some MS reported significant changes in this subcategory as compared with 1990, for instance Finland, Ireland and Latvia.

In the case of Finland, this is given by the net result of summing up under the category 4A.2 emissions and removals from all the lands converted in forest. While in 1990 emissions from drainage organic soils in cropland converted in forests balanced the removals reported under all the other conversions; no drainage of organic soils occur in the last years of the time series and therefore much more large sink was reported.

In the case of Ireland, the increase on removals by the post 1990 forest is due to an increase in forests area and productivity as new established forests mature. The slight decrease in the slope of the change in removals from 2007 onward is due to thinning harvests in productive forests at age 17 years old and onwards.

Finally, Latvia reports a constant increase of forest area that result in much more sink at the end of the time series than in the base year.

Figure 6. 6 Trend of emissions (+)/removals (-) in subcategory 4A2 "Land converted to Forest Land" in EU MS and Iceland (kt CO_2, 1990-2016)



For this year, about 45% of total carbon sink reported at EU level from subcategory 4A.2 was reported by France, Italy and Spain, while the 10 MS with the larger contribution represent about the 86% of the total sink of the new forest areas.

Methodological issues for Land converted to Forest Land category

Methods used to identify and represent the areas converted to forests, as well as to report GHG emissions and CO_2 removals from these areas, are generally the same as the ones used for the subcategory 4A.1. Nevertheless, different parameters are involved under each subcategory due to differences on growth patterns, management practices, etc. of these forests. In this sense, and following past recommendations from the ERTs of the EU GHG inventory, in the last years, Italy improved the methodology to refine the estimates and increase the accuracy under each forest related subcategories.

Most of the MS have developed land identification systems that are able to identify and track land use conversions to and from forest. Mainly, as already mentioned, these methods are based on information collected by the national forest inventories on systematic samples plots, and that, in many cases, is complemented by auxiliary information on the form of satellites images or aerial photography and national registries.

Estimates of GHG emissions and CO_2 removals from this subcategory are usually reported using tier 2 methods involving country-specific data collected during the national forest inventories. Under this subcategory, living biomass and dead organic matter carbon pools are in most of the cases reported as a net carbon sink. Mineral soils are reported either as a net source or a net sink of emissions depending on whether there is presence or absence of disturbed soils on new forest areas (i.e. natural regeneration or, management practices for soil preparation). Concerning organic soils, all the MS, with the exception of UK that uses the CARBINE model, have reported this carbon pool as a net source of emissions whenever new forest areas were established in this type of soils.

Nevertheless, it should be noted that the heterogeneity in approaches used by MS under 4A.2 suggests caution in interpreting differences in the implied carbon stock change factors among carbon pools. For instance, possible reasons of differences may include the length of the time series on activity data and their starting point, the use of time-averaged annual biomass growth, or the estimated CO_2 emissions from previous land use, including lagged emissions.

On top of that, concerning changes in the carbon stock of soils, there is a high variability among MS on the carbon reference values considered in the estimations. In general, carbon stock changes in soils are estimated either at tier 2 or at tier 3 level by using models (e.g. Denmark, UK).

6.2.2 Cropland (CRF 4B)

6.2.2.1 Overview of the Cropland category

Subject to intensive agriculture practices, Cropland category is an important contributor to EU GHG budget. This category, which includes arable lands for annual crops, permanent crops, set aside lands and rice-fields, represents the larger source of emissions among the six land use categories.

Based on individual submissions, total Cropland area at the level of EU MS and Iceland covers about 127.000 kha as reported for the year 2016, which represent 28% of total lands, although they show a constant decreasing trend of about 5% as compared with the year 1990.

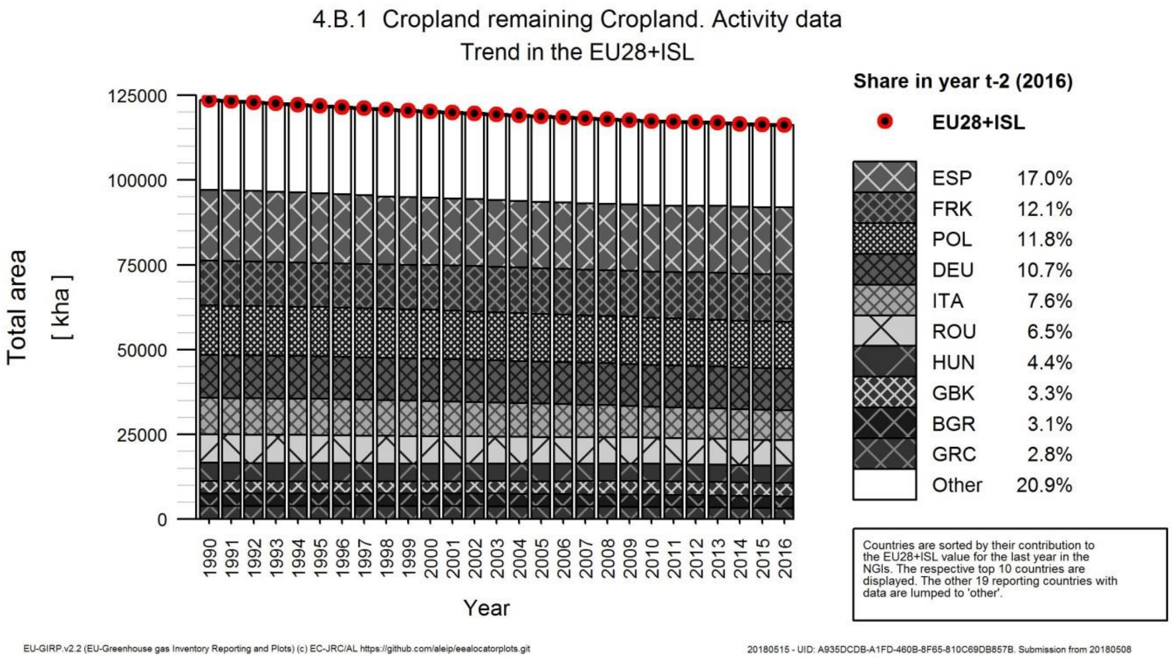
6.2.2.2 Cropland remaining Cropland (CRF 4B1)

Overview of Cropland remaining Cropland category

In line with the overall category, this subcategory has constantly decreased since 1990 (Figure 6. 7) from 123.567 kha in 1990 to 116.153 kha in 2016. This represents a decrease of 6%. With the exception of France, UK, Malta, Slovakia and Iceland, all MS report this year a decrease of Cropland area as compared with 1990.

The overall trend of this subcategory is driven by 10 MS which together contribute to about 80% of the total area, and more specifically, Spain, Poland, France and Germany which represent about half of the area reported under this subcategory.

Figure 6. 7 Trend of activity data in subcategory 4B1 "Cropland remaining Cropland" in EU MS and Iceland (kha, 1990-2016)



In terms of emissions, at the level of EU MS and Iceland, this subcategory has been always reported as a net source. As reported this year, GHG emissions reach 21.446 kt CO_2 which represents a decrease of 10% as compared to 1990 (Table 6. 17).

This trend is mainly driven by Germany, Sweden and UK which reports the larger emissions from this subcategory (Figure 6. 8). In general, emissions are the result of the oxidation of organic matter in soils which are particularly important in those MS with presence of cultivated areas on organic soils.

Nevertheless, some MS report a significant carbon sink in Cropland remaining Cropland. For instance, France, Romania and Spain which report a substantial net carbon sink in mineral soils and, in some case, also in the living biomass carbon pool. This is generally justified by the implementation of IPCC methodologies (i.e. tier 1 and tier 2) that result in a net sink when current management practices of soils are less intensive that those implemented 20 years before. And also, in MS with significant areas of woody crops (i.e. orchards, vineyards, Christmas trees, fruits, bushes, and olive trees) that provide a net sink of carbon.

A particular case is Romania, which reports a significant sink in this subcategory because, as explained in its NIR, Cropland areas include lands that are subject to Revegetation activities under the KP. Such areas are reported as tree plantations but they are managed as part of the agricultural land, mainly arable. Tree plantations classified as revegetated areas "behave" as forest plantations with regard to change in each carbon pools therefore resulting in a net carbon sink.

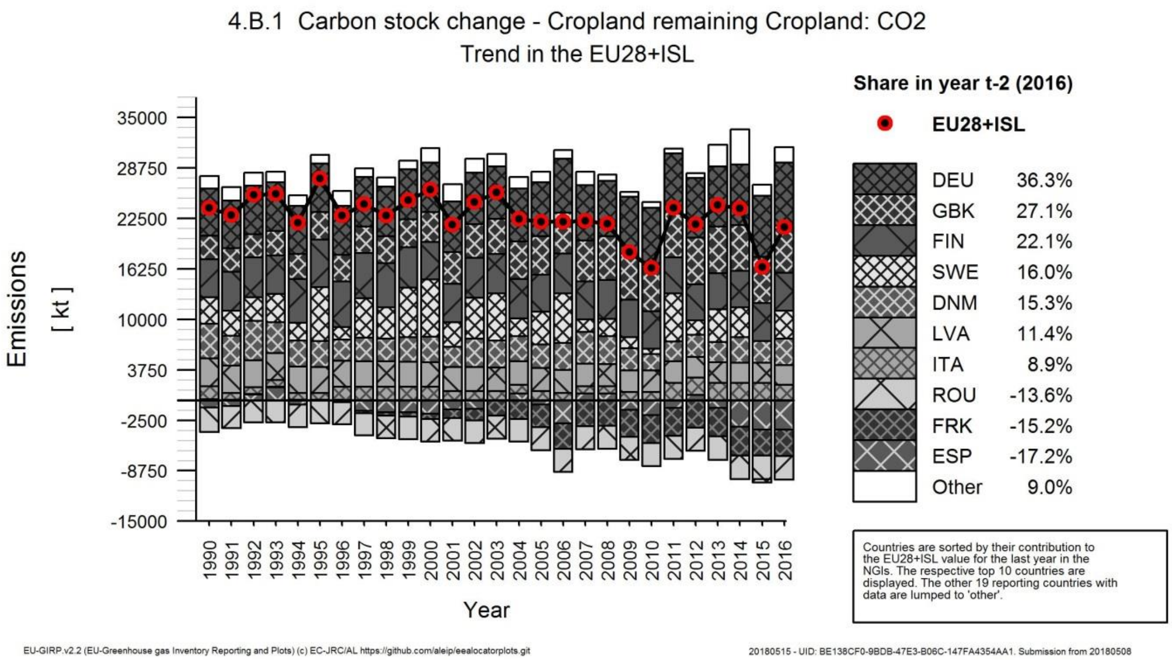
Table 6. 17 4B1 Cropland remaining Cropland: MS and Iceland contributions to net CO_2 emissions (+)/removals (-) (CRF table 4)

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016	
	1990	2015	2016		kt CO2	%	kt CO2	%
Austria	-18	-194	-184	-0.9%	-166	-899%	9	5%
Belgium	213	183	180	0.8%	-33	-16%	-3	-1%
Bulgaria	-702	673	601	2.8%	1 304	186%	-71	-11%
Croatia	197	155	290	1.4%	93	47%	135	87%
Cyprus	-135	-131	-131	-0.6%	4	3%	-1	0%
Czech Republic	90	43	36	0.2%	-54	-60%	-7	-16%
Denmark	4 306	2 727	3 278	15.3%	-1 028	-24%	552	20%
Estonia	493	579	576	2.7%	83	17%	-3	0%
Finland	4 706	4 651	4 742	22.1%	36	1%	91	2%
France	79	-3 265	-3 264	-15.2%	-3 343	-4246%	1	0%
Germany	5 880	7 553	7 783	36.3%	1 902	32%	230	3%
Greece	-808	-608	-179	-0.8%	629	78%	428	71%
Hungary	30	-566	-379	-1.8%	-409	-1379%	187	33%
Ireland	-16	-92	-131	-0.6%	-115	-712%	-39	-43%
Italy	1 638	2 157	1 918	8.9%	279	17%	-240	-11%
Latvia	3 466	2 462	2 436	11.4%	-1 030	-30%	-26	-1%
Lithuania	100	-109	-77	-0.4%	-177	-177%	33	30%
Luxembourg	-1	2	1	0.0%	3	213%	0	-11%
Malta	-1	-1	-1	0.0%	0	-44%	0	2%
Netherlands	1 467	794	763	3.6%	-704	-48%	-31	-4%
Poland	833	658	670	3.1%	-162	-19%	12	2%
Portugal	21	-205	-206	-1.0%	-227	-1082%	-1	-1%
Romania	-3 015	-2 914	-2 921	-13.6%	94	3%	-7	0%
Slovakia	-1 200	-1 120	-1 222	-5.7%	-22	-2%	-101	-9%
Slovenia	-250	-180	-180	-0.8%	70	28%	0	0%
Spain	-927	-3 638	-3 679	-17.2%	-2 752	-297%	-41	-1%
Sweden	3 248	-365	3 423	16.0%	175	5%	3 787	1039%
United Kingdom	2 909	5 762	5 803	27.1%	2 894	99%	41	1%
EU-28	**22 605**	**15 010**	**19 946**	**93%**	**-2 659**	**-12%**	**4 936**	**33%**
Iceland	1 217	1 510	1 500	7.0%	284	23%	-10	-1%
United Kingdom (KP)	2 920	5 762	5 803	27.1%	2 884	99%	41	1%
EU-28 + ISL	**23 832**	**16 521**	**21 446**	**100%**	**-2 385**	**-10%**	**4 926**	**30%**

Information above shows that as compared with the year 1990, France and Spain have reported in this submission a significant increase of removals in Cropland remaining cropland. This results mainly from an increase in soil organic carbon in mineral soils which is driven by changes in management practices. However, larger sink in living biomass of woody crops at the end of the time series also contribute the overall trend. By contrary, UK has reported a significant increase of emissions as compared with the base year driven also by larger emissions from mineral soils due to management practices.

Bulgaria shifted from a sink of carbon reported for the year 1990 to a source of emissions reported in this year due to carbon stock changes in living biomass in perennial woody crops. Bulgaria uses the IPCC tier 1 method to report carbon stock changes in this carbon pool, and this resulted in a source of emissions due to a higher loss of biomass in old perennial crops than a sink of carbon in young perennial crops (i.e. less than 30 years).

Figure 6. 8 Trend of emissions (+)/removals (-) in subcategory 4B1 "Cropland remaining Cropland" in EU MS and Iceland (kt CO_2, 1990-2016)



Methodological issues for Cropland remaining Cropland category

Lands included under this category generally are in line with the IPCC definition (Table 6. 18) however, there could be national particularities (e.g. treatment of some woody crops) that result in small differences among MS.

In some cases, because of the absence of annual information on activity data, along with the fact that management practices include crops-rotation cycles and fallow lands; some croplands areas may not be clearly separated from grasslands areas. In these cases, MS have implemented a number of years before a land is shifted from/to cropland and grassland.

In overall, following IPCC approach, the living biomass carbon pool is assumed in balance for annual crops, while carbon stock changes are often reported for conversions among annual and woody crops (e.g. Austria, Croatia, and Bulgaria). Concerning carbon stock changes in woody crops, MS often implement the IPCC approach, either by using country-specific data on biomass accumulation from growth and maturity cycles, or by using default data. However, which is not always transparently provided is how the lands in which woody crops have reached the maturity are identified and excluded from those that are still accumulating carbon.

Carbon stock changes in dead organic matter are in most of the cases reported following the IPPC assumption that the dead wood and litter stocks are not present in croplands or they are in equilibrium. In some cases, however, MS have reported this pool as a net sink (e.g. Latvia and Sweden) or as a net source (e.g. Romania).

A particular case is given by Finland which report the notation key IE since the net carbon stock change in dead organic matter is included in losses in living biomass, explaining that the amount of dead branches of currants and apple trees in modern orchards is very low and they are usually chipped and left to decay in the orchards.

About carbon stock change in soils, these have been reported under mineral soils as, either a net source or a net sink of carbon. The final net result is typically associated with an increase or decrease of the intensity in the soils management practices along the time series. By contrary, as reported by all MS, for cropland areas under organic soils, the net result of carbon stock changes associates with a net source of CO_2 emissions.

Methodologies for reporting this carbon pool follow, in most of the cases, IPCC tier 1 or tier 2 approach, where carbon stock changes are estimated as the difference on the carbon stock in soils at two moments in time. In few cases, carbon stock changes have been also estimated by using models (e.g. C-tool by Denmark and ICBM by Sweden).

Table 6. 18 Definitions of lands included by MS and Iceland under the category 4B: Cropland

MS	***Definition***
Austria	Arable land, including annual and perennial crops (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.
Belgium	Tillage land and agro-forestry systems with vegetation falling below the thresholds for forests.
Bulgaria	Cropland consists of annual crops (cornfields and kitchen gardens) and perennials (vineyards, fruit and berry plantation and nurseries). Arable land is the land worked regularly, generally under a system of crop rotation - area with annual crops, set - aside area as well as area with seeds and seedlings. Perennial crops include fruit and berry plantation, vineyards and other permanent crops, nurseries for wine, fruits, ornamental plants, forest trees etc. The orchard is a uniformly kept plantation (by annual pruning and regular treatment for protection from diseases and insects) of fruit trees (pip- trees, stone-trees and nut-trees).
Croatia	Cropland category includes non-irrigated arable land, permanently irrigated arable land, vineyards, fruit trees and berry plantations, olive groves, annual crops associated with permanent crops (Complex cultivation patterns).
Cyprus	This category contains cropped land, including lands with woody vegetation (i.e. fruit trees) where the vegetation does not meet the definition of forest. In particular, this category includes land principally occupied by agriculture, including: arable land, annual and permanent crops as well as vineyards, fruit trees and berry plantations, olive groves and other similar types of cultivation.
Czech Republic	Cropland is predominantly represented by arable land (92.6%), while the remaining area includes hop-fields, vineyards, gardens and orchards.
Denmark	Annual crops, wooden perennial crops, 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), house 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.
Estonia	Cropland is arable land, area where annual or perennial crops are growing (incl. fallow, orchards, short-term and long-term cultural grasslands and temporary greenhouses). It does not include built garden land under 0.3 ha (that is included in Settlements). Abandoned cropland is classified as cropland until it has not lost arable land features – changes in soil and vegetation have not taken place and the land is still usable as cropland without the implementation of specific treatments.
Finland	Arable crops, grass covered (for less than 5 years), set-aside, permanent horticultural crops, greenhouses and kitchen gardens.
France	Annual crops, temporary pastures (which last for maximum 6 annual harvests) and permanent crops (orchards, vineyards, olives, etc).

MS	*Definition*
Germany	Annual crops and cropland with perennial crops (long-lived crops: fruit crops, osiers, poplars, Christmas tree farms, nurseries) and lands for cultivation of vegetables, fruit and flowers.
Greece	Annual and perennial crops, temporary fallow land and perennial woody crops, i.e. tree crops and vineyards.
Hungary	Cropland contains arable lands, vegetable gardens, orchards and the vineyard areas, as well as set-aside croplands. Arable lands are any land area under regular cultivation irrespective of the rate or method of soil cultivation and whether the area is under crop production or not due to any reason, such as temporary inland waters or fallow. Areas under tree nurseries (including ornamental and orchard tree nurseries, vineyard nurseries, forest tree nurseries excluding those for the own requirements of forestry companies grown in the forest), permanent crops (e.g. alfalfa and strawberries), herbs and aromatic crops are included. Vegetable gardens are areas around residential houses where, in addition to meeting the owners' demand may produce some surplus of low amount which is usually traded. Orchards are land under fruit trees and bushes that may include several fruit species (e.g.: apples, pears, cherries, etc.). Included are non-productive orchards and orchards of systematic layout in vegetable gardens if the area is 200 m^2 or above in case of berries and 400 m^2 or above in case of fruit trees. Vineyards are areas where grapes are planted in equal row width and planting space, and include non-productive areas and vineyards in vegetable gardens (e.g. trellises) if grapes are planted in equal row width and planting space, and the size of the area is at least 200 m^2. Set-aside cropland is land that is abandoned but not converted to any other land use.
Ireland	Permanent crops and tillage land, 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).
Latvia	The cropland refers to the area of arable land, including orchards and extensively managed arable lands. Cropland also includes animal feeding glades, which according to national land use classification belong to forest land.
Lithuania	The area of cropland comprises of the area under arable crops as well as orchards and berry plantations. Arable land is continuously managed or temporary unmanaged land, used and suitable to use for cultivation of agricultural crops, also fallows, inspects, plastic cover greenhouses, strawberry and raspberry plantations, areas for production of flowers and decorative plants. Arable land set aside to rest for one or several years (<5 years) before being cultivated again as part of an annual crop-pasture rotation is still included under cropland. Orchards and berry plantations are areas planted with fruit trees and fruit bushes (apple-trees, pear-trees, plum-trees, cherry-trees, currants, gooseberry, quince and others).
Luxemburg	Agro-forestry systems where tree cover falls below the forest thresholds, respectively covered by permanent crops, annual crops, artificial meadows (not permanent) and lands temporarily set aside
Malta	In Malta cropland can be split into three types: arable area which is cultivated under a system of crop rotation; kitchen gardens that include small plots of cultivated land, in which most of the products are intended for consumption by the farmer; land under permanent crops where the crop occupies the same land for a period of time, normally 5 years or more. For inventory purposes, local cropland was split into two: annual crops and perennial woody crops. The main perennial crops considered for this inventory are vines, being the most cultivated crop.
Netherlands	Arable and tillage land, including rice-fields, and agro-forestry systems where the vegetation structure falls below the thresholds for forest and nurseries (including tree nurseries).
Poland	Agricultural land considered as cropland consists of: arable land includes land which is cultivated, i.e. sowed and fallow land. Arable land should be maintained in good agricultural condition. Cultivated arable land is understood as land sowed or planted with agricultural or horticultural products, willow and hops plantations, area of greenhouses, area under cover and area of less than 1000 m^2, planted with fruit trees and bushes, as well as green manure, fallow land includes arable land which are not used for production purposes but are maintained in good agricultural condition; orchards include land with the area of at least 1000 m^2, planted with fruit trees and bushes.
Portugal	Rain-fed annual crops (without irrigation and fallow-land integrated into crop-rotations), irrigated annual crops (under irrigation, greenhouses), rice cultivation lands, wineyards, olives and other species of woody crops
Romania	Cropland includes agricultural lands, i.e. lands covered or temporary uncovered by agricultural crops (major crops and horticultural plants cultures). It includes 3 groups (non-woody crops, woody crops

MS	Definition
	and other wooded land and trees outside forests (which do not meet the forest definition parameters, e.g. forest belts which are narrower than 20m) with 9 categories: orchard, vineyard, shrubs, cultivated land agricultural, temporary fallow land, deciduous tree, coniferous tree, deciduous and resinous trees and dead trees.
Slovakia	Cropland includes lands for growing cereals, root-crops, industrial crops, vegetables and other kinds of agricultural crops; perennial woody crops; lands temporary overgrown with grass or used for growing of fodder lasting several years; hotbeds and greenhouses if they are built up on the arable land; fallow land which is arable land left for regeneration for one growing season during which were not sow specific crops or just crops for green manure, eventually it is covered by spontaneous vegetation, which would be ploughed in.
Slovenia	Annual: arable land breeds more than 2 meters and grows the non-woody vegetation (cereals, potatoes, forage crops, vegetable crops, oilseed, ornamental plants, herbs, strawberries, hop fields) and agricultural fallow ground. Also temporary meadows and greenhouses. Perennial: permanent crops on arable land such as vineyards, extensive and intensive orchards, olive groves, nursery (for grapevines, fruit and forest trees), forest plantations and forest trees on agricultural land.
Spain	Annual crops and fallow land, perennial crops (olive groves, wines and other woody crops) and mix of annual and permanent crops (except when they qualify as forest land, i.e. in “dehesa”).
Sweden	Regularly tilled agricultural land.
United Kingdom	Arable and horticultureal land.
Iceland	All cultivated land not included under Settlements or Forest land and at least 0.5 ha in continuous area and minimum width 20 m. This category includes harvested hayfields with perennial grasses. Two subcategories of Cropland are defined on the Land use map, “Cropland” and “Cropland on drained soils”.

When Tier 2 methods were applied, they often consist on a country-specific soil organic carbon reference value along with IPCC default values for relative change factors (i.e. for Fmg, Flu, Fi). In some cases, IPCC default relative change factors have been slightly modified to adapt them to national circumstances; but changes rely more on expert judgment than on a statistical analysis or systematic measurements. There is one exception, Austria derived own factors by close comparison with IPCC similar strata.

Carbon stock change factors for living biomass of permanent crops vary depending on the types of crops and management practices across Europe, from North (i.e. bush-type currant crops) to South (i.e. olives crops and agro-forestry systems).

Table 6. 19 Implied net carbon stock change factor for carbon pools in 4B1 (t C ha-1 yr-1) reported by individual submissions in GHGI 2018.

Member States	Net carbon stock change in living biomass per area (t C/ha)		Net carbon stock change in dead organic matter per area (t C/ha)		Net carbon stock change in mineral soils per area (t C/ha)		Net carbon stock change in organic soils per area (t C/ha)	
	1990	2016	1990	2016	1990	2016	1990	2016
AUT	0.003	-0.008	NO	NO	0.000	0.045	NO	NO
BEL	NO	0.004	NO	NO	-0.041	-0.041	-10.000	-10.000
BGR	0.054	-0.044	NE	NE	-0.001	-0.001	NO	NO
HRV	-0.018	-0.028	NO	NO	0.000	0.000	-10.000	-10.000
CYP	0.147	0.149	NO	NO	NO	NO	NO	NO

Member States	Net carbon stock change in living biomass per area (t C/ha)		Net carbon stock change in dead organic matter per area (t C/ha)		Net carbon stock change in mineral soils per area (t C/ha)		Net carbon stock change in organic soils per area (t C/ha)	
	1990	2016	1990	2016	1990	2016	1990	2016
CZE	0.000	-0.001	NO	NO	-0.007	-0.002	NO	NO
DNM	0.008	-0.062	NO	NO	-0.046	0.002	-7.185	-6.526
EST	0.000	0.001	NO	NO	NO	-0.041	-6.100	-6.100
FIN	0.000	0.000	IE	IE	-0.016	0.002	-6.480	-6.588
FRK	-0.003	-0.002	NE	NE	0.001	0.065	NA	NA
DEU	0.001	-0.002	NA	NA	NA	NA	-8.100	-8.100
GRC	0.073	0.036	NO	NO	NO	NO	-10.000	-10.000
HUN	-0.002	-0.007	NO	NO	0.000	0.027	NO	NO
IRL	0.004	0.020	NO	NO	0.002	0.033	NO	NO
ITA	-0.018	-0.031	NO	NO	NO	NO	-10.000	-10.000
LVA	0.001	0.011	0.000	0.000	NA	NA	-7.900	-7.900
LTU	-0.015	0.006	NO	NO	-0.005	0.010	IE	IE
LUX	0.005	-0.008	NO	NO	0.001	0.001	NO	NO
MLT	0.162	0.201	NE	NE	0.048	0.020	NO	NO
NLD	NE	NE	NE	NE	NO	NO	-4.052	-3.962
POL	0.030	0.034	NO	NO	-0.002	-0.002	-1.014	-1.185
PRT	-0.002	0.018	NO	NO	NO	0.008	NO	NO
ROU	0.018	0.036	-0.002	-0.002	0.083	0.075	-2.500	-2.500
SVK	0.227	0.215	NO	NO	-0.008	0.007	NO	NO
SVN	0.331	0.318	NA,NO	NA,NO	-0.001	0.000	-10.000	-10.000
ESP	0.012	0.025	NA	NA	NO	0.026	NO	NO
SWE	0.003	0.017	0.002	0.000	0.005	-0.054	-6.220	-6.220
GBR	-0.002	-0.001	NO	NO	-0.091	-0.294	-5.000	-5.000
ISL	NO	NO	NO	NO	0.171	0.171	-7.900	-7.900

Whenever the Tier 1 assumption for carbon stock changes in living biomass of annual crops or dead organic matter was implemented, MS used the notation key NO or in some cases, NE, in accordance with the Decision 24/CP19, when the insignificant provision was applied, or in some cases also NA as requested by the ERT.

It should be noted that efforts have been implemented during the last years and are still ongoing to harmonize the use of the notation keys among MS.

6.2.2.3 Land converted to Cropland (CRF 4B2)

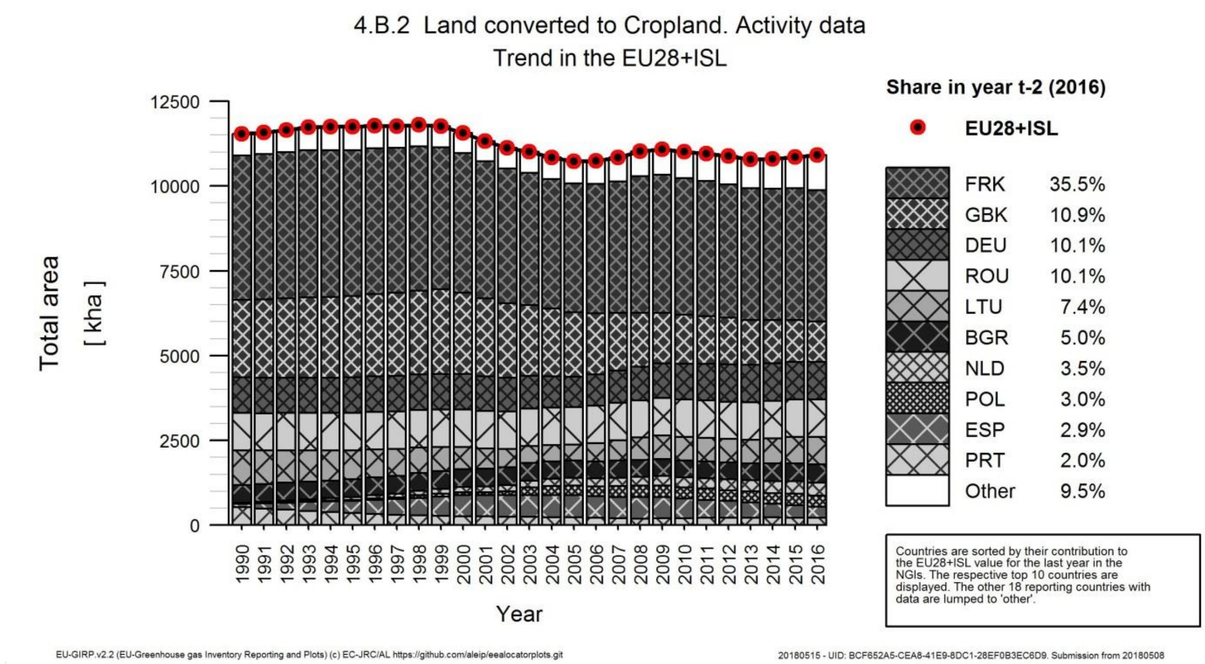
Overview of Land converted to Cropland category

In terms of area, this subcategory represents 9% of the total cropland areas reported at the level of EU and Iceland, however it accounts for 67% of the net CO_2 emissions that are reported under this category.

In overall, area reported for 2016 decreased by 5% as compared with 1990 from 11.529 kha, reported for the year 1990, to 10.908 Kha in 2016 (Figure 6. 9). Despite of this, contrary to the trend on areas reported under subcategory 4B.1, the decrease was not constant, but undergone a slightly increase in 90s.

Main conversions of lands to Cropland take place from areas of Grassland and Forest land. At the level of EU MS and Iceland the trend is mainly driven by France, UK, Romania and Germany which report more than 60% of total area of new Croplands, often associated with rotation of crops and grasses on the same land.

Figure 6. 9 Trend of activity data in subcategory 4B2 "Land converted to Cropland" in EU MS and Iceland (kha, 1990-2016)



In term of emissions, this subcategory is reported as a net source that reaches 42.693 Kt CO_2 in 2016. This represents a decrease of 14% as compared to 1990 (Table 6. 20). The major driver of the trend is France that reports about 40 % of the total emissions in this subcategory; followed by UK and Germany (Figure 6. 10)

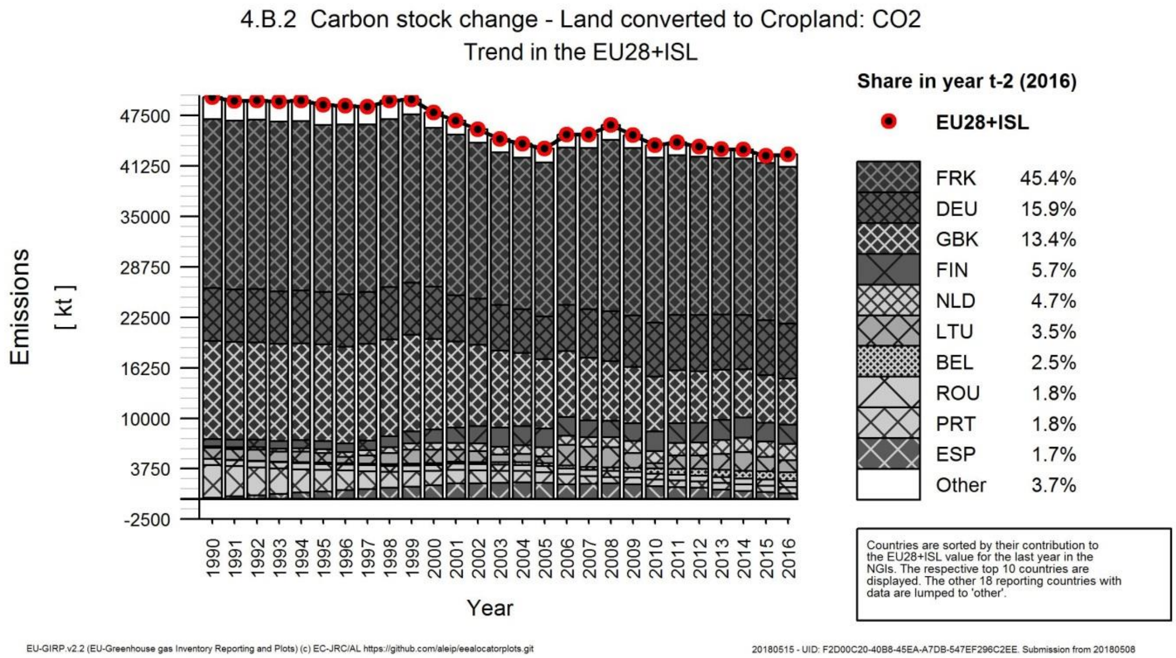
Nevertheless, some individual inventories report this subcategory as a small carbon sink as a result of removals from the living biomass carbon pool when Grassland or Other lands are converted to Croplands with woody vegetation. With some exceptions, all the other carbon pools have been reported as a net source of emissions.

Table 6. 20 4B2 Land converted to Cropland: MS and Iceland' contributions to net CO_2 emissions (+)/ removals (-) (CRF table 4)

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016	
	1990	2015	2016		kt CO2	%	kt CO2	%
Austria	194	203	224	0.5%	30	16%	20	10%
Belgium	36	990	1 059	2.5%	1 023	2812%	69	7%
Bulgaria	37	264	234	0.5%	197	535%	-30	-11%
Croatia	23	35	18	0.0%	-5	-23%	-17	-49%
Cyprus	-3	-30	-27	-0.1%	-24	-799%	3	10%
Czech Republic	114	84	84	0.2%	-30	-27%	0	0%
Denmark	-6	-57	36	0.1%	41	734%	93	162%
Estonia	NO	61	59	0.1%	59	∞	-2	-3%
Finland	894	2 366	2 416	5.7%	1 522	170%	50	2%
France	20 901	19 462	19 401	45.4%	-1 500	-7%	-62	0%
Germany	6 556	6 795	6 794	15.9%	238	4%	-2	0%
Greece	52	16	16	0.0%	-36	-70%	0	1%
Hungary	130	284	340	0.8%	211	163%	56	20%
Ireland	NO,IE	NO,IE	NO,IE	-	-	-	-	-
Italy	534	NO	542	1.3%	8	1%	542	∞
Latvia	NO	-357	-410	-1.0%	-410	-∞	-53	-15%
Lithuania	1 378	1 811	1 505	3.5%	127	9%	-306	-17%
Luxembourg	75	34	34	0.1%	-40	-54%	0	1%
Malta	4	3	3	0.0%	0	-7%	0	6%
Netherlands	180	1 893	1 988	4.7%	1 808	1007%	95	5%
Poland	226	63	63	0.1%	-163	-72%	0	0%
Portugal	4 048	780	766	1.8%	-3 282	-81%	-14	-2%
Romania	744	774	774	1.8%	31	4%	0	0%
Slovakia	466	79	67	0.2%	-399	-86%	-12	-16%
Slovenia	273	50	53	0.1%	-219	-81%	3	6%
Spain	154	854	713	1.7%	559	363%	-140	-16%
Sweden	18	83	149	0.3%	131	743%	66	79%
United Kingdom	12 113	5 813	5 659	13.3%	-6 455	-53%	-154	-3%
EU-28	**49 140**	**42 353**	**42 559**	**100%**	**-6 580**	**-13%**	**207**	**0%**
Iceland	635	90	91	0.2%	-544	-86%	1	1%
United Kingdom (KP)	12 114	5 856	5 701	13.4%	-6 413	-53%	-155	-3%
EU-28 + ISL	**49 775**	**42 486**	**42 693**	**100%**	**-7 082**	**-14%**	**207**	**0%**

As in other land use subcategories that involve the conversion of areas, major changes in the time series of emissions from Land converted to Cropland have been driven by the activity data. As for instance, in the case of Belgium and Netherlands that report a rather constant increase of the area converted to cropland under the subcategory 4B.2, which associate with a constant increase of the emissions in this subcategory.

Figure 6. 10 Trend of emissions (+)/ removals (-) in subcategory 4B2 “Land converted to Cropland” in EU MS and Iceland (kt CO_2, 1990-2016)



Methodological issues for Land converted to Cropland

For estimating and reporting carbon stocks changes in this subcategory, IPCC default methodology is generally used. The implementation of country-specific emissions factors or default factors depend on which type of lands is being converted to Cropland and, the carbon pool estimated. For instance, concerning the living biomass carbon pool, some MS consider the carbon stocks from one year of growth in Cropland following conversion, while other simply consider the oxidation of all the carbon stock in the land that is converted to cropland..

Usually it is assumed that the carbon stored in living biomass and dead organic matter is lost in the year of the conversion, while for soil organic carbon in mineral soils, following IPPC methodology, MS apply a 20 years transition period before the carbon stock of the soils converted to Cropland reach and equilibrium.

6.2.3 Grassland (CRF 4C)

6.2.3.1 Overview of Grassland category (CRF 4C)

Under this category is included, among others, natural and artificial meadows, range lands, moors, forage crops, that can be subject to economical activities (e.g. grazing lands), or be considered unmanaged lands. In several instances, Grassland areas cover also woody lands (i.e. trees and shrub lands) when they do not fall into the forest thresholds.

In overall, these areas represent a net source of emissions that are below the emissions from Settlements (i.e. conversions of lands to Settlements) and far from the emissions reported under Cropland.

Based on individual submissions, total Grassland area at the level of EU MS and Iceland covers 94.012 Kha in 2016.This represents 20% of the total reported areas. However, as for Cropland, these areas have constantly decreased since 1990 reaching a decrease of 5% in 2016.

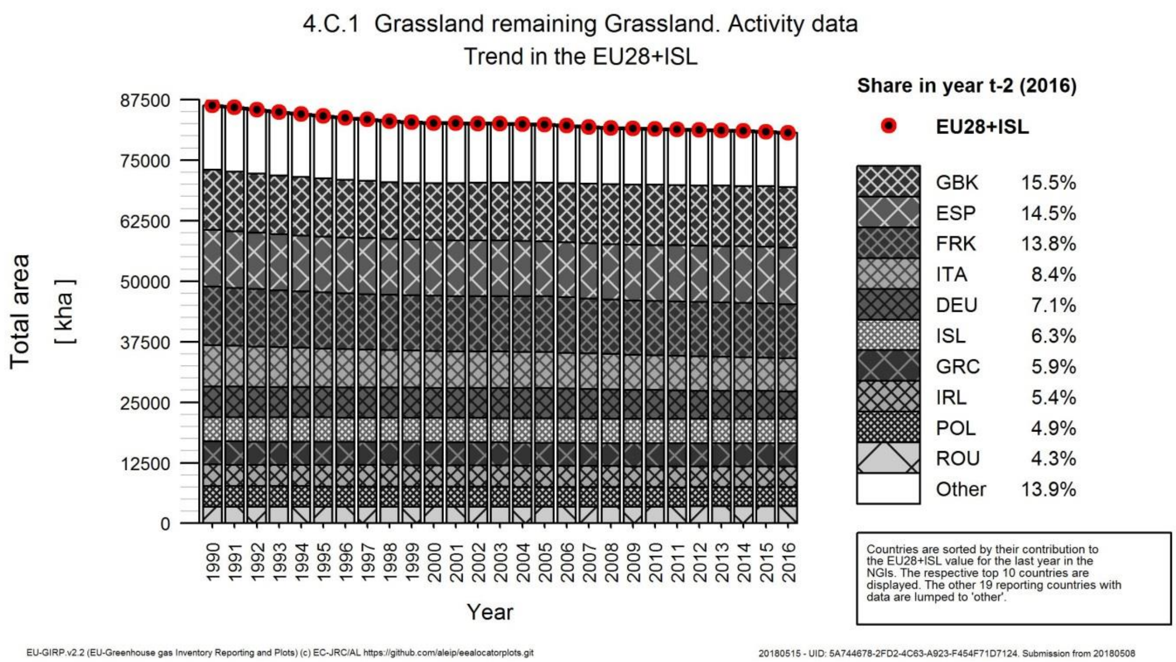
6.2.3.2 Grassland remaining Grassland (CRF 4C1)

Overview of Grassland remaining Grassland category

For the year 2016, total area reported under this subcategory reaches 80.665 Kha at the level of EU and Iceland. Following the general trend of these lands, this subcategory has also constantly decrease since 1990, and in 2016 it represents 7% less than the areas reported for 1990 (Figure 6. 11).

Three MS (i.e. UK, Spain and France) reported about 45% of the total area of grassland remaining grassland, while the 10 MS with the larger contribution account for more than 85 % of the total area.

Figure 6. 11 Trend of activity data in subcategory 4C1 "Grassland remaining Grassland" in EU MS and Iceland (kha, 1990-2016)



In terms of emissions, this subcategory has always resulted in a net source at EU level. In 2016, emissions reported at EU level and Iceland reaches 33.566 Kt CO_2, which represents a decrease of 30% as compared with the year 1990 (Table 6. 21).

Nevertheless, individual MS have reported this subcategory either as a net source or as a net sink of emissions. As in the case of Cropland areas, the net result of carbon stock changes in Grassland depends on the one hand on whether these areas are subject to agricultural activities, and if so, on the presence or absences of significant woody biomass and the intensity and variation of management practices across the years of the time series.

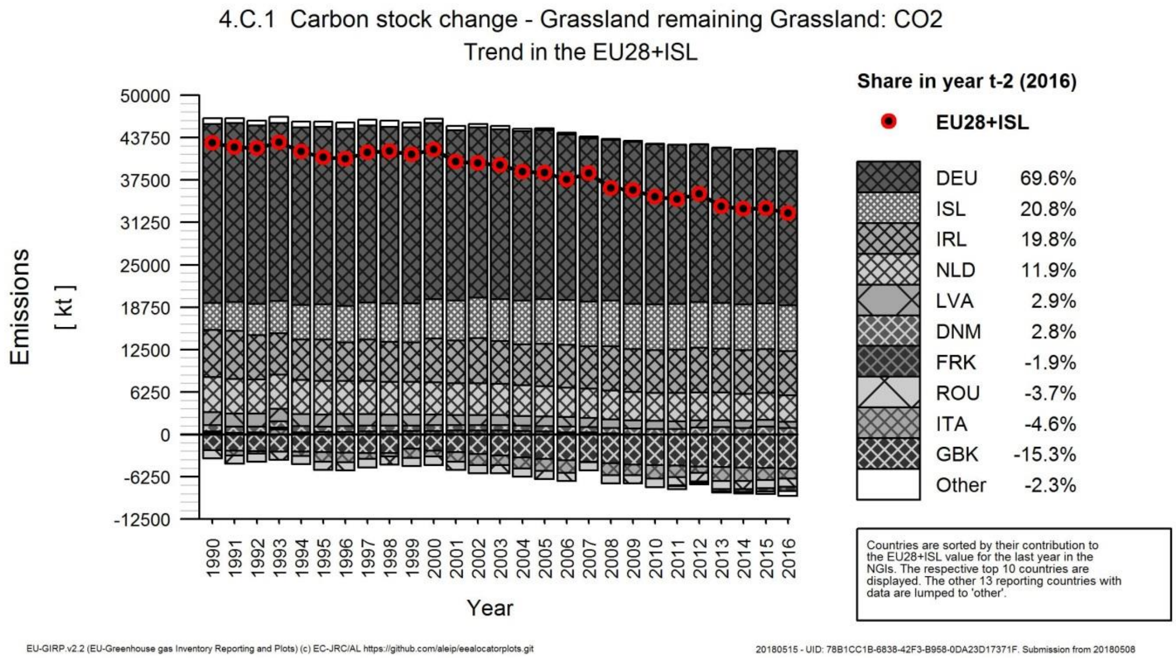
Table 6. 21 4C1 Grassland remaining Grassland: MS and Iceland' contributions to net CO_2 emissions (+)/removals (-) (CRF table 4)

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016	
	1990	2015	2016		kt CO2	%	kt CO2	%
Austria	294	296	296	0.9%	2	1%	0.1	0.0%
Belgium	-421	-359	-354	-1.1%	67	16%	5.2	1.5%
Bulgaria	NO,NE	NO,NE	NO,NE	-	-	-	-	-
Croatia	2.1	2.1	2.1	0.0%	0	0%	0.0	0%
Cyprus	-134	-118	-118	-0.4%	16	12%	0.1	0.1%
Czech Republic	48	-85	-479	-1.4%	-527	-1094%	-394	-467%
Denmark	903	1 141	918	2.7%	14	2%	-224	-20%
Estonia	49	42	43	0.1%	-7	-13%	0.7	1.6%
Finland	683	419	433	1%	-250	-36.6%	14	3.4%
France	208	-519	-627	-2%	-834	-402%	-108	-21%
Germany	26 368	22 790	22 729	68%	-3 640	-14%	-61	-0.3%
Greece	0.2	0.1	0.2	0.0%	0	-9%	0.1	232%
Hungary	51	-6	14	0.0%	-37	-72%	20	353%
Ireland	6 971	6 462	6 482	19.3%	-489	-7%	20	0.3%
Italy	5 268	-1 051	-647	-1.9%	-5 915	-112%	403	38%
Latvia	1 941	985	946	3%	-995	-51%	-40	-4.0%
Lithuania	NO,IE,NA	NO,IE,NA	NO,IE,NA	-	-	-	-	-
Luxembourg	NO	NO	NO	-	-	-	-	-
Malta	-1.7	-0.3	-0.2	0.0%	1.5	87%	0.1	20%
Netherlands	5 171	3 956	3 898	11.6%	-1 273	-25%	-58	-1.5%
Poland	981	359	358	1.1%	-623	-64%	-1.6	-0.4%
Portugal	NO	-369	-405	-1.2%	-405	-∞	-36	-10%
Romania	-1 222	-1 222	-1 222	-3.6%	0.1	0.0%	0.0	0%
Slovakia	NO	NO	NO	-	-	-	-	-
Slovenia	NA,NO	NO,NA	NO,NA	-	-	-	-	-
Spain	NO,NE,NA	NO,NE,NA	NO,NE,NA	-	-	-	-	-
Sweden	-621	-469	-467	-1%	155	25%	2.2	0.5%
United Kingdom	-2 344	-4 938	-5 011	-14.9%	-2 666	-114%	-73	-1.5%
EU-28	**44 194**	**27 318**	**26 788**	**80%**	**-17 406**	**-39%**	**-530**	**-2%**
Iceland	3 945	6 762	6 778	20.2%	2 833	72%	16	0.2%
United Kingdom (KP)	-2 344	-4 938	-5 011	-14.9%	-2 666	-114%	-73	-1.5%
EU-28 + ISL	**48 139**	**34 080**	**33 566**	**100%**	**-14 573**	**-30%**	**-513**	**-2%**

The EU trend in emissions from this subcategory is well affected by Germany, Ireland, Iceland and Netherlands (Figure 6. 12). While for some of these MS, the overall share in areas of grassland remaining grassland areas is not significant at EU level, all of them report important areas of grasslands managed in organic soils that generate a large amount of emissions.

By contrary some others MS have reported this subcategory as a net carbon sink. For instance, Romania or Italy that reports significant carbon sink from woody vegetation on grassland areas or UK that reports a significant net sink from mineral soils.

Figure 6. 12 Trend of emissions (+)/removals (-) in subcategory 4C1 "Grassland remaining Grassland" in EU MS and Iceland (1990-2016)



Methodological issues for Grassland remaining Grassland category

Despite different eco-regions and management approaches existing among the countries, definitions provided by MS and Iceland of Grassland areas show good match with the IPCC land use definition (Table 6. 22). One of the most significant differences that should be considered when comparing implied emissions factor is the presence or absence of reported unmanaged grassland.

In general, there are a wide-spread use of Tier 1 method for reporting carbon stock changes in living biomass and dead organic matter, which assumes no carbon stock changes for these pools (e.g. Spain, Bulgaria, and Slovenia). However, some MS have developed country-specific data and (or) methodologies to assess the changes in these pools (e.g. Estonia, Italy, Latvia and Sweden). When this is the case, these pools are generally reported as a net sink that is associated with the presence of woody biomass on grassland areas.

Under mineral soils, a significant number of MS have demonstrated that there are no changes over the time in the type of management practices that impact the carbon storage in the soils, or the absence of managed soils (e.g. Spain, Bulgaria, Lithuania and Slovenia). In these cases, MS have not provided quantitative estimates, and the notation keys were used instead. However, some others MS report this carbon pool by using IPCC methodology, with country-specific or default data.

For those MS that report presence of organic soils areas under grassland, this carbon pool has been always reported as a net source of emissions (Table 6. 23).

Table 6. 22 Definitions of lands included by MS and Iceland under the category 4C: Grasslands

MS	***Definition***
Austria	Meadows cut once/twice/several times, cultivated pastures, litter meadows, rough pastures, alpine meadows and pastures and abandoned grassland.
Belgium	Rangelands and pasture land that is not considered under cropland. It also includes systems with vegetation that fall below the threshold of forest land category and are not expected to exceed it, without human intervention.
Bulgaria	Grassland includes the permanent grasslands – natural meadows, low productive grasslands, permanent lawns and grassland which are not used for production purposes.
Croatia	Grassland includes pastures, land principally occupied by agriculture, with significant areas of natural vegetation, natural grasslands, moors and heathland, sclerophyllous vegetation.
Cyprus	This category includes rangelands and pasture land that are not considered Cropland. It also includes systems with woody vegetation and other non-grass vegetation such as bushes and sclerophyllous vegetation that fall below the threshold values used in the Forest Land category. The category also includes all pastures, natural grassland and scarcely vegetated areas.
Czech Republic	Grassland as defined in this inventory is mostly used as pastures for cattle and meadows for growing feed. Additionally, the fraction of permanently unstocked cadastral FL is also included under Grassland. This is because it predominantly has the attributes of Grassland (such as land under power transmission lines).
Denmark	Land defined as 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”.
Estonia	Grassland includes rangelands and pasture, land that is not considered cropland nor forest land: land with perennial grasses that is proper for mow and pasture, smaller fallows and former cultural grasslands that have lost arable land features and grassland from wild lands (natural grassland). Overgrown wooded pasture with canopy cover between 30 and 50% is classified as grassland or forest, depending on the main land-use purpose. The national land cover class ‘bushes’ (area covered with natural or wildered cultivated bush and shrub species where canopy cover is over 50%) is included into GL.
Finland	Grassland includes areas of extensive grass, ditches associated with agricultural land, areas of bioenergy plants and abandoned arable land. In this context, abandoned arable land refers to fields that are no longer used for agricultural production and where natural reforestation is possible or is already taking place.
France	Land covered by natural and seeded herbaceous for more than 5 years. Includes areas covered trees and bushes being under the forest definition or not included under land category.
Germany	Meadow and pasture areas that cannot be considered cropland. Includes land covered with trees and shrubs 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.
Hungary	Grassland includes meadows, i.e., land under grass (artificial planting included) where the production is utilized by cutting, irrespective of whether it is used for grazing sometimes, and pasture, i.e., land under grass (artificial planting included) that is utilized for grazing irrespective of whether it is used for cutting sometimes. Grassland includes areas with trees which are utilized for grazing and unmanaged grasslands which are not in use for agricultural purposes.
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) and other woodlands that don’t fulfil forest definition.
Latvia	The grassland category consists of lands used as pastures, as well as glades and bush-land which do not fit to forest definition, vegetated areas on non-forest lands complying to forest definition where land use type can be easily switched back to grassland without legal requirement of transformation of the land use, but except grassland used in forage production and extensively managed cropland.

MS	***Definition***
Lithuania	Grassland includes meadows and natural pastures planted with perennial grasses or naturally developed, on a regular basis used for moving and grazing. Grasslands cultivated for less than 5 years, in order to increase ground vegetation, still remain grasslands.
Luxemburg	All grasslands that are not considered as cropland including systems with vegetation or tree cover below forest threshold, natural grassland, recreational areas as well as agricultural systems. It includes one cut meadows; two and more cut meadows, cultivated pastures, litter meadows, rough pastures and pastures and abandoned grassland.
Malta	This category is split into other grassland and maquis. On the basis of expert judgement it was decided that maquis will be included in this category. The data of this category was derived from the Corine Land Cover 1996, 2000, 2006 under the sclerophyllous vegetation and Grassland.
Netherlands	Under Grassland (non-TOF) any type of terrain which is predominantly covered by grass vegetation is reported. It also includes vegetation that falls below the threshold used in the forest land category and is not expected to exceed the threshold used in the forest land category. It is further stratified in: 'Grassland vegetation', 'Nature', 'Orchards'. Trees outside forests (TOF) are wooded areas that comply with the forest definition except for their surface area (< 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 and fields.
Poland	Grassland consists of: permanent meadow and pastures include land permanently covered with grass, but does not include arable land sown with grass as part of crop rotation; permanent meadow are understood as the land permanently covered with grass and mown in principle in mountain area; also the area permanent pastures are understood as the land permanently covered with grass not mown but grazed in principle in mountain area; also the area of grazed pastures and meadows.
Portugal	Lands covered by permanent herbaceous cover.
Romania	Grassland includes land whose destination is grazing or mowing hay for livestock production, as well as other wooded land and trees outside forests (which do not meet forest definition parameters, e.g. forest belts which are narrower than 20m). It includes pastures, hayfields in hilly and mountainous areas and meadows in lowlands.
Slovakia	This category includes permanent grasslands and meadows used for the pasture or hay production, which is not considered as cropland.
Slovenia	Agricultural areas grown by grass and other herbs that are regularly cut or grazed. These areas are not in tillage or fallow ground. Included are areas covered with some of forest trees (less than 50 trees/ha) and the alpine pastures too. In this class there are swamp pastures and meadows on organic or mineral-organic soils, where the groundwater rises few times in the year. It includes also uncultivated agriculture land.
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. This corresponds to natural grazing land. All grasslands are assumed managed.
United Kingdom	Area classified as following broad habitats: improved grassland, natural grassland, calcareous grassland, acid grassland, bracken, dwarf shrub heath, fen/marsh/swamp, bogs and mountains.
Iceland	All land where vascular plant cover is >20% and not included under the SL, FL, CL or WL categories. This category includes as subcategory land which is being revegetated and meeting the definition of the activity and does not fall into other categories. Drained wetlands not falling into other categories are included in this category. Grassland is represented by five subcategories on the Land use map, i.e. “Other grassland”, “Land re-vegetated before 1990”, “Land re-vegetated since 1990”, “Grassland on drained soils”, and “Natural birch shrubland”.

Table 6. 23 Implied net carbon stock change factors for carbon pools in 4C1 (t C ha-1 yr-1) reported by individual submissions in GHGI 2018.

Member States	Net carbon stock change in living biomass per area (t C/ha)		Net carbon stock change in dead organic matter per area (t C/ha)		Net carbon stock change in mineral soils per area (t C/ha)		Net carbon stock change in organic soils per area (t C/ha)	
	1990	2016	1990	2016	1990	2016	1990	2016
AUT	NO	NO	NO	NO	0.002	0.002	-6.402	-6.402
BEL	NO	NO	NO	NO	0.156	0.208	-2.500	-2.500
BGR	NE	NE	NE	NE	NE	NE	NO	NO
HRV	NO	NO	NO	NO	NO	NO	-2.500	-2.500
CYP	0.241	0.247	NO	NO	NO	NO	NO	NO
CZE	NO	NO	NO	NO	-0.017	0.147	NO	NO
DNM	-0.069	-1.352	NO	NO	IE	IE	-6.790	-6.748
EST	0.001	0.001	NO	NO	NO	NO	-0.310	-0.292
FIN	0.374	0.370	NE	NE	NA	NA	-3.500	-3.500
FRK	-0.006	0.019	NE	NE	0.001	-0.004	NA	NA
DEU	-0.011	0.032	NO	NO	0.002	-0.002	-6.341	-6.181
GRC	0.000	0.000	NO	NO	NO	NO	NO	NO
HUN	NO	NO	NO	NO	-0.011	-0.003	NO	NO
IRL	NO	NO	NO	NO	-0.010	0.130	-4.963	-5.181
ITA	-0.011	0.056	0.004	0.004	NA,NO	NO,NA	-2.500	-2.500
LVA	0.007	0.042	0.001	-0.002	NA	NA	-6.100	-6.100
LTU	NO	NO	NO	NO	NO	NO	IE	IE
LUX	NO	NO	NO	NO	NO	NO	NO	NO
MLT	0.000	0.000	NE	NE	0.032	0.006	NO	NO
NLD	0.005	0.004	NO	NO,NE	0.000	0.002	-4.527	-4.594
POL	NO	NO	NO	NO	-0.047	-0.010	-0.254	-0.304
PRT	NO	NO	NO	NO	NO	0.245	NO	NO
ROU	0.098	0.095	NE	NE	NE	NE	0.250	0.250
SVK	NO	NO	NO	NO	NO	NO	NO	NO
SVN	NA	NA	NA	NA	NA	NA	NA	NA
ESP	NE	NE	NA	NA	NE	NE	NO	NO
SWE	0.167	0.125	0.231	0.269	0.098	0.084	-1.311	-1.698

Member States	Net carbon stock change in living biomass per area (t C/ha)		Net carbon stock change in dead organic matter per area (t C/ha)		Net carbon stock change in mineral soils per area (t C/ha)		Net carbon stock change in organic soils per area (t C/ha)	
	1990	2016	1990	2016	1990	2016	1990	2016
GBR	0.014	-0.001	NO	NO	0.042	0.124	NO,IE	NO,IE
ISL	0.000	0.000	0.000	0.000	0.000	0.000	-5.700	-5.700

6.2.3.3 Land converted to Grassland (CRF 4C2)

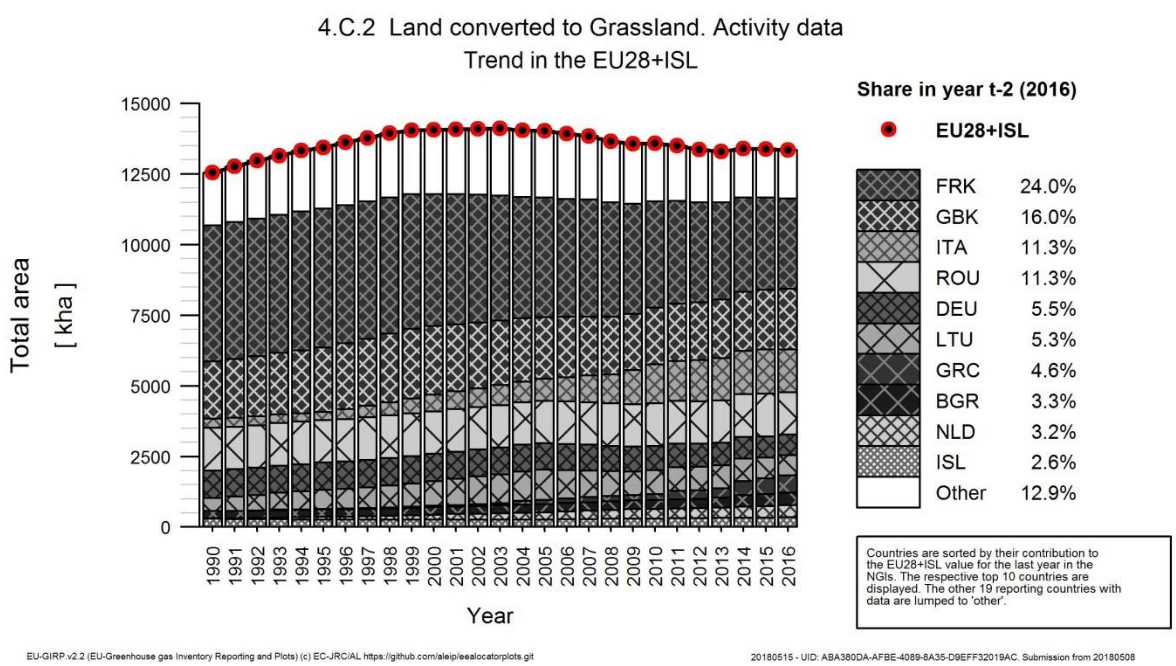
Overview of Land converted to Grassland category

In terms of area, this subcategory represents 14% of the total grassland areas reported at the level of EU MS and Iceland, however the carbon sink reported offsets about 75% of the emissions resulting from grassland remaining grassland.

The area reported under this subcategory for the year 2016 reaches 13.347 Kha, which represents an increase of 6% as compared with 1990 (Figure 6. 13). Main conversions to grassland areas take place on original cropland areas and, to a lesser extent, on forests land.

The main drivers of the EU trend on new grassland areas are France, UK, Italy and Romania that report more that 60% of the total are converted to Grassland.

Figure 6. 13 Trend of activity data in subcategory 4C2 "Land converted to Grassland" in EU MS and Iceland (kha, 1990-2016)



In term of emissions, for the year 2016, lands in conversion to Grassland represent at the level of EU and Iceland a total net sink of 24.195 kt CO_2 that results in an increase of about 33% compared to the year 1990 (Table 6. 24).

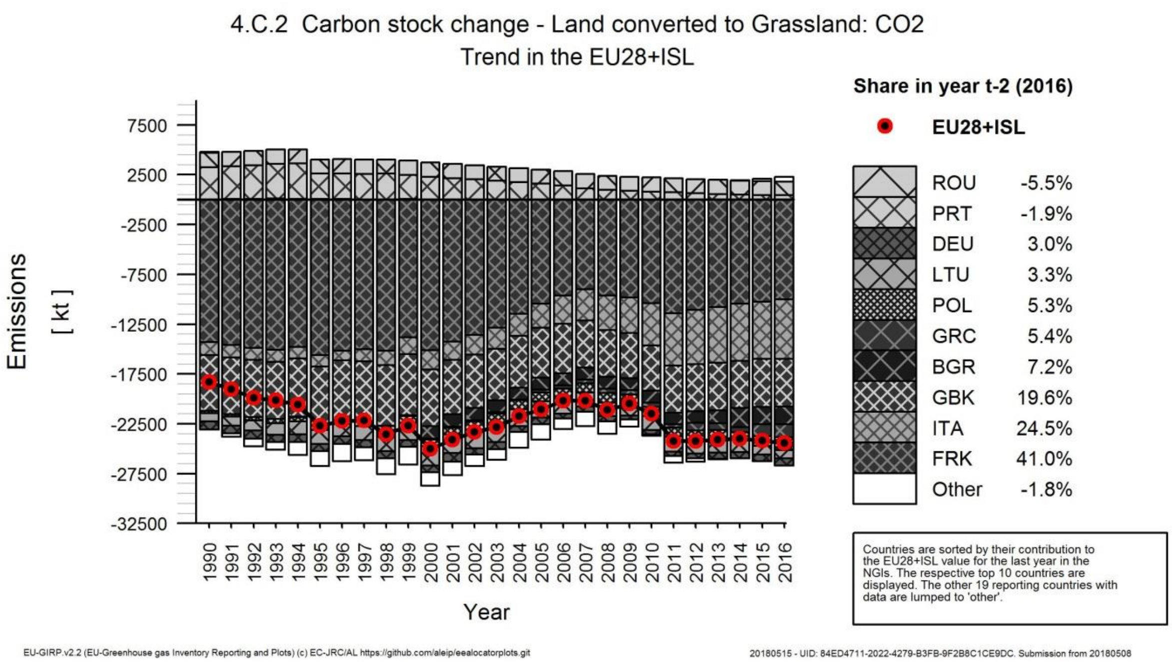
The trend in GHG emissions for this subcategory is driven by France, UK, Italy and Lithuania that report a significant carbon sink on mineral soils a result of the conversion of croplands areas to grassland. By contrary, final net emissions from this subcategory, as it has been reported for several MS (e.g. Romania and Sweden), are associated with emissions from the conversion of Forest land, and to a lesser extent, from woody crops, to Grassland.

Table 6. 24 4C2 Land converted to Grassland: MS and Iceland' contributions to the net CO_2 emissions (+)/removals (-) (CRF table 4)

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016	
	1990	2015	2016		kt CO2	%	kt CO2	%
Austria	332	55	37	-0.2%	-295	-89%	-18	-32%
Belgium	61	-96	-134	0.6%	-195	-319%	-38	-39%
Bulgaria	27	-1 730	-1 768	7.3%	-1 794	-6736%	-37	-2%
Croatia	-104	-120	-218	0.9%	-114	-109%	-98	-81%
Cyprus	NO,NE	-6	-6	0.0%	-6	-∞	-21%	-4%
Czech Republic	-145	-274	-183	0.8%	-38	-26%	91	33%
Denmark	15	208	207	-0.9%	193	1318%	-1	-1%
Estonia	1	-11	-12	0.0%	-13	-983%	-0.35	-3%
Finland	179	259	236	-1.0%	57	32%	-23	-9%
France	-14 316	-10 229	-10 009	41.4%	4 307	30%	220	2%
Germany	-825	-698	-732	3.0%	93	11%	-34	-5%
Greece	0.03	-1 227	-1 319	5.5%	-1 319	-4702903%	-92	-7%
Hungary	-36	-223	-136	0.6%	-100	-281%	87	39%
Ireland	3	9	31	-0.1%	28	979%	22	254%
Italy	-1 275	-5 740	-5 996	24.8%	-4 722	-370%	-256	-4%
Latvia	13	139	139	-0.6%	126	991%	-0.44	0%
Lithuania	-787	-842	-797	3.3%	-10	-1%	45	5%
Luxembourg	32	-46	-45	0.2%	-77	-244%	1	2%
Malta	-3	-0.4	-0.3	0.0%	3	88%	0.1	20%
Netherlands	218	250	270	-1.1%	53	24%	21	8%
Poland	-266	-981	-1 298	5.4%	-1 033	-389%	-317	-32%
Portugal	3 228	472	461	-1.9%	-2 767	-86%	-11	-2%
Romania	1 423	1 354	1 354	-5.6%	-69	-4.9%	0.00	0%
Slovakia	-204	-191	-179	0.7%	25	12%	12	6%
Slovenia	-429	33	43	-0.2%	472.2	110%	10	29%
Spain	-2 711	-360	-233	1.0%	2 478	91%	127	35%
Sweden	497	373	364	-1.5%	-133	-27%	-9	-2%
United Kingdom	-5 582	-4 607	-4 511	18.6%	1 072	19%	96	2%
EU-28	**-20 653**	**-24 231**	**-24 433**	**101%**	**-3 779**	**-18%**	**-202**	**-1%**
Iceland	2 400	285.8	266	-1%	-2 134	-89%	-20	-7%
United Kingdom (KP)	-5 589	-4 632	-4 538	18.8%	1 051	19%	94	2%
EU-28 + ISL	**-18 260**	**-23 971**	**-24 195**	**100%**	**-5 935**	**-33%**	**-224**	**-1%**

Major changes in the time series of emissions from Land converted to Grassland have been reported by Greece and Bulgaria as driven by the activity data. Specifically by the abandonment of cropland areas that resulted in an increase of grassland areas and consequently in a larger carbon sink reported in mineral soils at the end of the time series as compared with the base year.

Figure 6. 14 Trend of emissions (+)/removals (-) in subcategory 4C2 "Land converted to Grassland" in EU MS and Iceland (kt CO_2, 1990-2016)



Methodological issues for Land converted to Grassland category

For estimating and reporting carbon stocks changes in this subcategory, IPCC default methodology is generally used. The implementation of country-specific emission factors or default factors depends on which type of lands is being converted to Grassland and, the carbon pool that is being estimated. For instance, while some MS only consider a gross quantity of carbon loss from the conversion of forest lands to grassland, some other provide a net estimate on this carbon pool.

Usually, it is assumed that the carbon stored in living biomass and dead organic matter is lost in the year of the conversion, while for soil organic carbon in mineral soils, following IPPC methodology, MS apply a 20 years transition period before the carbon stock of the soils converted to Grassland reach and equilibrium.

6.2.4 Wetlands, Settlements and Other land (CRF Tables 4D, 4E, 4F)

6.2.4.1 Wetlands (CRF 4D)

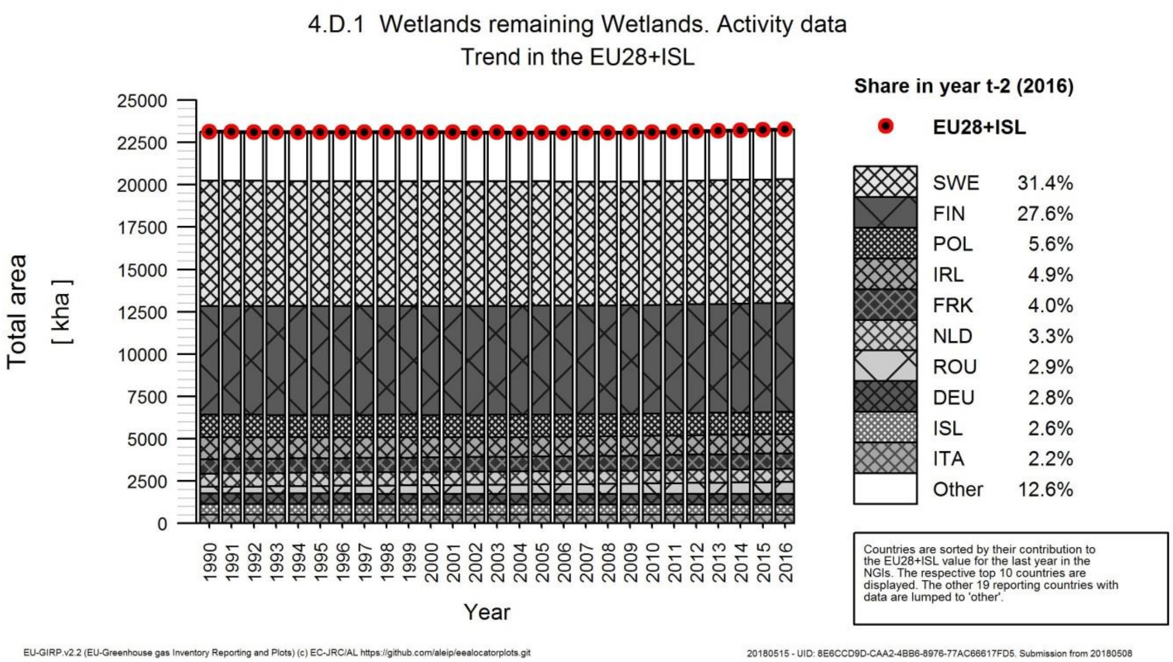
In terms of area, this category reaches at the level of EU and Iceland 24.420 Kha, which represents 5% of the total reported areas. The trend is strongly dominated by Sweden and Finland which, equal than all the other inventories, have reported constant values across the time series, at least, as regards to the dominant subcategory of wetlands remaining wetlands (Figure 6. 15).

The other subcategory, land converted to wetlands, represents 5% of the wetlands area but 20% of the final net emissions reported within the category. However, these areas that are dominated, in overall, by Romania and France, have increased by 32%, as compared with 1990, mainly driven by new areas reported by Sweden in the second half of the time series.

In terms of emissions, Wetlands remaining Wetlands reaches for the year 2016 about 14.000 Kt CO_2. Both sub-categories, 4D1 and 4D2, have been in overall reported as a net source of emissions resulting mostly from MS managing peat land areas. Nevertheless, in some instances, they have been also reported as a net carbon sink (see explanation bellow)

Under this category, MS include different lands that are not always subject to management activities. This explains why countries with the largest share on areas not always report the largest emissions. For instance, this happens when areas within wetlands include flooded lands, or other wetlands that are not subject to management activities.

Figure 6. 15 Trend of activity data and emissions (+)/removals (-) in subcategory 4D1 "Wetlands remaining Wetlands" in EU MS and Iceland (kha, Kt CO_2, 1990-2016)



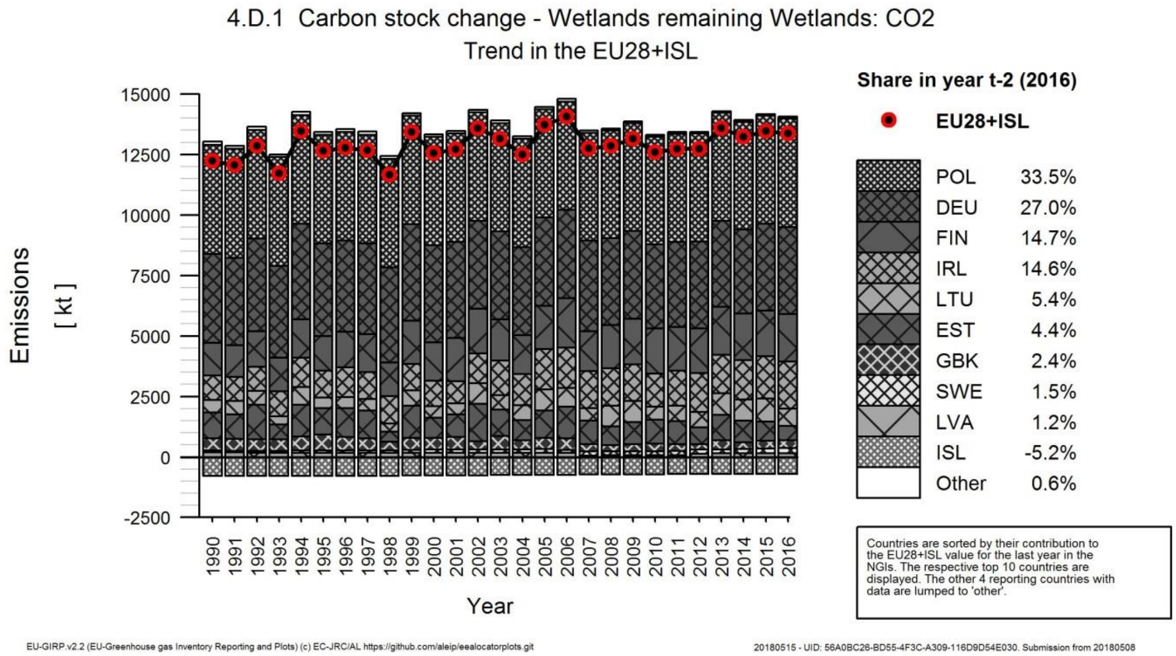
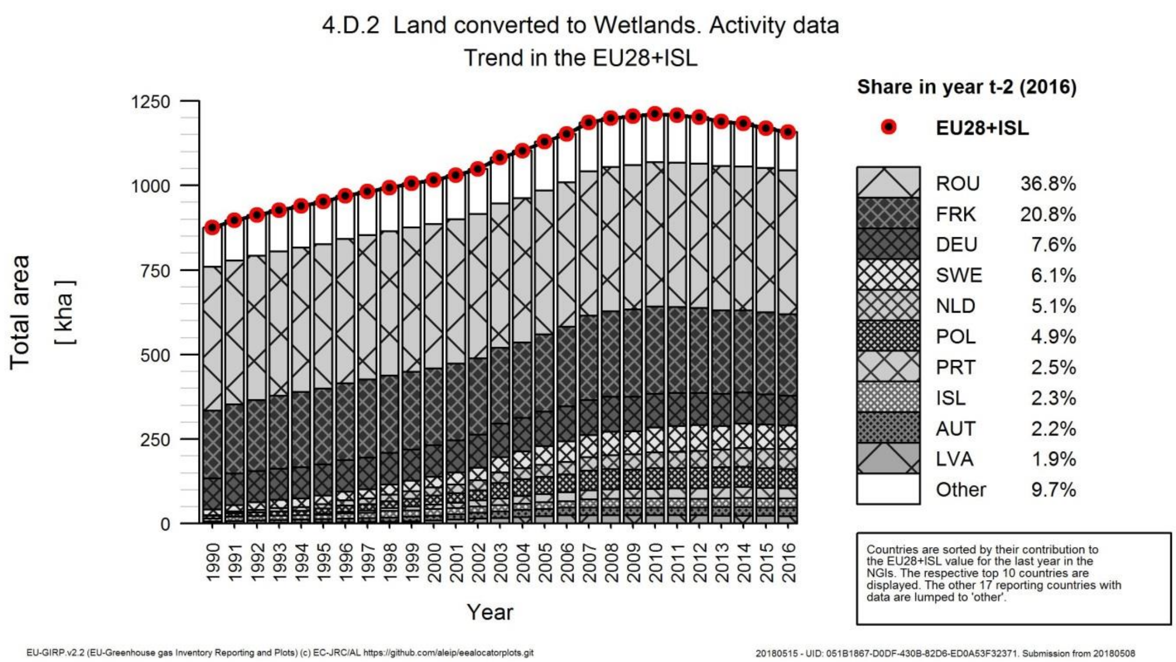
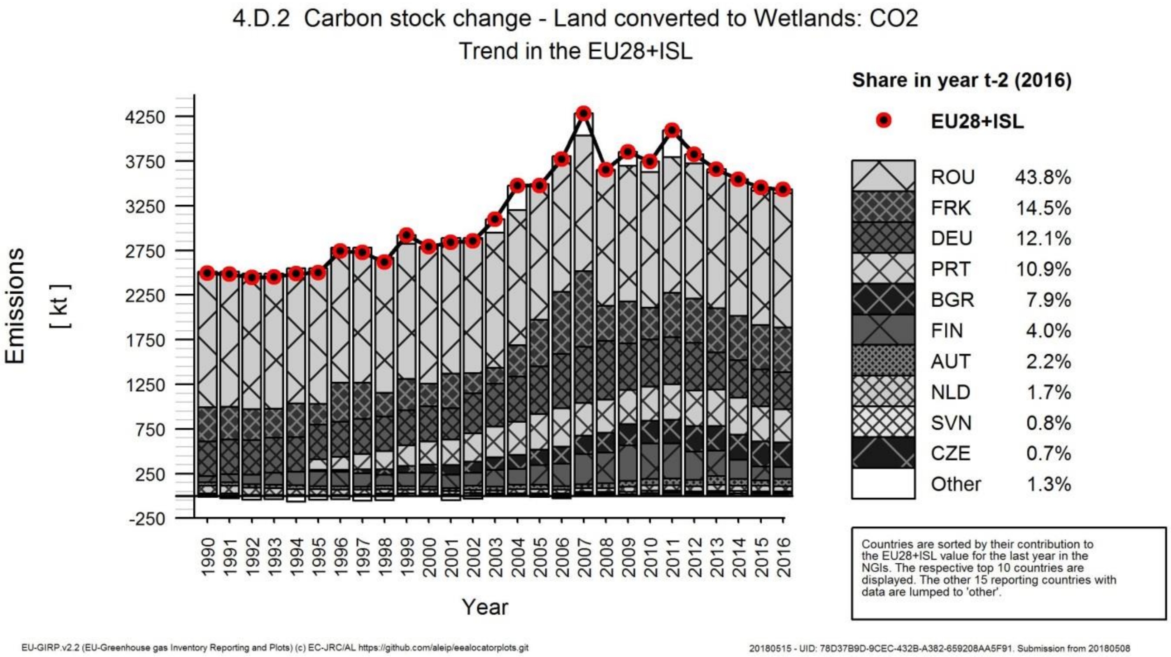


Figure 6. 16 Trend of activity data and emissions (+) / removals (-) in subcategory 4D2 "Lands converted to Wetlands" in EU MS and Iceland (kha, Kt CO_2, 1990-2016)





The graphs above show a significant increase of wetlands areas in Sweden that are not linked to any carbon stock changes. This fact is due to that new wetlands areas are the result of the conversion from Other lands (i.e. no carbon stocks are present in these areas) to Other wetlands (i.e. mires and areas saturated by fresh water)

The main driver of emissions in this subcategory is represented by peat extraction which, even if affecting small areas, has a big impact on final emissions. Within the EU, Poland, Germany, Ireland and Finland are the main drivers of the trend.

By contrary, Iceland under 4D1, reports a significant amount of GHG removals as a result of intact mires.

Table 6. 25 Definitions of lands included by MS and Iceland under the category 4D: Wetlands

MS	***Definition***
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.
Bulgaria	Wetlands category - wetlands surface water areas are included (wetlands) – covered with water or water saturated lands (throughout the year or partially in the year) which does not fall in the other categories. These are natural or artificial water-courses serving as water drainage channels, natural or artificial stretches of water, coastal lagoons, wetlands areas and peatbogs.
Croatia	Inland marshes, salt marshes, salines, intertidal flats, water courses, water bodies, coastal lagoons
Cyprus	This category contains areas of land that is covered or saturated by water for all or part of the year and that does not fall into the Forest Land, Cropland, Grassland or Settlements categories. In particular, it contains: inland and salt marshes, water courses and water bodies.
Czech	Category Wetlands includes riverbeds, and water reservoirs such as lakes and ponds, wetlands and

MS	*Definition*
Republic	swamps.
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).
Estonia	Land permanently saturated by water and/or areas where the peat layer is at least 30 cm and the minimum potential tree height does not conform to the forest land definition. It does include smaller bog holes.
Finland	Inland waters (reservoirs, natural lakes and rivers), 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, covering: CO_2 losses from extraction areas, and during extraction and spreading of peat. Also, it includes (but they are not estimated) 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), 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.
Hungary	Wetland includes the wetlands and water bodies as defined by the CORINE land-cover databases and contain inland marshes (low-lying land usually flooded in winter, and more or less saturated by water all year round), peat bogs (peat land consisting mainly decomposed moss and vegetable matter), water courses (natural or artificial water-courses including those serving as water drainage) and water bodies (natural or artificial lakes, ponds etc.).
Ireland	Natural unexploited wetlands and 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, have been included in this category (MAMB, 1992). Reservoirs or water bodies regulated by human activities have not been considered.
Latvia	Wetlands category includes all inland water bodies (rivers, ponds, lakes), swamps (constantly wet areas where height of trees cannot reach more than 5 m in height and ground vegetation consists mostly of sphagnum and different sword grasses), flood-lands (small areas) and alluvial lands (larger flood-lands).
Lithuania	Wetlands include peat extraction areas and peat lands which do not fulfil the definition of other categories. Water bodies and swamps (bogs) are also included under this category. Peat extraction areas are considered as managed land.
Luxemburg	Land that is covered or saturated by water for all or part of the year (e.g. peat land, reservoirs) and that does not fall into other categories.
Malta	In the Maltese islands wetlands are mostly saline.
Netherlands	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, including natural open water in rivers, but also man-made open water in channels, ditches and artificial lakes.
Poland	Wetland consists of: marine internal; surface flowing waters, which covers land under waters flowing in rivers, mountain streams, channels, and other water courses, permanently or seasonally and their sources as well as land under lakes and artificial water reservoirs. from or to which the water course flow; land under surface lentic water which covers land under water in lakes and reservoirs other than those described above, land under ponds including water reservoirs (excluding lakes and dam reservoirs for water level adjustment) including ditches and areas adjacent and related to ponds; land under ditches including open ditches acting as land improvement facilities for land used.
Portugal	Inland wetlands, coastal wetlands, salt marshes, saline and intertidal flats.
Romania	Wetlands includes all lands covered by water (rivers, ponds, dams, swimming pools, etc.) and land

MS	Definition
	affected by humidity (caused by water stagnation, marshy areas, etc.), with the exception of agricultural land. It contains two sections (waters and wetlands) and 11 categories (permanent streams, temporary streams, lakes, dams, floating vegetation, hydrophilic vegetation (stubble etc.), harbors, temporarily flooded areas, bogs, channels and piers.
Slovakia	The wetlands include artificial reservoirs and dam lakes, natural lakes, rivers and swamps.
Slovenia	Wetlands are defined as land that is temporarily or permanently saturated by water. Wetlands include lands such as fens, marshes, bogs and reeds and are not under agricultural use. Inland water bodies (major rivers, lakes and water reservoirs) are also part of Wetlands. Although there are small areas of raised bogs, all Wetlands are assumed managed.
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).
United Kingdom	Includes reservoirs and peat extraction sites currently registered for commercial extraction where extraction activity is visible on recent aerial/satellite photographs or by field visits. The areas of inland water exceeding 1km2 are included also in this category.
Iceland	All land that is covered or saturated by water for all or part of the year and does not fall into the SL, FL and CL categories. It includes intact mires and reservoirs as managed subdivisions and natural rivers and lakes as unmanaged subdivision. Wetland is in the land use map represented as three classes; “Lakes and rivers”, “Reservoirs”, and “Other Wetland”.

6.2.4.2 Settlements (CRF 4E)

In terms of area this land use category represents, at the level of EU MS and Iceland, 29.791 kha, and 6% of the total reported areas. For the 2016, Settlements areas have increased by 26 % as compared with 1990.

The expansion of these areas, which generally include urban areas, either sealed or unsealed, transport infrastructures, and industrial and commercial units, has been driven by the abandonment of agricultural lands.

In terms of emissions this land use category is reported as a net source of emissions that reaches, in 2016, 52.987 Kt CO_2. Out of this, 95% are due to emissions resulting from Land converted to Settlement, which although in term of areas it represent only 22% of the total category, it results in significant emissions when forest lands are converted to urban areas.

Definitions of lands included under this category vary across individual inventories (Table 6. 26).

Table 6. 26 Definitions of lands included by MS and Iceland under the category 4E: Settlements

MS	Definition
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.
Bulgaria	The Settlements refer to all classes of urban formation. These are areas that are functionally or administratively associated with public or private land in cities, villages or other settlement types.
Croatia	Continuous and discontinuous urban fabric area, industrial or commercial units, road and rail networks and associated land, port areas, airports, mineral extraction sites, dump sites, construction sites, green urban areas, sport and leisure facilities.
Cyprus	All developed land, including transportation infrastructure and human settlements of any size. In particular, it contains: industrial and commercial units, urban areas, port areas, airports, construction,

MS	Definition
	mineral extraction and waste dump sites.
Czech Republic	Settlements include two categories built-up areas and courtyards and other lands. Other lands includes all types of land-use were included with the exception of “unproductive land”, which corresponds to category 4.F Other Land. Hence, the Settlements category also includes all land used for infrastructure, as well as that of industrial zones and city parks.
Denmark	Urban cores, industrial areas, roads, high and low buildup areas. Low build-up areas are characterized as single-family houses surrounded by gardens, graveyards, sports facilities, etc. (estimates are reported only for low build-up areas).
Estonia	Built-up areas, with roads, streets and squares, traffic and power lines, urban parks, industrial and manufacturing land, sports facilities, airports, legal waste down points, construction sites and buildings with up to 0.3 ha of garden yard (including permanent greenhouses), and open cast areas (except peat extraction areas) are included into this land-use category
Finland	Combined area of NFI built-up land, traffic lines and power lines. Includes parks, yards, farm roads and barns.
France	Artificialized land (settlements, parks, roads and infrastructure, etc.).
Germany	Open settlement and transport areas.
Greece	Developed land, including transportation infrastructure and human settlements of any size, unless they are already included under other land-use categories.
Hungary	Settlements comprises the urban areas, industrial, commercial and transport units, as well as mines, dump and construction sites and artificial non-agricultural vegetated areas.
Ireland	Urban areas, roads, airports and the footprint of industrial commercial/institutional and residential buildings.
Italy	Artificial surfaces, transportation infrastructures (urban and rural), power lines and human settlements of any size, comprising also parks.
Latvia	According to national definitions settlements include: land under buildings including yards and gardens as well as land necessary to maintain and to access those buildings; land under roads including buffer zones; forest infrastructure excluding ditches and other wetlands, but including seed orchards, forest nurseries and fire-breaks; other infrastructure – buffer zones of industrial networks, quarries etc.
Lithuania	All urban territories, power lines, traffic lines and roads are included under this category as well as orchards and berry plantations planted in small size household areas and only used for householders’ meanings.
Luxemburg	Developed land, including transportation and any size of human settlement unless already included under other category.
Malta	The land-use category Settlements includes all classes of urban tree formations, namely trees grown along roads and streets, in public and private gardens, and in cemeteries, airports, construction sites, dumpsites, industrial or commercial units, port areas and sport and leisure facilities.
Netherlands	Developed land, including transportation infrastructure and human settlements of any size, unless they are already included under other categories.
Poland	Settlements consists of: residential areas include land not used for agricultural and forest production, put under dwelling buildings, devices functionally related to dwelling buildings (yards, drives, passages, playgrounds adjacent to houses), as well as gardens adjacent to houses; industrial areas include land put under buildings and devices serving the purpose of industrial production; other built-up areas include land put under buildings and devices related to administration; undeveloped urbanised areas include land that is not built over, allocated in spatial management plans to building development and excluded from agricultural and forest production; recreational and resting areas comprise the following types of land not put under buildings; areas of recreational centres,. children playgrounds, beaches, arranged parks, squares, lawns (outside street lanes); areas of historical significance: ruins of castles, strongholds, etc.; sport grounds: stadiums, football fields, ski-jumping take-offs, toboggan-run, sports rifleranges, public baths etc.; area for entertainment purposes: amusement, grounds, funfairs etc.; zoological and botanical gardens; areas of non-arranged greenery, not listed under woodlands or land planted with trees or shrubbery; transport areas including land put under: roads; stopping yards next to railway stations, bus stations and airports, maritime and river ports and other ports, as well as universal accesses to unloading platforms and storage yards; railway

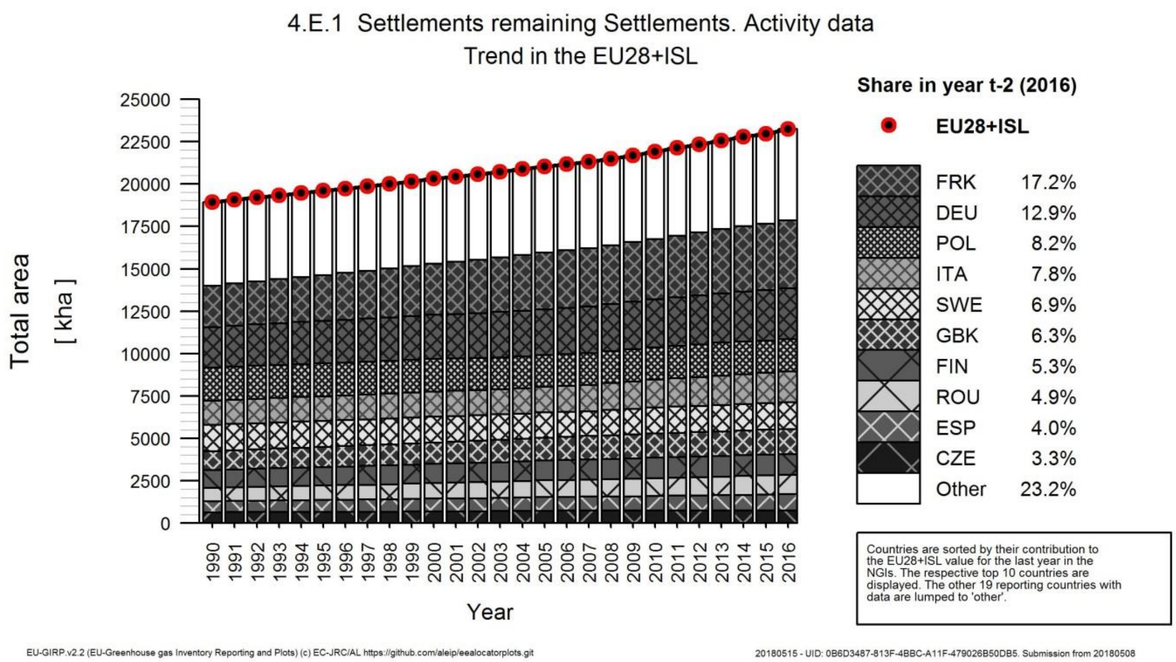
MS	*Definition*
	grounds; other transport grounds.
Portugal	Includes all artificial territories, including cities and villages, industry, roads and railway, ports and airports.
Romania	Settlements has 3 groups (urban/rural, buildings and infrastructure) and includes: fenced and constructed areas, sealed lands (e.g. car parks, roundabouts, platforms), urban/rural lawns, playgrounds in green areas, beach lawn and other areas with lawn, dwellings, industrial and administration buildings (e.g. banks, churches, railway stations, restaurants), warehouses, huts, ruins, greenhouses, graveyards, dirt roads, trails, rail roads and roads (street, sidewalk, square), bridges and dams.
Slovakia	The settlements include all developed land, including transportation infrastructure and human settlements of any size.
Slovenia	Settlements are all piece of land where the buildings, roads, parking places, mines, stone pits and all other infrastructure are in human use.
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.
United Kingdom	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.
Iceland	All areas included within map layers “Towns and villages” and “Airports” as defined in the IS geographical database. Also included as Settlement are roads classified with 15 m wide road zone, including primary and secondary roads. Roads within forest land are excluded as road zone does not reach 20 m. Settlement is in the land use map represented as two classes; “Settlements towns” and “Settlements other”.

As regards with the methods used for reporting carbon stock changes in these areas, many MS have used the Tier 1 assumption of equilibrium under the subcategory 4E1, therefore no carbon stock changes are reported, and the, notation key NO is therefore included in the CRF tables.

Nevertheless, few MS have reported this subcategory as a net source of emissions. For instance, Germany, France and Netherlands that have reported emissions as a result of disturbed organic soils in these areas, or UK from disturbed mineral soils.

By contrary, Sweden, Latvia, Poland and Slovenia have reported the subcategory 4E1 as a net sink of carbon due to carbon removals from living biomass on green urban areas (Figure 6. 17; Figure 6. 18). A particular case is Latvia that reports a remarkable increase in the sink of this category. Carbon stock changes in living and dead biomass for different land use categories are calculated using the recent available national forest inventory data and then with aerage values used for different periods. The increase of carbon stock in living biomass in settlements reflects increase of age and gross increment of trees growing on settlements, as well as area of settlements covered by woody vegetation.

Figure 6. 17 Trend of activity data and emissions (+)/removals (-) in subcategory 4E1 “Settlements remaining Settlements” in EU MS and Iceland (kha, kt CO_2 1990-2016)



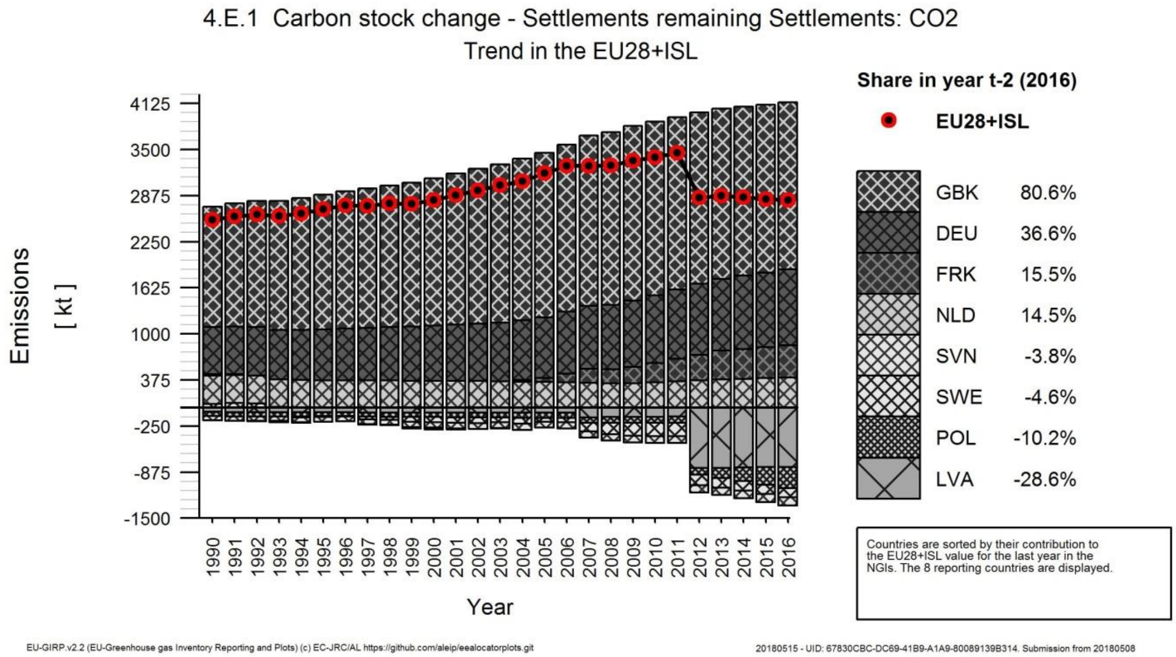
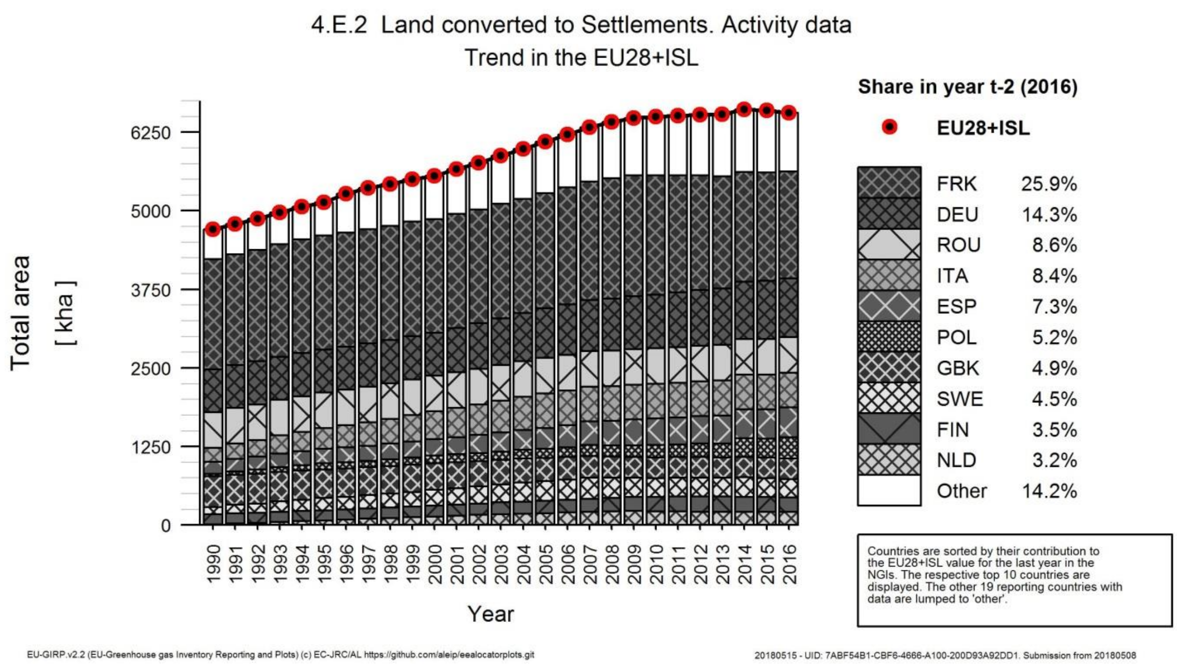
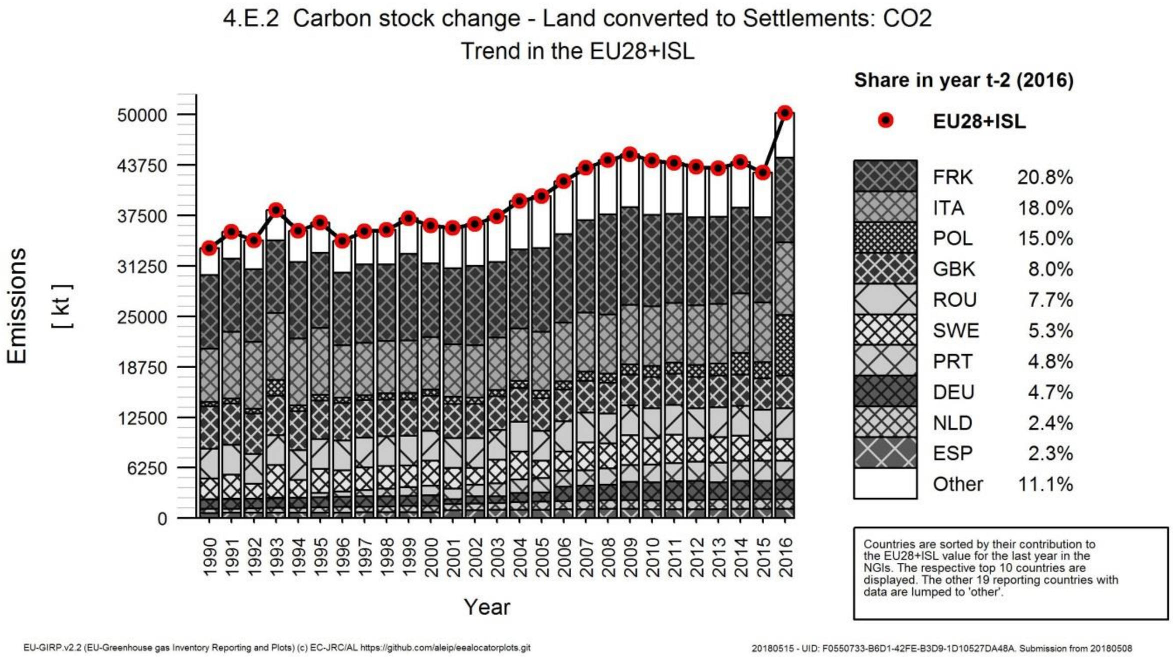


Figure 6. 18 Trend of activity data and emissions (+)/removals (-) in subcategory 4E2 "Land converted to Settlements" in EU 28 and Iceland (kha, kt CO_2 1990-2016)





As regards, with the subcategory 4E2, annual emissions from Land converted to Settlements have increased by 50% since 1990 (Table 6. 27). For the year 2016 this subcategory was reported as a net source of emissions reaching 53.151 kt CO_2.

Emissions are mainly the result of disturbed mineral soils and loss of carbon from living biomass when forests are converted to urban areas (France, Italy, Romania and UK). In fact, the conversion of forests in Settlements is an important component of the total deforestation, being around 30% of total area reported as deforested; and 16% of the Land converted to Settlements. While conversions to Wetlands and Other land may be caused by natural effects, a conversion to Settlement is always, by definition, the result of human actions.

When a land is converted to Settlements, carbon pools are not uniformly disturbed over the whole area. For instance, usually only part of the converted area is sealed, trees or upper soils layer is removed and, carbon stored in dead organic matter and soil organic matter diminish significantly. To address this issue, carbon stock changes associated with these deforestation events are reported using country-specific data and approaches.

Table 6. 27 4E2 Land converted to Settlements: MS and Iceland' contributions to the net CO_2 emissions (+)/removals (-) (CRF table 4)

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016	
	1990	2015	2016		kt CO2	%	kt CO2	%
Austria	577	391	379	0.7%	-198	-34%	-13	-3%
Belgium	163	853	877	1.7%	715	439%	25	3%
Bulgaria	469	781	719	1.4%	250	53%	-62	-8%
Croatia	207	684	673	1.3%	466	225%	-12	-2%
Cyprus	2	20	20	0.0%	18	1044%	0	0%
Czech Republic	86	96	124	0.2%	38	44%	28	29%
Denmark	13	67	153	0.3%	140	1096%	86	129%
Estonia	NO,NE	266	241	0.5%	241	∞	-26	-10%
Finland	871	687	571	1.1%	-300	-34%	-117	-17%
France	9 124	10 944	10 896	20.5%	1 772	19%	-48	0%
Germany	1 811	3 302	3 370	6.3%	1 560	86%	68	2%
Greece	50	120	134	0.3%	84	169%	13	11%
Hungary	110	209	213	0.4%	103	93%	5	2%
Ireland	80	75	91	0.2%	11	13%	16	21%
Italy	6 640	7 418	9 014	17.0%	2 375	36%	1 596	22%
Latvia	-34	-628	-619	-1.2%	-585	-1706%	8	1%
Lithuania	15	567	664	1.3%	649	4249%	97	17%
Luxembourg	145	65	62	0.1%	-84	-58%	-3	-5%
Malta	4	1	1	0.0%	-3	-77%	0	-11%
Netherlands	870	1 596	1 623	3.1%	753	87%	27	2%
Poland	477	1 755	7 247	13.6%	6 770	1418%	5 492	313%
Portugal	30	2 458	2 412	4.5%	2 381	7811%	-46	-2%
Romania	3 700	3 854	3 854	7.3%	154	4%	0	0%
Slovakia	96	84	80	0.2%	-16	-17%	-4	-5%
Slovenia	347	262	256	0.5%	-91	-26%	-5	-2%
Spain	646	1 147	1 160	2.2%	514	79%	13	1%
Sweden	2 608	2 365	2 511	4.7%	-97	-4%	145	6%
United Kingdom	6 887	6 187	6 394	12.0%	-493	-7%	207	3%
EU-28	**35 994**	**45 626**	**53 118**	**100%**	**17 125**	**48%**	**7 492**	**16%**
Iceland	13	5	5	0.0%	-8	-64%	0	-2%
United Kingdom (KP)	6 901	6 215	6 422	12.1%	-479	-7%	207	3%
EU-28 + ISL	**36 022**	**45 660**	**53 151**	**100%**	**17 130**	**48%**	**7 492**	**16%**

Major changes in the time series in Land converted to Settlements have been reported by Lithuania and Portugal, driven by the activity data. And, specifically for an increase in the conversion of areas that has associated larger carbon stock and therefore a more significant carbon lost from their conversions.

Noteworthy is also Poland that reports for the year 2016 a significant increase of emissions from from 4E.2 that is reflected in the overall trend of the LULUCF sector at EU level. Such increase results from significant conversion of forest lands used for expanding infrastructures required to support the growing population rates.

For reporting carbon stock changes in dead organic matter, it is generally assumed that the all the carbon stock in the pool is instantaneously oxidized in the moment of conversion from Forest land to Settlements. It is also assumed that there is no dead wood and litter on Settlements. Emissions are estimated based on per area average carbon stock of these carbon pools determined either at national or regional scale or specific to each deforestation site.

For reporting soils organic matter different assumptions have been implemented by MS, generally based on expert judgment or, occasionally, from some scientific studies. For instance, in Sweden carbon stock in Settlements is estimated as the weighted average of carbon stocks in two strata: unsealed and sealed. Unsealed area is usually considered to cover 40-60% of national settlements area (e.g. Austria, Luxembourg), going down to 2-3% in cities (i.e. Bulgaria). Associated carbon stocks are derived from one of the following options (depending on MS):

- data from measurements in green area of the city (from scientific studies);
- same carbon stock as under 'GL remaining GL' (assuming that under national circumstances GL is the source of land for Settlement's expansion);
- lowest carbon stock value among the major land categories Forest land, Cropland and Grassland (assuming limited change of carbon stock in the soil under construction);
- applying a factor against carbon stock in previous land use (e.g. constant loss of 50%).

6.2.4.3 Other land (CRF 4F)

The land use category Other land reached for the year 2016 at the level of the EU and Iceland 16.696 Kha, which represents about 4% of the total reported areas. This land use category has been reported rather constant across the time series as a result of the balance among the decrease in the subcategory 4F1 and the increase in the subcategory 4F2 (Figure 6. 19).

Main areas under the category 4F1 are reported by Sweden and Iceland, while new Other lands areas in the subcategory 4F2 are mainly reported by Portugal, France and Bulgaria but without a common pattern on the origin of these lands.

In terms of emissions, Inter-annual variation at EU level are due to Portugal, Bulgaria and Ireland.

In the case of Portugal, emissions/removals are dominated by the trend on activity data. Cropland and Grassland are the main categories being converted to Other Land, however the forest land category plays also an important role at the beginning of the time series. Consequently, this category is reported as a net source of emissions for the year 1990, 1991 and 1992 due to the loss of carbon in living biomass, and then, as a net sink of carbon, which increase until 2009 and then decrease, following the trend in agricultural areas. The net sink is the result of abandonment of agricultural areas that resulted in net carbon accumulation in soils under Other Land.

Noteworthy is the case of Ireland, which reports for the year 2006 a significant amount of emissions from Forest land converted to Other land. This is due to a former area of peat extraction (pre-1990) that was abandoned and then (since 1990) classified as forest, subsequently, a dump was built there and the area was reclassified as Other land. Ireland has informed that a process is ongoing to improve the reporting of these areas.

Finally, Bulgaria calculates the area in this category as the difference of the area of all land-use categories and the whole area of the country, so intended to avoid double accounting or omission of areas. Due to the land representation system, the year 2000 represents a change in the land use matrix.

Starting from that year, Bulgaria reports a leap on activity data and associated emissions of "Land converted to Other Land" that is reflected in the EU trend.

Definitions of Other land are close among MS and match in overall IPCC general description (Table 6. 28). In most of the cases, following the IPCC approach, this category is used to ensure that total area reported under LULUCF is constant along the time series, and it matches official country area. To this aim, this land category has the lower level of hierarchy and it includes all the areas that were not identified under any other land use category, that are in overall considered as unmanaged. This year, following a recommendation by the ERT the definitions of the category have been updated to better reflect lands that are included in the category. See for instance Ireland and UK.

A particular case is given by Portugal that included under this category shrubland areas. This country specific definition, although different than the one provided by IPCC is consistently applied across the time series. Portugal provided in its NIR specific information on this land use category and on the methods used to estimate carbon stock changes in these areas. Although Portugal plans to move shrubland areas under the land use category Grassland in next submission, as an interim solution, in 2018 carbon stock changes from Other land remaining Other land were included in land converted to Other land in order to ensure the completeness of the inventory.

Finally, as regards with Finland which include under this category "mineral soils on poorly productive forest lands" it should be noted that such lands correspond with a national defined category of its National forest inventory. That areas do not fulfil the threshold values for Forest Land and does not meet the criteria for any other land use category therefore these lands are included into the Other land category following the 2006 IPCC.

Table 6. 28 Definitions of lands included by MS and Iceland under the category 4F: Other lands

MS	***Definition***
Austria	Area with i) rocks and screes, ii) glaciers and iii) unmanaged alpine dwarf shrub heaths. It 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.
Bulgaria	Other land category includes bare soil, rock and all area that do not fall into any of other five land-use categories.
Croatia	Other land category represents a difference between the total area of Croatia and sum of all other land use categories.
Cyprus	Bare soil, rock, beaches, dunes and sand plains and all land areas that do not fall into any of the other five categories.
Czech Republic	Other land is not represented by any land use category within the Czech conditions and the natonal system of land use representation and land use change identificatition.
Denmark	Unmanaged area like moors, fens, beaches, sand dunes and other areas without human interference.
Estonia	Land areas that do not fall into any of the other five land-use categories.
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 cannot 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).
Hungary	Other Land includes comprises any area not included in another categories.
Ireland	Residual lands that are determinated when all other land use areas have been determined.
Italy	Other Land includes comprises any area not included in another categories. It is included to match overall consistency of country land area.
Latvia	According to the national land use statistics other lands include unmanaged lands, wetlands and settlements (1 459.3 mill. ha in 2008). Instead of the official statistics since 2009 the NFI is used to estimate area of other lands. It is assumed that other lands are dunes not covered by woody vegetation.
Lithuania	All other land which is not assigned to any other category such as quarries, sand - dunes and rocky areas is defined as Other land.
Luxemburg	This category includes bare soil, rock, ice, and all unmanaged land areas that do not fall into any of the other five categories. It allows the total of identified land areas to match the national area.
Malta	This category includes bare soil, rock, and all unmanaged land areas that do not fall into any of the other five categories. Mineral extraction sites in Malta are included under this land-use category.
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).
Poland	Other Land includes comprises any area not included in another categories. It is included to match overall consistency of country land area.
Portugal	Shrubland - includes all lands covered in woody vegetation that do not meet the forest or permanent crop definitions and Other land - includes all lands that do not meet the previous definitions, such as lands covered in rocks, sand dunes, etc.
Romania	Other land includes following categories: rocky areas, excavations, stone quarries (active, closed), stony debris, gravel/sand/earth pits, drilling perimeters and locally degraded lands.
Slovakia	Other land represents bare soil, rock and all unmanaged land areas that do not fall into any of the

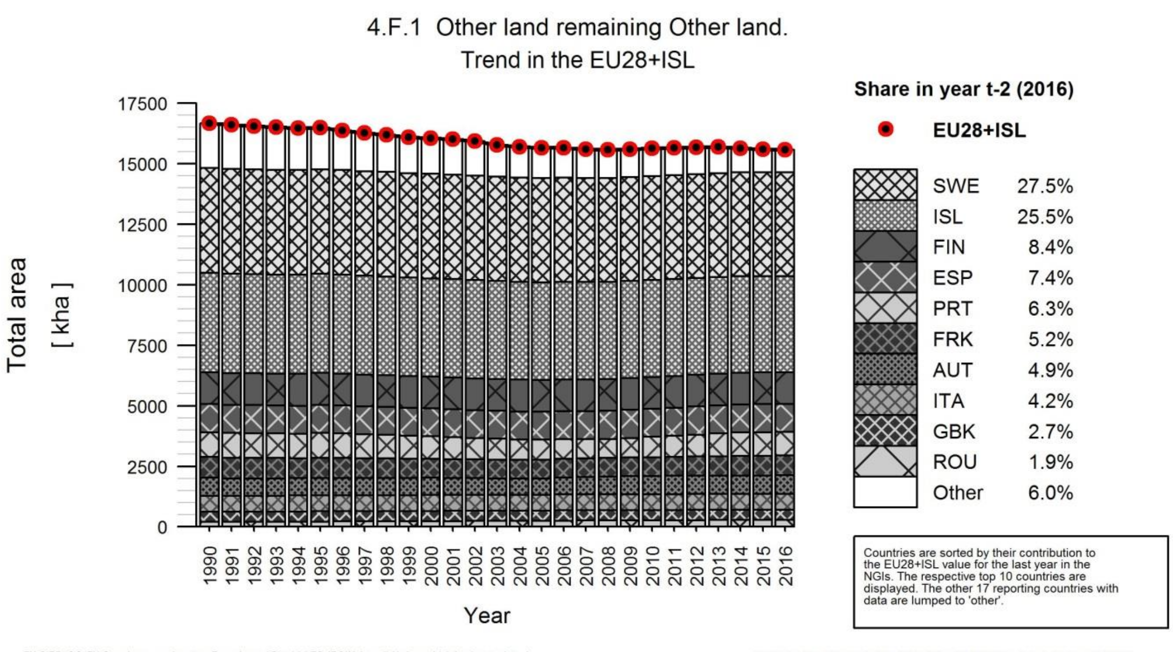
MS	Definition
	other categories.
Slovenia	Other land includes non-forest land covered with vegetation lover than 2 m or covered less than 75%, which is not used in agriculture. There are inbuilt areas with little or no vegetation as rocks, sands, sand banks (bigger than 5000 m2), waste and other opened areas. This is all land that is not classified in other land use definitions.
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. It is assumed unmanaged.
United Kingdom	For pre-1980 Other Land is the sum of the bare rock, sand/shingle, inland water and coastal water land. For Post-1980, Other Land contains the inland rock, standing water and canals and rivers and streams.
Iceland	Other Land is defined as areas that do not fall into the other land use categories. Other Land contains the inland rock, standing water and canals and rivers and streams broad habitat types in the Countryside Survey (Jackson, 2000). Areas of inland water exceeding 1km2 are included in 4D Wetlands, but water bodies below this threshold would still be included under Other Land.

In terms of emissions, Other land represents a net source as a result of the conversion from other categories to Other land. It reaches for the year 2016, 106 kt CO_2.

Specifically, emissions are the result of carbon oxidation from living biomass and soils, when lands are converted to Other land. However, some MS have reported a net sink of carbon in mineral soils, following such conversions

As explained above, a particular case is given by Portugal that reports all the carbon pools as being a net sink under 4F.2 due to the woody biomass that is presented in this category according with its own national definition.

Figure 6. 19 Trend of activity data in subcategories 4F1 and 4F2 "Other land remaining Other Land" and "Land converted to Other land" in EU MS and Iceland (kha, kt CO_2 1990-2016)



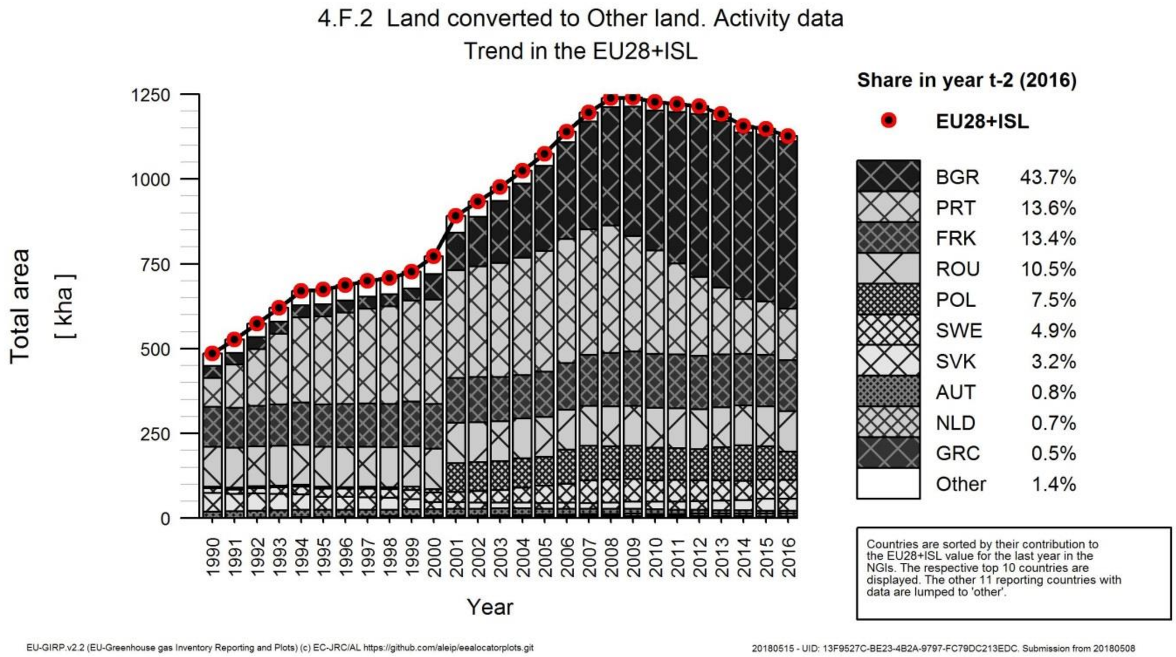
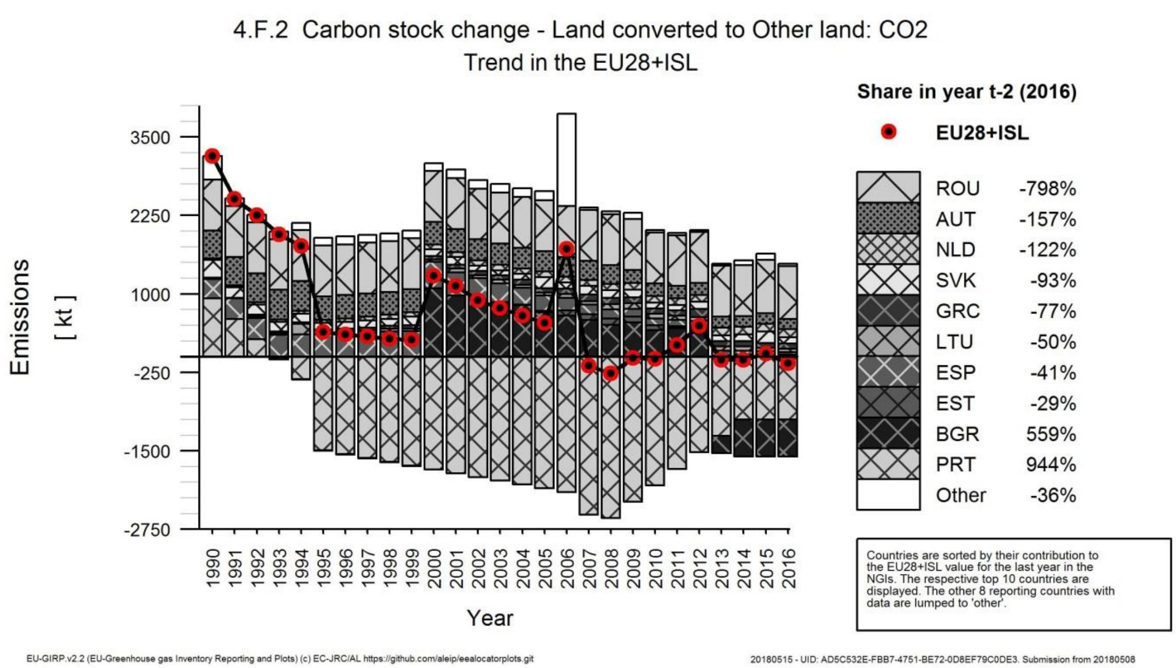


Figure 6. 20 Trend of emissions (+)/removals (-) in subcategory 4F2, "Land converted to Other lands" in EU MS and Iceland (kt CO_2, 1990-2016)



6.2.5 LULUCF – non-key categories

In this section, general overview of emissions and removals for non-key categories is provided.

Table 6. 29 Aggregated GHG emission from non-key categories in the LULUCF sector

EU-28 + ISL	Aggregated GHG emissions kt CO_2 equivalents.			Share in sector 4. LULUCF in 2016	Change 1990-2016		Change 2015-2016	
	1990	2015	2016		kt CO_2 equ.	%	kt CO_2 equ.	%
4.A Forest Land: Emissions and removals from drainage and rewetting and other management of organic and mineral soils (CH_4)	1 884.5	1 375.3	1 389.9	-0.48%	-495	-26%	15	1%
4.A Forest Land: Emissions and removals from drainage and rewetting and other management of organic and mineral soils (CO_2)	404.7	459.2	463.8	-0.16%	59	15%	5	1%
4.A Forest Land: Emissions and removals from drainage and rewetting and other management of organic and mineral soils (N_2O)	3 187.2	3 134.8	3 136.0	-1.08%	-51	-2%	1	0%
4.A.1 Forest Land: Land Use (CH_4)	1 942.3	1 129.2	1 395.0	-0.48%	-547	-28%	266	24%
4.A.1 Forest Land: Land Use (N_2O)	816.6	655.2	689.5	-0.24%	-127	-16%	34	5%
4.A.2 Forest Land: Land Use (CH_4)	128.7	50.3	76.3	-0.03%	-52	-41%	26	52%
4.A.2 Forest Land: Land Use (N_2O)	498.1	337.3	329.1	-0.11%	-169	-34%	-8	-2%
4.B Cropland: Emissions and removals from drainage and rewetting and other management of organic and mineral soils (CH_4)	682.4	666.1	667.6	-0.23%	-15	-2%	1	0%
4.B Cropland: Emissions and removals from drainage and rewetting and other management of organic and mineral soils (CO_2)	2 149.1	1 822.4	1 857.0	-0.64%	-292	-14%	35	2%
4.B Cropland: Emissions and removals from drainage and rewetting and other management of organic and mineral soils (N_2O)	0.0	0.0	0.0	0.00%	0.0	0%	0.0	0%
4.B.1 Cropland: Land Use (CH_4)	90.4	70.1	72.7	-0.03%	-18	-20%	3	4%
4.B.1 Cropland: Land Use (N_2O)	57.2	46.9	47.5	-0.02%	-10	-17%	1	1%
4.B.2 Cropland: Land Use (CH_4)	57.2	52.8	52.8	-0.02%	-4	-8%	0.1	0%
4.B.2 Cropland: Land Use (N_2O)	3 870.4	3 301.1	3 316.5	-1.14%	-554	-14%	15	0%
4.C Grassland: Emissions and removals from drainage and rewetting and other management of organic and mineral soils (CH_4)	1 590.1	1 483.1	1 480.3	-0.51%	-110	-7%	-3	0%
4.C Grassland: Emissions and removals from drainage and rewetting and other management of organic and mineral soils (CO_2)	958.9	985.9	1 025.8	-0.35%	67	7%	40	4%

EU-28 + ISL	Aggregated GHG emissions kt CO_2 equivalents.			Share in sector 4. LULUCF in 2016	Change 1990-2016		Change 2015-2016	
	1990	2015	2016		kt CO_2 equ.	%	kt CO_2 equ.	%
4.C Grassland: Emissions and removals from drainage and rewetting and other management of organic and mineral soils (N_2O)	86.0	97.7	98.1	-0.03%	12	14%	0.5	0%
4.C.1 Grassland: Land Use (CH_4)	852.2	203.1	241.2	-0.08%	-611	-72%	38	19%
4.C.1 Grassland: Land Use (N_2O)	381.6	129.5	130.4	-0.04%	-251	-66%	1	1%
4.C.2 Grassland: Land Use (CH_4)	46.5	43.4	46.6	-0.02%	0	0%	3	7%
4.C.2 Grassland: Land Use (N_2O)	275.8	157.5	157.9	-0.05%	-118	-43%	0.4	0.2%
4.D Wetlands: Emissions and removals from drainage and rewetting and other management of organic and mineral soils (CH_4)	1 981.0	1 832.7	1 828.2	-0.63%	-153	-8%	-4	-0.2%
4.D Wetlands: Emissions and removals from drainage and rewetting and other management of organic and mineral soils (CO_2)	1 855.1	1 745.9	1 714.9	-0.59%	-140	-8%	-31	-2%
4.D Wetlands: Emissions and removals from drainage and rewetting and other management of organic and mineral soils (N_2O)	120.5	144.0	144.9	-0.05%	24	20%	1	1%
4.D.1 Wetlands: Land Use (CH_4)	62.7	26.1	5.1	0.00%	-58	-92%	-21	-80%
4.D.1 Wetlands: Land Use (N_2O)	18.8	7.9	1.7	0.00%	-17	-91%	-6	-79%
4.D.2 Wetlands: Land Use (CH_4)	7.3	9.2	9.2	0.00%	2	26%	0.0	0%
4.D.2 Wetlands: Land Use (CO_2)	2 494.0	3 452.0	3 429.7	-1.18%	936	38%	-22	-1%
4.D.2 Wetlands: Land Use (N_2O)	39.4	94.7	91.9	-0.03%	52	133%	-3	-3%
4.E Settlements: Biomass Burning (CH_4)	53.0	63.1	69.1	-0.02%	16	30%	6	9%
4.E Settlements: Biomass Burning (CO_2)	40.7	62.8	142.3	-0.05%	102	250%	80	127%
4.E Settlements: Biomass Burning (N_2O)	4.9	6.3	10.2	0.00%	5	108%	4	63%
4.E.1 Settlements: Land Use (CH_4)	13.5	21.4	21.8	-0.01%	8	62%	0.4	2%
4.E.1 Settlements: Land Use (CO_2)	2 547.6	2 826.8	2 813.1	-0.97%	266	10%	-14	0%
4.E.1 Settlements: Land Use (N_2O)	140.1	200.2	199.1	-0.07%	59	42%	-1	-1%
4.E.2 Settlements: Land Use (CH_4)	10.5	21.1	22.0	-0.01%	12	109%	1	4%
4.E.2 Settlements: Land Use (N_2O)	2 330.2	3 833.8	4 119.2	-1.42%	1 789	77%	285	7%
4.F.2 Other Land: Land Use (CH_4)	0.0	0.0	0.0	0.00%	0.0	0%	0.0	0%

EU-28 + ISL	Aggregated GHG emissions kt CO_2 equivalents.			Share in sector 4. LULUCF in 2016	Change 1990-2016		Change 2015-2016	
	1990	2015	2016		kt CO_2 equ.	%	kt CO_2 equ.	%
4.F.2 Other Land: Land Use (CO_2)	3 194.8	51.1	-105.7	0.04%	-3 300	-103%	-157	-307%
4.F.2 Other Land: Land Use (N_2O)	0.1	0.0	0.0	0.00%	0	-78%	0	-18%
4.F.3 Other Land: Direct N_2O Emissions from N Mineralization/Immobilization (N_2O)	627.7	1 480.9	1 477.6	-0.51%	850	135%	-3	0%
4.F.4 Other Land: Biomass Burning (CH_4)	141.4	70.5	211.8	-0.07%	70	50%	141	200%
4.F.4 Other Land: Biomass Burning (CO_2)	0.0	0.0	0.0	0.00%	0.0	0%	0.0	0%
4.F.4 Other Land: Biomass Burning (N_2O)	23.2	11.6	34.7	-0.01%	12	50%	23	200%
4.G Atmospheric Deposition: Land Use (N_2O)	15.1	-	16.8	-0.01%	2	11%	17	∞
4.G Nitrogen Leaching and Run-off: Land Use (N_2O)	1 134.6	-	1 015.8	-0.35%	-119	-10%	1 016	∞
4.H Other LULUCF: Land Use (CH_4)	0.0	220.7	219.8	-0.08%	220	100%	-1	-0.4%
4.H Other LULUCF: Land Use (CO_2)	0.0	78.9	68.8	-0.02%	69	100%	-10	-13%
4.H Other LULUCF: Land Use (N_2O)	118.9	169.3	172.3	-0.06%	53	45%	3	2%

6.2.6 Other source of emissions: Tables 4(I)-4(V)

6.2.6.1 Direct nitrous oxide (N_2O) emissions from nitrogen (N) inputs to managed soils (CRF Table 4(I))

Under CRF table 4(I) MS reports N_2O emissions resulting from the addition of organic and inorganic fertilizers to managed soils under land use categories other than Cropland and Grassland.

The majority of MS stated that fertilization is not part of the management practices of forests, while, if any, emissions from the addition of nitrogen inputs in Wetlands, and or Settlements, or in few cases also under forests, are often reported under Agriculture sector when it was not possible to separate emissions by land use category. Therefore under the LULUCF almost all the MS have reported these emissions using the notation key NO or IE (Table 6. 30).

Exceptions are given by Finland, Sweden, UK and Iceland, which report N_2O emissions under this source category due to forest fertilization. Sweden reports more than half of the total emissions in the EU from nitrogen fertilization as a result of nitrogen inputs occasionally applied to increase the wood production in older forests stands. And, Finland reports 30% of the remaining emissions as a result of forest growth fertilizations and, to a lesser extent, forest vitality fertilizations. By last, UK and Iceland report low emissions in this source as a result of inorganic nitrogen fertilizers applied to forest when absolutely necessary. When in the case of UK is during the first rotation on ‘poor’ soils, such as reclaimed slag heaps, impoverished brown field sites and upland organic soils, and in Iceland, in some cases for fertilization of cultivated forest at the planting stage.

In addition, Ireland reports N_2O emissions resulting from the addition of organic fertilizers in Settlements areas.

Activity data for reporting this source of emissions results from national or sectorial statistics (e.g. sales statistics), which provide the total amount and type of fertilizer, then, the IPCC default value of 0.01 kg N_2O-N/kg N yr-1 is mainly used to derive N_2O emissions from nitrogen inputs to managed soils.

For the year 2016 this source of emissions reaches 45 kt CO_2 equivalents, which represent about 33% less than in 1990.

Table 6. 30 Direct nitrous oxide (N_2O) emissions from nitrogen (N) inputs to managed soils (kt CO_2 eq.))

Member State	N2O Emissions in kt CO2 equiv.			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016	
	1990	2015	2016		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	NO	NO	NO	-	-	-	-	-
Belgium	NO	NO	NO	-	-	-	-	-
Bulgaria	NO	NO	NO	-	-	-	-	-
Croatia	NO	NO	NO	-	-	-	-	-
Cyprus	NE,NO	NO,NE	NO,NE	-	-	-	-	-
Czech Republic	NO	NO	NO	-	-	-	-	-
Denmark	NO,IE	NO,IE	NO,IE	-	-	-	-	-
Estonia	NA,NO	NO,NA	NO,NA	-	-	-	-	-
Finland	21	13	17	38.6%	-3	-16%	5	38%
France	NO	NO	NO	-	-	-	-	-
Germany	NO	NO	NO	-	-	-	-	-
Greece	NO	NO	NO	-	-	-	-	-
Hungary	NO,IE,NA	NO,IE,NA	NO,IE,NA	-	-	-	-	-
Ireland	NO,IE	5	4	9.7%	4	∞	-0.2	-4%
Italy	NO,IE	NO,IE	NO,IE	-	-	-	-	-
Latvia	NO	NO	NO	-	-	-	-	-
Lithuania	NO	NO	NO	-	-	-	-	-
Luxembourg	NO	NO	NO	-	-	-	-	-
Malta	NA,NO	NO	NO	-	-	-	-	-
Netherlands	NO,NE,IE	NO,NE,IE	NO,NE,IE	-	-	-	-	-
Poland	NO,IE,NA	NO,IE,NA	NO,IE,NA	-	-	-	-	-
Portugal	NO,IE	NO,IE	NO,IE	-	-	-	-	-
Romania	NO,IE,NA	NO,IE,NA	NO,IE,NA	-	-	-	-	-
Slovakia	NO	NO	NO	-	-	-	-	-
Slovenia	NO	NO	NO	-	-	-	-	-
Spain	NO	NO	NO	-	-	-	-	-
Sweden	49	23	21	46.1%	-28	-58%	-3	-12%
United Kingdom	9	2	2	5.5%	-6	-71%	0.1	4%
EU-28	**78**	**43**	**45**	**100%**	**-33**	**-43%**	**2**	**5%**
Iceland	0.0	0.1	0.1	0.1%	0.0	267%	0.0	0%
United Kingdom (KP)	9	2	2	5.5%	-6	-71%	0.1	4%
EU-28 + ISL	**78**	**43**	**45**	**100%**	**-33**	**-43%**	**2**	**5%**

6.2.6.2 Emissions and removals from drainage and rewetting and other management of organic and mineral soils (CRF Table 4(II))

Under CRF table 4(II), CO_2, CH_4 and N_2O emissions and removals from drainage and rewetting and other management of organic and mineral soils areas are reported. However, part of these emissions are already covered under other sectors, so countries shall avoid double counting (e.g. nitrous oxide emissions from drained cropland and grassland soils are covered in the agriculture sector) or they may be reported under other tables within the LULUCF (e.g. CO_2 emissions or removals from drainage of wetlands areas are often already included in CRF tables 4.A to 4.F).

For the year 2016, total emissions from this source reached 13.978 kt CO_2 equivalent (Table 6. 31;

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016	
	1990	2015	2016		kt CO2	%	kt CO2	%
Austria	NO,IE	NO,IE	NO,IE	-	-	-	-	-
Belgium	NO,NA	NO,NA	NO,NA	-	-	-	-	-
Bulgaria	NO	NO	NO	-	-	-	-	-
Croatia	NO	NO	NO	-	-	-	-	-
Cyprus	NE,NO	NO,NE	NO,NE	-	-	-	-	-
Czech Republic	NO	NO	NO	-	-	-	-	-
Denmark	NO,IE	NO,IE	NO,IE	-	-	-	-	-
Estonia	IE,NA,NO	NO,IE,NA	NO,IE,NA	-	-	-	-	-
Finland	NO,IE,NA	NO,IE,NA	NO,IE,NA	-	-	-	-	-
France	863	863	863	17%	0.0	0%	0.0	0%
Germany	NO,IE	NO,IE	NO,IE	-	-	-	-	-
Greece	NO	NO	NO	-	-	-	-	-
Hungary	786	359	308	6.1%	-478	-61%	-51	-14%
Ireland	468	446	451	8.9%	-18	-4%	4.8	1.1%
Italy	NO	NO	NO	-	-	-	-	-
Latvia	855	1 236	1 294	26%	439	51%	59	5%
Lithuania	1 933	1 643	1 679	33%	-255	-13%	35.3	2.1%
Luxembourg	NO	NO	NO	-	-	-	-	-
Malta	NE,NO	NE,NO	NO,NE	-	-	-	-	-
Netherlands	NO,NE,IE,NA	NO,NE,IE,NA	NO,NE,IE,NA	-	-	-	-	-
Poland	NA	NA	NA	-	-	-	-	-
Portugal	NO	NO	NO	-	-	-	-	-
Romania	NO,NA	NO,NA	NO,NA	-	-	-	-	-
Slovakia	NO	NO	NO	-	-	-	-	-
Slovenia	NO	NO	NO	-	-	-	-	-
Spain	0.0	0.0	0.0	0.0%	0.0	14%	0.0	0%
Sweden	NO,IE,NA	NO,IE,NA	NO,IE,NA	-	-	-	-	-
United Kingdom	177	177	177	3.5%	0.0	0%	0.0	0%
EU-28	**5 083**	**4 724**	**4 772**	**94%**	**-311**	**-6.1%**	**48**	**1.0%**
Iceland	285	290	290	5.7%	5.0	2%	0.0	0.0%
United Kingdom (KP)	177	177	177	3.5%	0	0%	0.0	0%
EU-28 + ISL	**5 368**	**5 013**	**5 061**	**100%**	**-306**	**-5.7%**	**48.1**	**1.0%**

Table 6. 32; and Table 6. 33) that occurred mostly in organic soils and that are mainly reported by UK, Finland, Sweden and Iceland.

Table 6. 31 CO_2 Emissions and removals from drainage and rewetting and other management of organic and mineral soils (kt CO_2 eq.))

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016	
	1990	2015	2016		kt CO2	%	kt CO2	%
Austria	NO,IE	NO,IE	NO,IE	-	-	-	-	-
Belgium	NO,NA	NO,NA	NO,NA	-	-	-	-	-
Bulgaria	NO	NO	NO	-	-	-	-	-
Croatia	NO	NO	NO	-	-	-	-	-
Cyprus	NE,NO	NO,NE	NO,NE	-	-	-	-	-
Czech Republic	NO	NO	NO	-	-	-	-	-
Denmark	NO,IE	NO,IE	NO,IE	-	-	-	-	-
Estonia	IE,NA,NO	NO,IE,NA	NO,IE,NA	-	-	-	-	-
Finland	NO,IE,NA	NO,IE,NA	NO,IE,NA	-	-	-	-	-
France	863	863	863	17%	0.0	0%	0.0	0%
Germany	NO,IE	NO,IE	NO,IE	-	-	-	-	-
Greece	NO	NO	NO	-	-	-	-	-
Hungary	786	359	308	6.1%	-478	-61%	-51	-14%
Ireland	468	446	451	8.9%	-18	-4%	4.8	1.1%
Italy	NO	NO	NO	-	-	-	-	-
Latvia	855	1 236	1 294	26%	439	51%	59	5%
Lithuania	1 933	1 643	1 679	33%	-255	-13%	35.3	2.1%
Luxembourg	NO	NO	NO	-	-	-	-	-
Malta	NE,NO	NE,NO	NO,NE	-	-	-	-	-
Netherlands	NO,NE,IE,NA	NO,NE,IE,NA	NO,NE,IE,NA	-	-	-	-	-
Poland	NA	NA	NA	-	-	-	-	-
Portugal	NO	NO	NO	-	-	-	-	-
Romania	NO,NA	NO,NA	NO,NA	-	-	-	-	-
Slovakia	NO	NO	NO	-	-	-	-	-
Slovenia	NO	NO	NO	-	-	-	-	-
Spain	0.0	0.0	0.0	0.0%	0.0	14%	0.0	0%
Sweden	NO,IE,NA	NO,IE,NA	NO,IE,NA	-	-	-	-	-
United Kingdom	177	177	177	3.5%	0.0	0%	0.0	0%
EU-28	**5 083**	**4 724**	**4 772**	**94%**	**-311**	**-6.1%**	**48**	**1.0%**
Iceland	285	290	290	5.7%	5.0	2%	0.0	0.0%
United Kingdom (KP)	177	177	177	3.5%	0	0%	0.0	0%
EU-28 + ISL	**5 368**	**5 013**	**5 061**	**100%**	**-306**	**-5.7%**	**48.1**	**1.0%**

Table 6. 32 N_2O Emissions and removals from drainage and rewetting and other management of organic and mineral soils (kt CO_2 eq.)

Member State	N2O Emissions in kt CO2 equiv.			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016	
	1990	2015	2016		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	NO	NO	NO	-	-	-	-	-
Belgium	NO,NA	NO,NA	NO,NA	-	-	-	-	-
Bulgaria	NO	NO	NO	-	-	-	-	-
Croatia	NO	NO	NO	-	-	-	-	-
Cyprus	NE,NO	NO,NE	NO,NE	-	-	-	-	-
Czech Republic	NO	NO	NO	-	-	-	-	-
Denmark	26.8	24	24	0.7%	-3	-10%	0.0	0.1%
Estonia	1.5	1.3	1.3	0.0%	-0.1	-9%	0.0	0%
Finland	1 218	1 213	1 212	34%	-6	-0.5%	-0.3	-0.02%
France	NO,NA	NO,NA	NO,NA	-	-	-	-	-
Germany	235	308	313	9%	77	33%	4.3	1.4%
Greece	NO	NO	NO	-	-	-	-	-
Hungary	0.1	1.3	1.3	0.0%	1	788%	0.0	0.0%
Ireland	105	184	185	5.2%	81	77%	1.4	0.8%
Italy	NO	NO	NO	-	-	-	-	-
Latvia	571	572	572	16%	0.8	0.1%	0.1	0.0%
Lithuania	39	40	41	1.1%	1.3	3%	0.1	0.3%
Luxembourg	NO	NO	NO	-	-	-	-	-
Malta	NE,NO	NE,NO	NO,NE	-	-	-	-	-
Netherlands	NO,NE,IE,NA	NO,NE,IE,NA	NO,NE,IE,NA	-	-	-	-	-
Poland	NA	NA	NA	-	-	-	-	-
Portugal	NO	NO	NO	-	-	-	-	-
Romania	27	27	27	0.8%	0	0%	0.0	0%
Slovakia	NO	NO	NO	-	-	-	-	-
Slovenia	NO	NO	NO	-	-	-	-	-
Spain	0.0	0.0	0.0	0.0%	0	14%	0.0	0%
Sweden	1 169	1 042	1 041	29%	-128	-11%	-0.6	-0.1%
United Kingdom	54	57	57	1.6%	3	6%	0.0	0.1%
EU-28	**3 446**	**3 469**	**3 475**	**98%**	**28**	**0.8%**	**5.2**	**0.2%**
Iceland	66	76	77	2.2%	10.5	16%	0.2	0.3%
United Kingdom (KP)	54	57	57	1.6%	3	6%	0.0	0.1%
EU-28 + ISL	**3 513**	**3 546**	**3 551**	**100%**	**39**	**1.1%**	**5.5**	**0.2%**

Table 6. 33 CH_4 Emissions and removals from drainage and rewetting and other management of organic and mineral soils (kt CO_2 eq.)

Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016	
	1990	2015	2016		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	24	24	24	0.4%	0.0	0%	0.0	0%
Belgium	NO,NA	NO,NA	NO,NA	-	-	-	-	-
Bulgaria	NO	NO	NO	-	-	-	-	-
Croatia	NO	NO	NO	-	-	-	-	-
Cyprus	NE,NO	NO,NE	NO,NE	-	-	-	-	-
Czech Republic	NO	NO	NO	-	-	-	-	-
Denmark	15.7	57	60	1.1%	44	283%	2.9	5%
Estonia	0.1	0	0	0.0%	-0.01	-9%	0.0	0%
Finland	1 533	919	919	17.1%	-614.6	-40%	-0.3	-0.03%
France	57	57	57	1.1%	0.0	0%	0.0	0%
Germany	845	821	819	15.3%	-26	-3%	-1.9	-0.2%
Greece	NO	NO	NO	-	-	-	-	-
Hungary	NO,NA	NO,NA	NO,NA	-	-	-	-	-
Ireland	377	364	368	6.9%	-10	-3%	3	1%
Italy	NO	NO	NO	-	-	-	-	-
Latvia	456	438	448	8.3%	-8	-2%	10	2%
Lithuania	NO,NE	NO,NE	NO,NE	-	-	-	-	-
Luxembourg	NO	NO	NO	-	-	-	-	-
Malta	NE,NO	NE,NO	NO,NE	-	-	-	-	-
Netherlands	NO,NE,IE,NA	NO,NE,IE,NA	NO,NE,NA	-	-	-	-	-
Poland	NA	NA	NA	-	-	-	-	-
Portugal	NO	NO	NO	-	-	-	-	-
Romania	NO,NA	NO,NA	NO,NA	-	-	-	-	-
Slovakia	NO	NO	NO	-	-	-	-	-
Slovenia	NO	NO	NO	-	-	-	-	-
Spain	0	0	0	0.0%	0	14%	0	0%
Sweden	467	438	437	8.1%	-30.78	-7%	-1.2	0%
United Kingdom	NO,NE,NA	NO,NE,NA	NO,NE,NA	-	-	-	-	-
EU-28	**3 776**	**3 118**	**3 131**	**58%**	**-644**	**-17%**	**13**	**0%**
Iceland	2 362.3	2 238.7	2 234.5	41.6%	-127.7	-5%	-4	-0.2%
United Kingdom (KP)	NO,NE,NA	NO,NE,NA	NO,NE,NA	-	-	-	-	-
EU-28 + ISL	**6 138**	**5 357**	**5 366**	**100%**	**-772**	**-13%**	**9**	**0%**

6.2.6.3 Direct nitrous oxide (N_2O) emissions from nitrogen (N) mineralization/immobilization associated with loss/gain of soil organic matter resulting from change of land use or management of mineral soils (CRF Table 4(III))

Under CRF table 4(III), direct nitrous oxide emissions from nitrogen mineralization associated with loss of soil organic matter resulting from change of land use or management of mineral soils are reported by almost all the MS. This implies significant efforts by MS to increase the completeness for this source of emissions during the last years.

For the year 2016, net emissions from this source category reached 9.755 kt CO_2 equivalent, which represent an increase of 26% as compared to 1990. Significant emissions under this category are reported by France, Romania, UK and Poland (Table 6. 34) and in most of the cases they were estimated using IPCC methodologies and default emissions factors.

Table 6. 34 Direct nitrous oxide (N_2O) emissions from nitrogen (N) mineralization/immobilization associated with loss/gain of soil organic matte resulting from change of land use or management of mineral soils (kt CO_2eq.)

Member State	N2O Emissions in kt CO2 equiv.			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016	
	1990	2015	2016		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	129	120	121	1.2%	-7	-6%	1.3	1%
Belgium	6	155	161	1.7%	155	2447%	6.2	4%
Bulgaria	179	500	499	5.1%	320	178%	-0.7	-0.1%
Croatia	38	101	102	1.0%	64	169%	0.7	1%
Cyprus	NE,NO	NO,NE	NO,NE	-	-	-	-	-
Czech Republic	9	5	5	0.0%	-4	-47%	-0.3	-6%
Denmark	0.2	10	9	0.1%	9	5238%	-0.8	-8%
Estonia	0.0	16	16	0.2%	16.31	142339%	0.2	1.23%
Finland	29	39	38	0.4%	8.9	31%	-1.0	-3%
France	2 191	2 201	2 200	22.6%	9.5	0%	-0.8	0.0%
Germany	482	445	446	4.6%	-36	-8%	1.6	0.4%
Greece	1	15	14	0.1%	13	985%	-0.3	-2%
Hungary	24	39	39	0.4%	14	59%	-0.7	-2%
Ireland	19	141	128	1.3%	110	588%	-13	-9%
Italy	551	518	704	7.2%	154	28%	187	36%
Latvia	0	34	35	0.4%	35	12022%	1.2	4%
Lithuania	73	103	116	1.2%	43	58%	12.7	12%
Luxembourg	17	11	10	0.1%	-7	-41%	-0.6	-5%
Malta	NO,IE	NO,IE	NO,IE	-	-	-	-	-
Netherlands	6	129	136	1.4%	130	2313%	6.7	5%
Poland	173	1 090	1 220	12.5%	1 047	604%	130	12%
Portugal	507	333	324	3.3%	-183	-36%	-8.6	-3%
Romania	1 305	1 990	1 990	20.4%	686	53%	0.0	0%
Slovakia	75	18	18	0.2%	-57	-76%	0.1	0.5%
Slovenia	42	27	27	0.3%	-14.9	-35%	-0.1	-0.5%
Spain	80	152	140	1.4%	60	75%	-12	-8%
Sweden	53	152	145	1.5%	92.66	176%	-6.3	-4%
United Kingdom	1 772	1 119	1 100	11.3%	-672	-38%	-19	-2%
EU-28	**7 762**	**9 462**	**9 746**	**100%**	**1 984**	**26%**	**284**	**3%**
Iceland	0.1	0.5	0.5	0.0%	0.4	514%	0.00	0.0%
United Kingdom (KP)	1 773	1 128	1 109	11.4%	-664	-37%	-19	-1.7%
EU-28 + ISL	**7 764**	**9 472**	**9 755**	**100%**	**1 992**	**26%**	**284**	**3%**

6.2.6.4 Indirect nitrous oxide (N_2O) emissions from managed soils (CRF Table 4(IV))

This source category covers indirect N_2O emissions from managed soils. Under certain conditions and land use categories, these emissions can be reported under Agriculture sector. For instance, those associated with the addition on nitrogen inputs on Cropland and Grassland or with the mineralization of nitrogen associated with loss of soil organic matter resulting from change of land use or management on mineral soils in Cropland remaining Cropland. Moreover, if the sources of nitrogen cannot be separated in any other way than between cropland and grassland, these emissions were reported also under the Agriculture sector.

Therefore, given that most of the fertilizer are added in Cropland and Grassland areas according to the CRF table 4 (I) and that direct nitrogen emissions are mostly reported so far under Cropland remaining

Cropland, an important number of the MS have reported in the CRF table 4(IV) the notation key IE (i.e. included elsewhere).

Nevertheless, the reporting of these emissions has also undergone a significant increase in the last year submission following recommendations provided during the EU QA/QC checks.

For the year 2016, indirect N_2O emissions reported under LULUCF reach 1.033 kt CO_2 equivalents (Table 6. 35). These emissions are mainly reported by Germany, UK and France. To a lesser extent, others MS have provided for first time also minor quantities of indirect N_2O emissions.

Table 6. 35 Indirect nitrous oxide (N_2O) emissions from managed soils (kt CO_2 eq.)

Member State	N2O emissions in kt CO2 equiv.			Share in EU-28+ISL emissions in 2016	Change 2015 - 2016		Change 1990 - 2016	
	1990	2015	2016		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	15	14	14	1%	0.1	1%	-0.8	-6%
Belgium	IE	IE	IE	-	-	-	-	-
Bulgaria	40	113	112	11%	-0.1	0%	72.0	178%
Croatia	IE	IE	IE	-	-	-	-	-
Cyprus	NE,0	NE,0	NE	-	-	-	-	-
Czech Republic	2	1	1	0.1%	-0.1	-6%	-0.9	-47%
Denmark	IE	IE	IE	-	-	-	-	-
Estonia	0.0	4	4	0%	0.04	1%	3.7	142339%
Finland	2	3	3	0.3%	0.0	0.0%	1.0	45%
France	491	473	470	46%	-2.6	-1%	-20.5	-4%
Germany	109	100	100	10%	0.4	0.4%	-8.1	-8%
Greece	NE,NO	NE,NO	NE,NO	-	-	-	-	-
Hungary	3	6	6	1%	0.2	3%	2.6	80%
Ireland	IE	IE	IE	-	-	-	-	-
Italy	10	NO	6	1%	6.0	-	-4.2	-41%
Latvia	0.0	0.6	0.6	0.1%	0.02	4%	0.6	7676%
Lithuania	16	23	24	2%	0.6	2%	7.3	44%
Luxembourg	4	2	2	0%	-0.1	-5%	-1.6	-41%
Malta	IE	IE	IE	-	-	-	-	-
Netherlands	IE	IE	IE	-	-	-	-	-
Poland	IE	IE	IE	-	-	-	-	-
Portugal	20	12	21	2%	9.6	83%	0.8	4%
Romania	IE	IE	IE	-	-	-	-	-
Slovakia	15	5	5	0%	0.2	4%	-10.2	-68%
Slovenia	9	6	6	1%	-0.1	-1%	-3.4	-36%
Spain	3	6	5	0.5%	-0.5	-8%	2.3	75%
Sweden	8	4	3	0.3%	-0.4	-11%	-4.4	-57%
United Kingdom	401	253	248	24%	-4.2	-2%	-153.1	-38%
EU-28	**1 150**	**1 023**	**1 033**	**100%**	**9.1**	**1%**	**-117.1**	**-10%**
Iceland	IE	IE	IE	-	-	-	-	-
United Kingdom (KP)	401	253	248	24%	-4.2	-2%	-153.1	-38%
EU-28 + ISL	**1 150**	**1 023**	**1 033**	**100%**	**9.1**	**1%**	**-117.1**	**-10%**

6.2.6.5 CO_2, CH_4 & N_2O emissions from Biomass Burning (CRF Table 4(V))

This source category covers CO_2, and non-CO_2 emissions from biomass burning as a result of wildfires and controlled burning, on all the land use categories.

Following the IPCC approach, many MS that implement the stock-different method to estimate carbon stock changes in forest living biomass use the notation key IE in the CRF table 4 (V) so avoiding double counting of CO_2 emissions. In addition, MS have also used the notation keys NO or NA when wildfires or controlled burning do not take place under certain categories, or NE for those land use categories for which the IPCC does not provide methods. An example is the reporting of emissions from biomass burning in Settlement (e.g. Estonia).

In general, controlled burning on managed lands is not a common practice in the EU MS and Iceland, with few exceptions for confined areas (.e.g. Finland, Sweden, and UK in forest lands and, Spain and UK in grasslands). In addition, northern countries report negligible emissions from biomass burning (i.e. controlled burning and wildfires).

Methodologies used to report CO_2 emissions for fires are always based on Tier 2 methods by using information on activity data provided by national statistics and country-specific emission factors. By contrary, Tier 1 methodologies are also used for estimation of CH_4 and N_2O emissions resulting from fires.

Overall, emissions from biomass burning decreased in 2016 compared to 1990 (Table 6. 36, Table 6. 37 and Table 6. 38) although increased compared with previous year. Nevertheless, their trends and variability are related with wildfire incidence, which is characterized by a large inter-annual variability driven mainly by climate conditions. MS that often report the larger quantities of emissions as a result of the biomass burning are Italy, France, Spain, and Greece.

This year, Portugal reports a significant increase of emissions from wildfires in forests as compared with recent years, which is driven by larger areas affected by fires.

Table 6. 36 CO_2 emissions from Biomass Burning (in kt CO_2)

Member State	CO2 Emissions in kt			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016	
	1990	2015	2016		kt CO2	%	kt CO2	%
Austria	NO,IE	NO,IE	NO,IE	-	-	-	-	-
Belgium	5	NO	NO	-	-5	-100%	-	-
Bulgaria	32	171	197	3.8%	165	510%	27	16%
Croatia	9	115	65	1.2%	56	619%	-50	-44%
Cyprus	0.5	1	112	2.1%	111	22659%	110	8225%
Czech Republic	16	40	17	0.3%	1	4%	-24	-59%
Denmark	NO,IE	NO,IE	NO,IE	-	-	-	-	-
Estonia	IE,NE,NO	NO,NE,IE	NO,NE,IE	-	-	-	-	-
Finland	4	2	4	0.1%	-0.4	-9%	2.0	127%
France	1 741	632	505	9.7%	-1 236.4	-71%	-127	-20%
Germany	NO,IE	NO,IE	NO,IE	-	-	-	-	-
Greece	146	13	38	0.7%	-108	-74%	25	188%
Hungary	NO,IE,NA	NO,IE,NA	NO,IE,NA	-	-	-	-	-
Ireland	478	196	39	0.7%	-439	-92%	-157	-80%
Italy	5 071	741	863	16.6%	-4 208	-83%	123	17%
Latvia	218	70	71	1.4%	-147	-67%	1	2%
Lithuania	1	1	0	0.0%	-1	-82%	-0.4	-58%
Luxembourg	NO	NO	NO	-	-	-	-	-
Malta	NO,NE	NE,NO	NO,NE	-	-	-	-	-
Netherlands	4	5	5	0.1%	1	28%	0.0	1%
Poland	107	23	58	1.1%	-49	-46%	35	148%
Portugal	1 683	728	2 603	50.0%	920	55%	1 875	258%
Romania	4	10	9	0.2%	5	130%	-2	-15%
Slovakia	43	95	47	0.9%	5	11%	-47	-50%
Slovenia	21	3	16	0.3%	-4.7	-23%	13	398%
Spain	843.43	225.52	174.76	3.4%	-669	-79%	-51	-23%
Sweden	NO,IE	NO,IE	NO,IE	-	-	-	-	-
United Kingdom	97	256	387	7.4%	290	301%	131	51%
EU-28	**10 524**	**3 327**	**5 210**	**100%**	**-5 314**	**-50%**	**1 883**	**57%**
Iceland	NE,NA	NO,NE,NA	NO,NE,NA	-	-	-	-	-
United Kingdom (KP)	97	256	387	7.4%	290	3.01	131	0.51
EU-28 + ISL	**10 524**	**3 327**	**5 210**	**100%**	**-5 314**	**-50%**	**1 883**	**57%**

Table 6. 37 CH_4 emissions from Biomass Burning (in kt CO_2 eq.)

Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016	
	1990	2015	2016		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	0.5	0.3	0.0	0.0%	-0.4	-90%	-0.3	-86%
Belgium	1	NO	NO	-	-1	-100%	-	-
Bulgaria	2	13	15	0.7%	12	510%	2	16%
Croatia	1	14	9	0.4%	8	625%	-5	-36%
Cyprus	0.1	0.1	12	0.6%	12	22659%	12	8225%
Czech Republic	44	32	33	1.5%	-11	-26%	1	4%
Denmark	0.65	0.03	0.03	0.0%	-0.62	-95%	0.00	11%
Estonia	0.28	0.00	0.00	0.0%	-0.28	-99%	0.00	43%
Finland	4.9	0.43	0.68	0.0%	-4	-86%	0.25	59%
France	951	881	935	42.9%	-16	-2%	54	6%
Germany	7	3	2	0.1%	-5	-76%	-1	-46%
Greece	63	11	32	1.5%	-31	-49%	21	193%
Hungary	23	18	9	0.4%	-14	-60%	-9	-50%
Ireland	85	35	7	0.3%	-78	-92%	-28	-80%
Italy	1 483	291	396	18.2%	-1 087	-73%	105	36%
Latvia	24	13	13	0.6%	-11	-46%	-0.18	-1%
Lithuania	3	1	1	0.0%	-2	-77%	-1	-47%
Luxembourg	NO	NO	NO	-	-	-	-	-
Malta	NE,NO	NE,NO	NO,NE	-	-	-	-	-
Netherlands	0.2	0.3	0.3	0.0%	0.09	35%	0.00	1%
Poland	44	36	45	2.1%	1	1%	8	23%
Portugal	300	141	450	20.7%	150	50%	309	220%
Romania	0.4	1.1	1.1	0.1%	0.7	168%	0.00	0%
Slovakia	10	23	19	0.9%	9	89%	-4	-17%
Slovenia	2	0.2	1	0.1%	-0.4	-23%	1	398%
Spain	314	180	162	7.4%	-152	-48%	-19	-10%
Sweden	2.1	1.7	3.1	0.1%	1.0	49%	1.4	83%
United Kingdom	16	21	35	1.6%	19	116%	14	67%
EU-28	**3 382**	**1 717**	**2 180**	**100%**	**-1 202**	**-36%**	**462**	**27%**
Iceland	NE,NA	0.2	NO,NE,NA	-	-	-	-0.2	-100%
United Kingdom (KP)	16	21	35	1.6%	19	116%	14	67%
EU-28 + ISL	**3 382**	**1 718**	**2 180**	**100%**	**-1 202**	**-36%**	**462**	**27%**

Table 6. 38 N_2O emissions from Biomass Burning (in kt CO_2 eq.)

Member State	N2O Emissions in kt CO2 equiv.			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016	
	1990	2015	2016		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	0.3	0.2	0.0	0.0%	-0.3	-90%	-0.2	-86%
Belgium	5	NO	NO	-	-5	-100%	-	-
Bulgaria	2	8	10	1.2%	8	510%	1	16%
Croatia	1	10	6	0.8%	6	657%	-3	-34%
Cyprus	0.0	0.1	4	0.5%	4	22659%	4	8225%
Czech Republic	29	21	22	2.6%	-7	-26%	1	4%
Denmark	0.43	0.03	0.04	0.0%	-0.40	-92%	0.00	11%
Estonia	0.04	0.00	0.00	0.0%	-0.04	-98%	0.00	65%
Finland	0.47	0.05	0.08	0.0%	-0.39	-82%	0.03	67%
France	530	414	455	55.4%	-74	-14%	41	10%
Germany	4	2	1	0.1%	-3	-76%	-1	-46%
Greece	5	1	3	0.3%	-3	-49%	2	193%
Hungary	15	12	6	0.7%	-9	-59%	-6	-50%
Ireland	23	10	2	0.2%	-21	-92%	-8	-80%
Italy	262	39	45	5.5%	-217	-83%	7	17%
Latvia	3	2	2	0.2%	-1	-37%	-0.02	-1%
Lithuania	3	1	1	0.1%	-2	-76%	-1	-46%
Luxembourg	NO	NO	NO	-	-	-	-	-
Malta	NE,NO	NE,NO	NO,NE	-	-	-	-	-
Netherlands	0.2	0.2	0.2	0.0%	0.06	31%	0.00	1%
Poland	10	7	3	0.3%	-7	-71%	-4	-59%
Portugal	49	23	74	9.0%	25	50%	51	220%
Romania	0.1	0.4	0.4	0.0%	0.2	168%	0.00	0%
Slovakia	7	15	13	1.5%	6	89%	-3	-17%
Slovenia	1	0.2	1	0.1%	-0.2	-23%	1	398%
Spain	285	167	149	18.1%	-136	-48%	-18	-11%
Sweden	0.2	0.1	0.3	0.0%	0.1	49%	0.1	83%
United Kingdom	14	14	25	3.1%	11	77%	11	77%
EU-28	**1 249**	**748**	**822**	**100%**	**-427**	**-34%**	**74**	**10%**
Iceland	NE,NA	0.2	NO,NE,NA	-	-	-	-0.2	-100%
United Kingdom (KP)	14	14	25	3.1%	11	77%	11	77%
EU-28 + ISL	**1 249**	**748**	**822**	**100%**	**-427**	**-34%**	**74**	**10%**

6.2.7 Emissions from Harvested Wood Products in the EU GHG inventory

This carbon reservoir covers emissions and removals, resulting from carbon stock changes in harvested wood products (HWP), as a result of the annual carbon inflow to the pool (i.e. gains), and carbon outflow from the pool (i.e. losses).

According to the 2006 IPCC GL, HWP includes all wood material (including bark) that leaves harvest sites. Slash and other material left at harvest sites should be regarded as dead organic matter in the associated land use category and not as HWP.

Harvested wood products carbon pool represents at the level of EU MS and Iceland a net carbon sink of about -38.235 kt CO_2 in 2016 (Table 6. 39). Most of the countries reported this carbon pool as a net sink, however six MS estimated that HWP is a net source of emissions for the year 2016.

The main contributors to the carbon sink are Poland, Romania, Sweden, Finland and Germany, while larger emissions are reported by Belgium.

In line with the recommendations provided during the EU QA/QC checks, and with the information contained in the improvement plans of individual submissions, more MS have provided more accuracy and complete estimates for this carbon pool in recent submissions. For instance, Cyprus, Iceland and Poland, in the last case, estimates have significantly contributed to an increase in the sink reported at EU level.

The methods and data sources for estimating carbon stock changes in HWP are consistent with methodologies provided by 2006 IPCC GL.

Contrary to the information provided in previous submissions, and after the correction of some identified mistakes, individual inventories implemented the IPCC Approach B (i.e. production approach) to provide estimates on HWP consistently with the reporting of the carbon pool under the KP reporting. Nevertheless, and despite efforts implemented during the QA/QC checks Malta has misallocated the information reported on HWP in the CRF table Table4.Gs1 in the 2018 submission, although this has not impact at EU level since Malta does not produce harvested wood products.

MS reported carbon stock changes in HWP considering individual estimates for the semi-finished wood products categories of (i) Solid wood, disaggregated in Sawnwood and wood panels, and (ii) Paper and paperboard. To this aim, the IPCC default half-life values have been used by all MS in individual inventories.

In addition, some MS have stated that carbon stock changes in HWP are insignificant or that the poo, as considered under the Approach B, does not exist (e.g. Luxembourg, Malta).

By other hand, Belgium that currently report only HWP from 2000 onwards informed during the QA/QC checks that efforts are ongoing to increase the accuracy and consistency of the reporting of this pool covering the whole time series

With regards to the activity data, most of the MS have based their estimates on the information provided by the FAOSTAT database, the TIMBER database of the United Nations Economic Commission for Europe (UNECE, 2011), national statistics when available, or, in specific cases, on information collected by surveying wood industries.

Table 6. 39 Information on HWP as taken from EU MS and Iceland submissions for the year 2016.

Member State	Net CO_2 emissions (+) /removals (-) kt CO_2	GHG source and sink categories		Approach A	Approach B	Approach C
Austria	**-1041.85**	1. Solid wood	x		**x**	
		2. Paper and paperboard	x			
		3. Other (please specify)				
Belgium	**301.11**	1. Solid wood	x		**X**	
		2. Paper and paperboard	x			
		3. Other (please specify)	NO			
Bulgaria	**-544.01**	1. Solid wood	x		**x**	
		2. Paper and paperboard	x			
		3. Other (please specify)	NA,NO			
Croatia	**-763.42**	1. Solid wood	x		**x**	
		2. Paper and paperboard	x			
		3. Other (please specify)	NO			
Cyprus	**24.69**	1. Solid wood	x		**x**	

Member State	Net CO_2 emissions (+) /removals (-) kt CO_2	GHG source and sink categories		Approach A	Approach B	Approach C
		2. Paper and paperboard	NO			
		3. Other (please specify)	x			
		1. Solid wood	x			
Czech Republic	**-430.67**	2. Paper and paperboard	x		**x**	
		3. Other (please specify)	NA			
		1. Solid wood	x			
Denmark	**-173.90**	2. Paper and paperboard	x		**x**	
		3. Other (please specify)				
		1. Solid wood	x			
Estonia	**-1139.54**	2. Paper and paperboard	x		**x**	
		3. Other (please specify)	x			
		1. Solid wood	x			
Finland	**-3642.41**	2. Paper and paperboard	x		**x**	
		3. Other (please specify)	NA			
		1. Solid wood	x			
France	**-1562.86**	2. Paper and paperboard	x		**x**	
		3. Other (please specify)	NO			
		1. Solid wood	x			
Germany	**-2328.38**	2. Paper and paperboard	x		**x**	
		3. Other (please specify)	NO			
		1. Solid wood	x			
Greece	**68.47**	2. Paper and paperboard	x		**x**	
		3. Other (please specify)	NO			
		1. Solid wood	x			
Hungary	**-112.22**	2. Paper and paperboard	x		**x**	
		3. Other (please specify)	NA			
		1. Solid wood	x			
Ireland	**-799.52**	2. Paper and paperboard	x		**x**	
		3. Other (please specify)	NO			
		1. Solid wood	x			
Italia	**171.88**	2. Paper and paperboard	x		**x**	
		3. Other (please specify)	NO			
		1. Solid wood	x			
Latvia	**-2144.25**	2. Paper and paperboard	x		**x**	
		3. Other (please specify)	NO			
		1. Solid wood	x			
Lithuania	**-1043.37**	2. Paper and paperboard	x		**x**	
		3. Other (please specify)	NA			
		1. Solid wood	NO			
Luxembourg	**NO**	2. Paper and paperboard	NO		**x**	
		3. Other (please specify)	NO			
		1. Solid wood	NO			
Malta	**NO**	2. Paper and paperboard	NO		**x**	
		3. Other (please specify)	NO			

Member State	Net CO_2 emissions (+) /removals (-) kt CO_2	GHG source and sink categories		Approach A	Approach B	Approach C
Netherlands	**86.11**	1. Solid wood	x		**x**	
		2. Paper and paperboard	x			
		3. Other (please specify)	NA			
Poland	**-4234.53**	1. Solid wood	x		**x**	
		2. Paper and paperboard	x			
		3. Other (please specify)	NA			
Portugal	**-171.80**	1. Solid wood	x		**x**	
		2. Paper and paperboard	x			
		3. Other (please specify)	NO			
Romania	**-6576.32**	1. Solid wood	x		**x**	
		2. Paper and paperboard	x			
		3. Other (please specify)	NO			
Slovakia	**-1063.63**	1. Solid wood	x		**x**	
		2. Paper and paperboard	x			
		3. Other (please specify)	NO			
Slovenia	**-101.84**	1. Solid wood	x		**x**	
		2. Paper and paperboard	x			
		3. Other (please specify)	NA			
Spain	**-1941.53**	1. Solid wood	x		**x**	
		2. Paper and paperboard	x			
		3. Other (please specify)	NO			
Sweden	**-8226.46**	1. Solid wood	x		**x**	
		2. Paper and paperboard	x			
		3. Other (please specify)	NA			
United Kingdom	**-844.44**	1. Solid wood	x		**x**	
		2. Paper and paperboard	x			
		3. Other (please specify)	NO			
Iceland	**-0.07**	1. Solid wood	x		**x**	
		2. Paper and paperboard	NO			
		3. Other (please specify)	NO			

6.2.8 Emissions from organic soils in the EU GHG inventory

At the level of the EU MS and Iceland, organic soils reported under the three main land use categories (i.e. Forest land, Cropland and Grassland) cover about 18.495 kha that are mainly located in northern countries.

Total CO_2 emissions linked to that area in 2016, reached 97.235 kt CO_2 which represents about 30% of total EU net removals from LULUCF (Table 6. 40). Emissions from organic soils in these land categories decreased as compared with 1990. Finland and Sweden report together more than half of the total area of organic soil in these categories.

Organic soils are an important source of emissions when they are under management practices that disturb the organic matter stored in the soil. In general, emissions from these soils are reported using country-specific values when they represent an important source within the total budget of GHG emissions. In contrast, MS with small areas of organic soil often use default IPCC factors to report emissions from this carbon pool.

Overall, among these 3 main land use categories, most of the organic soils area is reported under Forest land, however most of the emissions are due to managed organic soils in Grasslands and Croplands (Table 6. 40).

In Finland, organic soils areas were derived from NFI database and geo-referenced soil database across all land uses. In Sweden, data is also provided by NFI combined with Swedish Forest Soil Inventory. Emission factors are derived based on field measurements from systematic monitoring system.

Organic soils in Forest land show the lowest values of implied emission factors due to the fact that not the entire area of organic soils under forest land is drained. Positive values of implied emission factor (i.e. removals) under forest organic soils correspond to UK that reports a net sink in this pool by using CARBINE model.

Table 6. 40 Area, CO_2 emissions and average implied C stock change factors in the EU MS and Iceland reported for the year 2016 for organic soils.

Land use subcategory	Area (Kha)	ICECF (tC/ha)	CO_2 emissions (Kt CO_2)
4A1	12019	[-2.60; 0.88]	12843
4A2	391		1244
4B1	1679	[-10.00; -1.18]	28892
4B2	303		5526
4C1	3906	[-6.74; 0.25]	45366
4C2	197		3364

6.3 Uncertainties

For the year 2016, LULUCF uncertainty was estimated in 32.36% for the uncertainty of the level and 19.0 % for the uncertainty of the trend (Table 6. 41).

For more information on the uncertainty analysis please refer to chapter 1.6.

Table 6. 41 Level and trend uncertainty assessment of the annual EU-28 emission/removal on LULUCF land subcategories and GHG sources.

Source category	Gas	Emissions Base Year	Emissions 2016	Emission trends Base Year-2016	Level uncertainty estimates based on MS uncertainty estimates	Trend uncertainty estimates based on MS uncertainty estimates
4.A Forest Land	CO2	-365 749	-405 577	10.9%	19.6%	0.1%
4.A Forest Land	CH4	2 116	1 856	-12.3%	69.0%	0.1%
4.A Forest Land	N2O	2 830	2 447	-13.5%	84.8%	0.1%
4.B Cropland	CO2	71 732	61 143	-14.8%	47.5%	0.1%
4.B Cropland	CH4	514	498	-3.2%	126.9%	0.2%
4.B Cropland	N2O	3 759	3 187	-15.2%	116.1%	0.1%
4.C Grasland	CO2	23 094	5 475	-76.3%	373.6%	0.8%
4.C Grasland	CH4	1 680	939	-44.1%	148.5%	0.4%
4.C Grasland	N2O	738	344	-53.4%	117.7%	0.3%
4.D Wetlands	CO2	14 872	15 698	5.6%	57.1%	0.1%
4.D Wetlands	CH4	1 929	1 552	-19.5%	59.1%	0.1%
4.D Wetlands	N2O	2 276	1 923	-15.5%	42.9%	0.1%
4.E Settlements	CO2	28 343	41 993	48.2%	50.1%	0.1%
4.E Settlements	CH4	78	113	44.3%	96.4%	0.4%
4.E Settlements	N2O	5 739	4 912	-14.4%	67.4%	0.3%
4.F Other Land	CO2	2 817	460	-83.7%	721.0%	1.9%
4.F Other Land	CH4	141	212	49.7%	29.3%	0.1%
4.F Other Land	N2O	535	1 246	132.8%	31.4%	0.4%
4.G Harvested wood products	CO2	-27 851	-27 897	0.2%	42.4%	0.2%
4.G Harvested wood products	CH4	0	0		0.0%	
4.G Harvested wood products	N2O	0	0		0.0%	
4.H Other	CO2	0	69		30.4%	
4.H Other	CH4	0	220		100.0%	
4.H Other	N2O	493	516	4.5%	93.4%	0.0%
4.I	CO2	0	0		0.0%	0.0%
4.I	CH4	0	0		0.0%	0.0%
4.I	N2O	21	17	-15.9%	206.7%	0.3%
4.II	CO2	1 933	1 679	-13.2%	74.6%	0.1%
4.II	CH4	1 549	979	-36.8%	139.5%	0.6%
4.II	N2O	1 284	1 277	-0.6%	140.8%	0.0%
4.III	CO2	0	0		0.0%	0.0%
4.III	CH4	0	0		0.0%	0.0%
4.III	N2O	140	273	94.6%	733.0%	5.4%
4.IV	CO2	0	0		0.0%	0.0%
4.IV	CH4	0	0		0.0%	0.0%
4.IV	N2O	3 697	3 746	1.3%	44.4%	0.1%
4.V	CO2	13	68	429.5%	38.4%	1.6%
4.V	CH4	7	10	36.3%	38.5%	0.6%
4.V	N2O	2	7	268.5%	37.6%	1.2%
4 (werhe no subsector data were submitted)	*all*	*217*	*650*	200.3%	*55.9%*	*151.2%*
Total - 4	**all**	**-221 048**	**-279 966**	**26.7%**	**32.6%**	**19.0%**

6.4 Sector-specific quality assurance and quality control and verification

6.4.1 Time series consistency

The EU greenhouse gas inventory is compiled by aggregation of national GHG inventories, thus, its consistency strictly depends on the consistency of MS and Iceland inventories.

The time-series consistency is annually checked for every individual submission as part of quality control procedures implemented under the EU GHG Monitoring Mechanism Regulation[64]. Consistency is checked, in terms of land use category definitions and land representation across time and over space (e.g. the sum of all land use areas should be constant over time and match the official country area, and be consistent with related KP information), as well as trends and outliers in emissions and areas (i.e. reasons for potential outliers of implied carbon stock changes factors).

[64] http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32013R0525

MS provide early submissions to the European Commission that is in charge to implement a set of quality checks and to provide suggestions on how to resolve any detected potential problem.

One of the key features of the methodologies implemented by national systems is to ensure full consistency in definitions, parameters and datasets used for preparing the entire time series for the LULUCF sector. The main challenge is to ensure consistency when historical data used are not fully adequate to the reporting requirements or they do not provide data for every year of the time series.

Land use definitions are not fully consistent across the MS (i.e. in the sense of identical quantitative thresholds), but they are mainly consistent with IPCC definitions. Differences are given by slightly different treatment of particular lands (e.g. different thresholds for forest definitions; hedges or bush areas categorized either under the Cropland, Grassland or Forest land; woody plantations either under Cropland or Forest land), which is mainly related to historical definitions and available databases.

Following the improvements made within the national systems over recent years, in 2018 submissions there were very small inconsistencies in the time series of activity data and land allocation on land sub-categories (e.g. against country's official geographical area). Such small differences are justified as due to data updating and to the mapping systems (e.g. measurement errors, increase of land area or coastal erosion). In general, the total land reported under UNFCCC varies by less than 1% from the official geographical area, so the risks that some significant emissions have not been counted are very small.

6.4.2 Quality Assurance and Quality control

Information submitted under the LULUCF sector by EU MS and Iceland are under double QA/QC systems: one at the country level, and another one, carried out in the context of the EU GHG Monitoring Mechanism Regulation, performed at EU level by the Joint Research Centre of the European Commission in collaboration with MS and Iceland.

At the EU level, the first and main activity is the annual checking of early versions of national GHG inventories that are submitted in January. The checks focus on completeness, accuracy, and transparency, and they are intended to identify and resolve calculation errors and time-series consistency issues. QA/QC procedures are implemented by interacting with national experts to get clarifications and to plan possible improvements. During the analysis of the 2018 submissions, around 200 findings (i.e. potential issues) were communicated to the MS and Iceland on, for instance, the use and justifications of notations keys, potential inconsistencies in land representation, wrong interpretation on how to fill in some tables, inconsistent reporting of activity data among CRF tables and between CRF tables and NIR, outliers in IEFs values for all categories, and lack of transparency for specific national circumstances that affected the EU trend.

Specifically, completeness and consistency checks are applied to time-series of estimates reported under Convention and under KP. The following list provides some examples of the checks that are implemented, but it does not intend to represent an exhaustive list:

1. Completeness check: the use of the any notation key "NE", but also possible inappropriate use of "NA" or "NO", whenever IPCC methods are available, is carefully monitored and followed up where necessary with the relevant MS;
2. Checks of time-series of activity data for both KP and UNFCCC information
    a. Total reported land area against official data from national authorities and international databases (i.e. country's official websites, FRA 2010 (FAO));
    b. Discontinuities in time series for any land subcategory and subdivisions;
    c. The share of the land category "Other land" on the total area reported;
    d. Consistency among areas reported under the KP and UNFCCC.
3. Checks of the time-series of emissions factors (for each land subcategory and subdivision, and each carbon pool)

a. Comparison of IEF with IPCC default factors;
b. Discontinuities in IEFs along the time series;
c. Comparison of IEF among MS, taking into consideration of eco-regions, soil type and method used for each country, and any information provided in the latest NIR, including the definition of the pool;
d. Comparison with other data sources (country's official submission under other international processes, e.g. FAO);
e. Comparison of CO_2 and N_2O emissions to check consistency of C/N ratio

4. Check the consistency within annual submissions
    a. Between GHG inventory tables; e.g. activity data for the estimation of N_2O emissions from mineral soils in land under conversion from Forest land and Grassland to Cropland.
    b. Among LULUCF and Agriculture (e.g. Histosols areas reported among sectors)
5. Check the consistency between KP and GHG inventory tables (land area between UNFCCC and KP: 4A2 with AR; sum of area of 4B2.1; 4C2.1; 4D2.1; 4E2.1; 4D2.1 with D; 4A1 with FM).
6. Consistency within KP and UNFCCC tables
    a. Area reported under activity tables matches NIR-2;
    b. NIR-2 is consistent across years (i.e. is ARD area increasing or constant over the commitment period? Is CM, GM area change explained by transfers to other elected 3.4 activities? Is the final area reported for an activity in the year X equal to the initial area reported for the same activity in the year X+1?);
    c. For each category, data reported in CRF table 4.1 is identical to data reported in the background tables. **To note**: Despite this check and the recomedation received for the EU'ERT, following a recommendation from the 2016 ERT, Estonia is not reporting unmanaged wetlands under "other wetlands" in the CRF table 4.D however those areas were included in CRF 4.1. This leads to an inconsistency among the information of these tables that is directly affecting LULUCF sector of the EU GHG inventory.
    d. For KP CRF 1990 data relevant for net-net accounting of elected activities are provided.
7. Consistency with the 2006 IPCC GL, ERT recommendations and reporting requirements set under decision 2/CMP7.
    a. Is a key category? If so, is a higher tier implemented?
    b. Pools omitted from accounting under the KP: is documentation provided demonstrating that the pool is "not a source"?
    c. Transparency and documentation: description of data sources, methods, assumptions, inferences used.
    d. Are reported values supported by adequate information on uncertainties?
    e. Are rationales, methodological changes and quantitative effects of recalculations explained in the NIR?
8. Accounting tables: check of the CRF reporting tool settings

Additional activities at EU level are meant to improve reporting and the quality of both national GHG inventories of the MS and Iceland, and EU, as follows:

- Starting 2010, the EU has implemented an internal review, as an annual exercise, which focuses on key LULUCF issues identified mainly in conjunction with reporting under Kyoto Protocol. The exercise is led by the JRC and involves LULUCF reviewers also involved in the UNFCCC review process. For example, in 2012 the exercise focused on reporting DW, LT and SOC. In 2013 the following issues were analyzed: "providing transparent demonstration and justification that a pool is not a source" and "methods used by MS to estimate emissions from DOM and SOM in Forest land converted to Settlements". In 2014 and 2015 assessments were carried out to verify data on burned areas reported by MS in their GHG inventories and those reported in EFFIS[65].

- Efforts for improving and harmonizing MS inventories, in close cooperation with the research community. Examples include:
    - Two support-projects for improved reporting by some MS are implemented by the European Commission;
    - Starting in 2010, the implementation of the “JRC decision trees on notation keys”: a) Use of notations keys for C POOLS - Tables 4(KP-I) of mandatory or elected activities and b) Use of notations keys for GHG sources- Tables 4(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 checks by EU, both for reporting under the Convention and Kyoto Protocol.
- For the purpose of enhancing reporting, sharing experiences amongst MS, and also for the harmonization of methods for estimation of the sector, 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 reporting under the Kyoto Protocol, 16-17 May 2018 Arona (Italy), Italy
    - JRC technical workshop on LULUCF reporting under the Kyoto Protocol, 26-27 April 2017 Stresa (Italy), Italy
    - JRC technical workshop on LULUCF reporting under the Kyoto Protocol, 02-03 May 2016 Stresa (Italy), Italy.
    - JRC technical workshop on LULUCF reporting under the Kyoto Protocol, 26-27 May 2015 Arona (NO), Italy.
    - JRC technical workshop on LULUCF reporting under the Kyoto Protocol, 05-07 May 2014, Arona (NO), Italy.
    - II JRC technical workshop on LULUCF reporting under the Kyoto Protocol, 04-06 November 2013, Arona (NO), Italy.
    - JRC technical workshop on LULUCF reporting under the Kyoto Protocol, 27 February-1 March 2013, Ispra (VA), Italy.
    - “JRC technical workshop on LULUCF issues under the Kyoto Protocol”, held in Brussels, November 21, 2011.
    - “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 (VA), Italy. 27-28 January 2010.
    - Technical workshop on LULUCF reporting issues under the Kyoto Protocol, Ispra (VA), Italy. November 13-14, 2008.
    - “Technical meeting on specific forestry issues related to reporting and accounting under the Kyoto Protocol” Ispra (VA), Italy. 27-29 November 2006).
    - “Improving the Quality of Community GHG Inventories and Projections for the LULUCF Sector”. Ispra (VA), Italy. September 22-23, 2005.

For further information on these workshops, and additional activities see: http://forest.jrc.ec.europa.eu/activities/lulucf/workshops/.

6.4.3 Verification

Relatively little information on verification is included in national GHG inventories. For forest land, the JRC has implemented the Carbon Budget Model (CBM), a forest growth model developed by the

[65] http://forest.jrc.ec.europa.eu/effis/

Canadian Forest Service and adapted to the EU conditions (Pilli et al. 2014[66], Pilli et al. 2016[67],[68]), to estimate carbon stock changes in all forest carbon pools for 26 MS (all countries except Malta and Cyprus). Overall, at EU level, the results from CBM were very close to the sum of individual inventories (a difference of only 3% for the average sink 2000-2015 in the category "forest land remaining forest land"). However, for few MS the differences were larger and deserve further investigations. The results of this modeling have been offered to MS as a potential verification exercise (see Bulgaria' NIR); in some cases the comparison of model results with GHG inventories resulted in identifying errors in the GHG inventory. It is expected that more comparisons of national GHG inventories with CBM results will be carried out in coming years. Another exercise on comparison was implemented by the EU JRC for biomass burning data[69], carrying out a comparison of the data reported by some MS with the data provided by the European Forest Fire Information system.

Besides that, a comprehensive analysis of MS submissions has been also carried out in 2015[70]. In this context, some inconsistencies were found that were communicated to concerned MS during the 2016 QA/QC process.

Finally, the JRC recommended to national LULUCF experts to verify, where available data allow, the gain-loss methodology applied for estimating their forest land with an alternative estimate prepared by applying the stock-difference method, and vice versa.

6.4.4 Improvement status and plan

Improvements and major changes from previous submissions

The following improvements were introduced to addresses the recommendations from the EU GHG inventory ERT; to correct issues identified during our internal QA/QC process and/or the results of our internal peer review:

- More references have been introduced to the work carried out along with MS to address identified issues. For instance, as requested by the ERT, to clarify that former issue identified in the Italy's GHG under 4A.2.1 is now solved.
- More descriptions were added to better explain the overall trend and internal variability of the EU across land use categories.
- The overall completeness of the sector has been increased. For instance, this year Cyprus has reported estimates of emissions and removals previously reported as NE (e.g. HWP or 4B.2). France has also included estimates for living biomass under the subcategory 4.B.1.
- More detailed explanations have been included across the sector to explain the underlying reasons for the use of the notation key NE.
- Correction of identified typo errors introduced across the text for dates, activity data and emissions.

[66] Pilli R., Grassi G., Kurz W.A., Smyth C.E. and Blujdea V. (2013). Application of the CBM-CFS model to estimate Italy's forest carbon budget, 1995 to 2020. Ecological modeling. 266, 144-171.

[67] Pilli, R., Grassi, G., Kurz, W., Abad Viñas, R., Guerrero Hue, N. (2016) Modelling forest carbon stock changes as affected by harvest and natural disturbances. I. Comparison with countries' estimates for forest management. Carbon Balance and Management vol. 11 no. 1 p. 5. doi: 10.1186/s13021-016-0047-8

[68] Pilli, R., Grassi, G., Kurz, W., Moris, J., Abad Viñas, R. (2016) Modelling forest carbon stock changes as affected by harvest and natural disturbances. II. EU-level analysis Carbon Balance and Management vol. 11 no. 1 p. 20. doi:10.1186/s13021-016-0059-4

[69] Abad Viñas, R., San-Miguel-Ayanz, J., Grassi, G. (2015) Reporting of Biomass Burning under the LULUCF sector. Comparative assessment of data reported under the UNFCCC and EFFIS. EUR 27170 EN. Luxembourg: Publications Office of the European Union, 2015. JRC95415.

[70] Viorel NB Blujdea, Raúl Abad Viñas, Sandro Federici & Giacomo Grassi (2016): The EU greenhouse gas inventory for the LULUCF sector: I. Overview and comparative analysis of methods used by EU member states, Carbon Management, DOI: 10.1080/17583004.2016.1151504

- Correction of some of the inconsistencies identified across the activity data reported in CRF tables 4.1 and 4.A-4.F.
- Updated of the definitions used by MS for their land use categories have been included.
- More completed and accurate estimations for HWP.
- New section with overall information for non-key categories.

Planned improvements

The following improvements are foreseen for next submission:

- Implementation of corrections for “unresolved” issues identified during the QA/QC checks that for differences reasons could not be implemented this year.
- Further addition of sector-specific checks that could not be performed in the current submission.
- Further analysis of the EU trends and incorporation of better descriptions across the sections.
- Enhance the harmonization of the use of notation keys for the implementation of the IPCC assumption of equilibrium, under Tier 1 methods.
- Work with Luxembourg in order to increase the consistency of the reporting of dead wood along the time series.

6.5 Sector-specific recalculations, including changes in response of to the review process and impact on emission trend

Table 6. 42 to Table 6. 47 provide information on the contribution of Member States to EU-28+ISL recalculations in sectors 4A, 4B, 4C, 4D, 4E and 4F (all GHGs) for 1990 and 2015 and main explanations for the largest recalculations in absolute terms.

Table 6. 42 4A Forest Land: Contribution of MS to EU-28+ISL Recalculations in CO_2 for 1990 and 2015 (difference between latest submission and previous submissions in kt CO_2 and percent)

	1990		2015		Main explanations
	kt CO_2.	%	kt CO_2	%	
Austria	-	-	-	-	
Belgium	421	14.3	988	23.6	Flanders : First application of the stock-difference approach, using the second cycle of the forest inventory. Wallonia : Discrepancies between final area in table 4-1 and total area in tables 4.A to 4F were corrected (recalculation of the areas for land remaining in the same category). Carbon stocks in forest were updated according to the latest regional forest inventory data. These recalculations bring a significant decrease of the forest management sink in the recent years and a limited decrease of the emissions from deforestation.
Bulgaria	-	-	-	-	
Croatia	10	0.1	149	2.7	Areas of Forest land remaining forest land and lands converted to and from forest land are reported according to results of conducted survey through LULUCF 1 project.
Cyprus	5	5.3	-154	-91.4	Change of BCEFI (biomass conversion and expansion factor for increment). Use of interpolated and extrapolated data to cover the entire period 1990 to the reported year instead of using an average (for the entire period. Use of corrected data for area of land remaining in Forest Land category and converted to Forest Land category. The correction reflects the implementation of the rule of 20-year transition period to Forest Land.
Czech Republic	-164	-3.3	121	2.0	Updated activity data, revised inputs. Since the last submission, the emission estimates were recalculated for the entire category and reporting period.
Denmark	-	-	-	-	
Estonia	-195	-6.5	-512	-20.7	The entire time series of activity data is annually recalculated for all areas of land categories and land-use conversions, since new data about land-use transitions is collected every year and new estimates will be integrated into overall activity data. Soil emission factors were updated for Land remaining forest land.
Finland	41	0.2	-2 546	-7.1	New area estimates were calculated due to the updating of NFI data. New NFI data was implemented in the biomass estimations. The new AD estimates induced the recalculations of time series for gains and losses in living tree biomass as well as carbon stock changes in DOM and SOM pools.
France	-1 091	-2.8	-6 883	-12.7	4A1: Increases are modified over the last years due to the new method of extrapolation of IGN data (associated with an update of the last campaign). Samples are modified over the entire series because of changes in closure coefficients (in connection with the new IGN campaign) and the updating of wood energy consumption over the last few years. 4A2: All forest soils are assumed to be mineral and the French organic soils are only in grassland and cultivation. Update of growth factors and mortality over the last years due to the update of the IGN.
Germany	-	-	-0	-0.0	
Greece	-3	-0.3	79	3.5	Complete reconstruction of the land use, land-use change matrices for the period 1990 –2016. Inclusion in the NIR of a complete set of both annual and 20-years land use, land-use change matrices for the period 1990 – 2016 following previous ERT's recommendation.

	1990		2015		Main explanations
	kt CO_2.	%	kt CO_2	%	
					Update of the Forest Management Plans database.
Hungary	149	4.3	470	8.0	Net carbon stock change in deadwood on land converted to forest land, net carbon stock change in litter on wetland converted to forestland and the indirect N_2O emmissions from leaching and run off relating to N mineralization associated with loss of SOM are reported for the first time.
Ireland	-	-	-5	-0.1	The NFI data for 2012 allowed the recalculation of forest areas for 2006 to 2012.
Italy	217	1.2	888	2.2	Update of activity data
Latvia	-2 979	-19.8	553	18.3	Recalculations are done due to recalculation of the NFI data based on repeated measurement of borders of the plots and their sectors, implementation of updated NFI data on carbon stock changes in living biomass, implementation of more accurate and research based estimates of land area of category Forest Land coverted to other land use category, implementation of country specific emission factor for carbon losses from drained organic forest soils.
Lithuania	25	0.3	224	2.5	Recalculations were done due to several national carbon stock values applied for 2018 submission. National carbon stock values in forest litter, forest land remaining forest land mineral soils, land converted to forest land mineral soils and litter were applied, which resulted in recalculations of categories: 4.A.1 Wildfires, 4.A.2 Land converted to forest land carbon stock change (litter and mineral soils), 4.A.2 Wildfires. For more information see NIR Chapter 6.2.2 and Annex VIII).
Luxembourg	-	-	-0	-0.0	Minor recalculations
Malta	-	-	-	-	
Netherlands	99	5.2	201	8.3	New method for TOF, orchards and dead wood. This year a subcategory 'Trees outside Forest" (TOF) has been introduced under Grassland. TOF constitutes of units of land with trees that do not meet the minimum area requirement for the forest definition.
Poland	-52	-0.2	-65	-0.2	Factors related adjustment of carbon stocks calculation in category 4.A. Update of data on mineral soil share on forest land.
Portugal	-610	-10.7	0	0.0	
Romania	-	-	2 641	10.4	CO_2 emissions were recalculated for 2015 year taking into account the updated AD
Slovakia	-325	-3.9	105	2.1	Change of biomass expansion factor for increment (BEFI) and values of below-ground biomass to above-ground biomass ratio (R).
Slovenia	332	7.4	809	13.7	New data on loss in living biomass, updated EFs for soil. Emissions was recalculated due to consideration of relatively high variation in EF for some periods recognized during the 2016 revision
Spain	-11 919	-50.9	-452	-1.2	Incorporation of the provisional estimate of land use areas and changes in land use for the period 1970-1989, based on the available statistics. Elimination of transition from forest land to non-herbaceous grassland.
Sweden	1 249	3.1	6 196	12.8	Recalculations due to updated estimates of litter and mineral soils (areas and emission factors) and drained organic soils (areas). Living biomass and areas due to updated samples affecting the extrapolation estimates for 2014, and 2015.
United Kingdom	-6 905	-65.7	-8 218	-51.5	Improvements to forest area activity data and revisions to the CARBINE model for calculating forest carbon stock change.

	1990		2015		Main explanations
	kt CO_2.	%	kt CO_2	%	
EU28	-21 697	-5.7	-5 410	-1.3	
Iceland	-0	-0.9	25	7.3	Areas for all years are recalculated annually for cultivated forest with updated information from systematic sampling plots sampled in the summer of 2017. Area depended GHG-fluxes will change in same manner. In addition, biomass C-stock changes are recalculated for the year 2015 with mid-year approach where new C-stock change data from the 2017 data sampling in cultivated forest are added (See the Icelandic NIR Chapter 6.4 for further explanation of mid-year approach).
United Kingdom (KP)	-6 905	-65.5	-8 218	-51.4	Improvements to forest area activity data and revisions to the CARBINE model for calculating forest carbon stock change.
EU28+ISL	-21 697	-5.7	-5 385	-1.3	

Table 6. 43 4B Cropland: Contribution of MS to EU-28+ISL Recalculations in CO_2 for 1990 and 2015 (difference between latest submission and previous submissions in kt CO_2 and percent)

	1990		2015		Main explanations
	kt CO_2.	%	kt CO_2	%	
Austria	27	18.4	42	128.2	The estimate of the (shares of) conversions between annual cropland, perennial cropland and grassland on basis of the IACS system was slightly changed. The measurements of country specific orchard biomass and vineyard biomass were completed and the significantly too high default values of perennial biomass growth rates, stocks and turn-over periods were replaced by these country specific values. The assessment of the soil C stock changes in cropland remaining cropland was further improved.
Belgium	-2	-1.0	-2	-0.2	Flanders area: land converted to cropland: recalculations for deforestation for the entire time series due to use of the carbon stock change method
Bulgaria	0	0.0	0	0.0	
Croatia	31	16.3	26	21.5	Revision of activity data on land areas based on newly delivered CLC data for year 1990, as well as the new data on land use changes from specially designed CLC 1990-2006 change databases, accordingly
Cyprus	-138	100.0	-161	100.0	Not applicable (the results of calculations are reported for the first time)
Czech Republic	93	82.9	127	41 272.8	Updated activity data, revised inputs. Since the last submission, the emission estimates have been recalculated following the suggestions of the latest review (L.15) and on the initiative of the inventory team.
Denmark	-111	-2.5	72	2.8	Recalculations have been made due to the new version of C-TOOL and a new methodology to distribute the animal manure and the area with catch crops has been implemented to better evaluate the modelled outcome with the in-dependent soil sampling. No changes in the input to C-TOOL were made.
Estonia	393	389.0	520	434.1	New methodology and emission factors were applied for calculating C stock changes in mineral soils. In addition, emission factor from Sweden was used for organic soils instead of IPCC default value and calculation errors were corrected.
Finland	9	0.2	351	5.3	New area estimates were calculated due to the updating of NFI data.
France	602	2.9	826	5.2	4B1: Addition of organic soil surfaces. Change in carbon fluxes due to the one-year extension of changes in management practices (since 1989 and not 1990) 4B Emissions Removal: Addition of diretc and indirect CO_2 emissions related to organic soils
Germany	0	0.0	0	0.0	
Greece	52	6.5	-879	-306.3	Complete reconstruction of the land use, land-use change matrices for the period 1990 –2016. Inclusion in the NIR of a complete set of both annual and 20-years land use, land-use change matrices for the period 1990 – 2016 following previous ERT's recommendation. Update of croplands area in 2015 in accordance with the final 2015 HELSTAT report.
Hungary	0	0.1	0	0.2	Direct N_2O emissions for CL-CL: we changed the C/N ratio from 15 to 10 to all subcategories in order to be consistent in the entire CL-CL area; Indirect N_2O emissions from leaching and run off related to N mineralization associated with loss of SOM
Ireland	-42	-161.7	-38	-71.6	The recalculations in 4.B Cropland relate to the refinement of LPIS data. This has led to recalculation of emissions and removals for all years in the reporting period.
Italy	0	0.0	0	0.0	

	1990		2015		Main explanations
	kt CO_2.	%	kt CO_2	%	
Latvia	167	5.1	-792	-27.3	Recalculations are done due to recalculation of the NFI data based on repeated measurement of borders of the plots and their sectors, implementation of updated NFI data on carbon stock changes in living biomass, implementation of more accurate and research based estimates of land area of category Forest Land coverted to other land use category, implementation of updated data of area of organic soils.
Lithuania	-2 299	-43.8	-1 230	-30.1	Recalculations were done due to national carbon stock values in mineral soils applied (national carbon stock values in mineral soils of cropland and grassland). Recalculations were done in categories 4.B.1 Cropland remaining cropland carbon stock change (mineral soils), 4.B.2 Land converted to cropland carbon stock change (mineral soils). For more information see NIR Chapter 6.3.2 and Annex VIII). Several recalculations were done due to the errors found in previous calculation. These includes recalculations of carbon stock changes in biomass in land converted to cropland (category 4.B.Land converted to cropland carbon stock changes). Recalculations were also done due to the updated organic soil share in cropland and grassland categories (4.B.1 Carbon stock changes (organic soils); 4.B.2 Carbon stock changes (organic soils).
Luxembourg	0	0.0	-2	-5.9	Revision of activity data.
Malta	0	-0.1	0	2.3	Recalculation has been carried out from the previous submission of 2017, due to a minor human error during the entry of the values in the working spreadsheet.
Netherlands	10	0.6	21	0.8	Reported carbon stock losses in biomass in this category were recalculated for the whole time series due to the methodological changes
Poland	32	3.1	359	99.1	Update of LUC matrix; ccorrection of EF for organic soils emssions
Portugal	0	0.0	0	0.0	
Romania	0	0.0	24	1.1	CO_2 emissions were recalculated for 2015 year taking into account the updated AD
Slovakia	-244	-50.0	-211	-25.4	4.B.1 - Disaggregation of the category into annual cropland converted to perennial woody cropland and perennial woody cropland converted to annual cropland. 4.B.2 - Recalculated values of carbon stock change in living biomass, corrected values of carbon fraction of dry matter for broadleaved forests.
Slovenia	107	127.0	26	16.9	The carbon stock value in orchards and vineyards was reconsidered, which resulted in updated EF and recalculations.
Spain	199	20.5	-295	-11.8	Incorporation of the provisional estimate of land use areas and changes in land use for the period 1970-1989, based on the available statistics. Incorporation of the estimation of emissions associated with the fires that have occurred on cropland.
Sweden	-16	-0.5	156	35.7	Recalculations due to updated estimates of litter and mineral soils (areas and emission factors) and drained organic soils (areas). Living biomass and areas due to updated samples affecting the extrapolation estimates for 2014, and 2015.
United Kingdom	-89	-0.6	-173	-1.5	Minor consistency improvements in the methodology for calculating carbon stock change from cropland management activities and updates to deforestation activity data.
EU28	-1 220	-1.6	-1 232	-2.0	
Iceland	-39	-2.0	-42	-2.5	C-stock changes of mineral soil calcualted for the first time

	1990		2015		Main explanations
	kt CO_2.	%	kt CO_2	%	
United Kingdom (KP)	-89	-0.6	-165	-1.4	Minor consistency improvements in the methodology for calculating carbon stock change from cropland management activities and updates to deforestation activity data.
EU28+ISL	-1 260	-1.6	-1 266	-2.0	

Table 6. 44 4C Grassland: Contribution of MS to EU-28+ISL Recalculations in CO_2 for 1990 and 2015 (difference between latest submission and previous submissions in kt CO_2 and percent)

	1990		2015		Main explanations
	kt CO_2.	%	kt CO_2	%	
Austria	-1	-0.2	-23	-6.1	The estimate of the (shares of) land-use changes between annual cropland, perennial cropland and grassland on basis of the IACS system was slightly changed. The 2014 and 2015 values of the grassland areas had to be updated according to the most recent agricultural statistics.
Belgium	-16	-4.7	-36	-8.6	Flanders: new calculations using carbon stock change method (forest land converted to grassland), new value soil C settlements (settlements converted to grassland)
Bulgaria	-	-	-	-	
Croatia	-25	-32.9	-39	-49.9	Correction of activity data on land areas based on delivered CLC data for year 1990, as well as the data on land use changes from specially designed CLC 1990-2006 change databases, accordingly.
Cyprus	-134	100.0	-124	100.0	Not applicable (the results of calculations are reported for the first time)
Czech Republic	49	33.4	192	34.9	Updated activity data, revised inputs. Since the last submission, the emission estimates have been recalculated following the suggestions of the latest review.
Denmark	0	0.0	-0	-0.0	
Estonia	-9	-15.5	-7	-18.1	Higher BCEFS value for living biomass carbon stock calculations was used and the estimation of C stock changes in living biomass under Land converted to grassland subcategory was corrected. New country-specific emission factors were developed for mineral soils, and organic soil emission factor from Sweden was updated.
Finland	-	-	-4	-0.6	New area estimates were calculated due to the updating of NFI data.
France	218	1.5	218	2.0	4C1: Addition of organic soils areas in grassland. 4C Addition of direct and indirect CO_2 emissions and CH_4 on grassland organic soils.
Germany	0	0.0	-0	-0.0	
Greece	-0	-2.4	155	11.2	Complete reconstruction of the land use, land-use change matrices for the period 1990 –2016. Inclusion in the NIR of a complete set of both annual and 20-years land use, land-use change matrices for the period 1990 – 2016 following previous ERT's recommendation.
Hungary	0	0.3	-28	-14.0	There was a methodological change in category 4.C.2.1 FLtoGL in DOM pool
Ireland	292	4.1	1 176	20.7	Recalculations to emissions and removals in the Grassland category in this submission are due to revised assessment of land area statistics and management practices. This has lead to a revised assessment of the area of organic soils under grassland which require drainage.
Italy	19	0.5	2	0.0	Update of activity data and errors corrections.

	1990		2015		Main explanations
	kt CO_2.	%	kt CO_2	%	
Latvia	1 053	116.9	823	272.7	Recalculations are done due to recalculation of the NFI data based on repeated measurement of borders of the plots and their sectors, implementation of updated NFI data on carbon stock changes in living biomass, implementation of more accurate and research based estimates of land area of category forest land coverted to other land use category, implementation of updated data of area of organic soils, implementation of results of study on carbon stock in mineral soils in cropland and grassland (in submission 2018, carbon stock changes in mineral soils in cropland converted to grassland are reported as NA).
Lithuania	1 044	58.7	1 676	68.1	Recalculations were done due to national carbon stock values in mineral soils applied (national carbon stock values in mineral soils of cropland and grassland). Recalculations were done in category 4.C.2 Land converted to grassland carbon stock change (mineral soils). For more information see NIR Chapter 6.3.2 and Annex VIII). Several recalculations were done due to the errors found in previous calculation. These include recalculations of carbon stock changes in biomass in land converted to grassland (category 4.C.2 Land converted to grassland carbon stock changes). Recalculations were also done due to the updated organic soil share in cropland and grassland categories (4.C.1 Carbon stock changes (organic soils); 4.C.2 Carbon stock changes (organic soils).
Luxembourg	-	-	1	1.6	Revision of activity data.
Malta	0	0.0	0	0.2	Minor recalculations
Netherlands	-95	-1.7	-215	-4.9	New method for TOF, orchards and dead wood. This year a subcategory ‘Trees outside Forest” (TOF) has been introduced under Grassland. TOF constitutes of units of land with trees that do not meet the minimum area requirement for the forest definition.
Poland	2	0.3	-77	-14.2	Update of LUC matrix; correction of EF for organic soils emssions
Portugal	-	-	-	-	
Romania	-	-	-69	-34.3	CO_2 emissions were recalculated for 2015 year taking into account the updated AD
Slovakia	-2	-1.0	-0	-0.0	Recalculated values of carbon stock change in living biomass, corrected values of carbon fraction of dry matter for broadleaved forests.
Slovenia	-153	-55.5	-91	-73.3	Emissions were recalculated due to inclusion of new data on biomass growth obtained from SORS as well as biomass growth after conversion to perennial grassland, which improved EFs. In the NIR 2018 soil carbon stock values were updated, excluding forest land, based on data from soil monitoring, carried out on agricultural land (Mali et al., 2016, Mali et al., 2017).
Spain	-2 944	-1 263.6	-1 778	-125.4	Incorporation of the provisional estimate of land use areas and changes in land use for the period 1970-1989, based on the available statistics. Elimination of transition from forest land to non-herbaceous grassland.
Sweden	-482	-134.7	-156	-257.1	Recalculations due to updated estimates of litter and mineral soils (areas and emission factors) and drained organic soils (areas). Living biomass and areas due to updated samples affecting the extrapolation estimates for 2014, and 2015.
United Kingdom	-6	-0.1	-249	-2.7	Updates to deforestation activity data.
EU28	-1 190	-4.7	1 346	52.5	
Iceland	-0	-0.0	-4	-0.1	Revision of area of other land converted to natural birch shrubland

	1990		2015		Main explanations
	kt CO_2.	%	kt CO_2	%	
United Kingdom (KP)	-6	-0.1	-249	-2.7	Updates to deforestation activity data.
EU28+ISL	-1 191	-3.7	1 341	13.8	

Table 6. 45 4D Wetlands: Contribution of MS to EU-28+ISL Recalculations in CO_2 for 1990 and 2015 (difference between latest submission and previous submissions in kt CO_2 and percent)

	1990		2015		Main explanations
	kt CO_2.	%	kt CO_2	%	
Austria	-	-	-	-	
Belgium	-1	-6.7	1	4.8	Update of areas in the three regions following last data available.
Bulgaria	-	-	-	-	
Croatia	-40	-45.9	7	138.0	Recalculations in this category of land refers to the correction of activity data on land areas based on delivered CLC data for year 1990, as well as the data on land use changes from specially designed CLC 1990-2006 change databases, accordingly.
Cyprus	-1	100.0	-12	100.0	Not applicable (the results of calculations are reported for the first time)
Czech Republic	-0	-0.1	-0	-0.4	Updated activity data, revised inputs
Denmark	-	-	-	-	
Estonia	2	0.2	7	0.9	Updated activity data, growing stocks and dead wood volumes from the NFI was used for estimating carbon losses due to land conversion to Wetlands.
Finland	-9	-0.7	-80	-3.7	New area estimates were calculated due to the updating of NFI data.
France	0	0.0	-0	-0.0	
Germany	-	-	-0	-0.0	
Greece	-	-	-	-	
Hungary	-	-	136	61.2	Minor recalculations
Ireland	37	2.5	-509	-20.4	The main recalculation with the Wetland land use category is the revision of areas associated with the extraction and use of peat for horticultural use. This has had a significant impact on the absolute emissions of carbon to the atmosphere.
Italy	-	-	-	-	
Latvia	-162	-13.3	381	38.9	Recalculations are done due to recalculation of the NFI data based on repeated measurement of borders of the plots and their sectors, implementation of updated NFI data on carbon stock changes in living biomass, implementation of updated data on extracted peat for horticulture purposes.
Lithuania	56	10.9	-	-	Recalculations were done as a result of internal land use and land-use change database review in State Forest Service. Database review was done taking into account NFI field measurement data, National Paying Agency data of declared agricultural land and the initial data from studies (Study 1 and Study 2) conducted in 2012, in order to improve accuracy in land-use matrix preparation.
Luxembourg	-	-	-	-	
Malta	-	-	-	-	

	1990		2015		Main explanations
	kt CO_2.	%	kt CO_2	%	
Netherlands	-2	-1.9	-3	-5.3	Reported carbon stock gains and losses in biomass in this category were recalculated for the whole time series due to the methodological changes
Poland	-0	-0.0	-46	-1.0	Update of LUC matrix; Wl's organic soils emssions was restored to maitain the correctness of reported data
Portugal	-	-	-	-	
Romania	-	-	-13	-0.9	CO_2 emissions were recalculated for 2015 year taking into account the updated AD
Slovakia	-	-	-	-	
Slovenia	3	300.6	0	1.3	The main recalculations in the Wetlands category, namely Land converted to Wetlands in the NIR 2018 submission were provided due to updated soil emission factors
Spain	-169	-514.6	35	176.9	Incorporation of the provisional estimate of land use areas and changes in land use for the period 1970-1989, based on the available statistics Estimate of the emissions associated with the exploitation peatlands and the horticultural use of peat.
Sweden	3	4.1	4	2.3	Recalculations due to updated estimates of litter and mineral soils (areas and emission factors) and drained organic soils (areas). Living biomass and areas due to updated samples affecting the extrapolation estimates for 2014, and 2015.
United Kingdom	-	-	51	19.0	Updates to peat extraction activity data.
EU28	-283	-1.6	-41	-0.2	
Iceland	-	-	-	-	
United Kingdom (KP)	-	-	51	19.0	Updates to peat extraction activity data.
EU28+ISL	-283	-1.6	-41	-0.2	

Table 6. 46 4E Settlements: Contribution of MS to EU-28+ISL Recalculations in CO_2 for 1990 and 2015 (difference between latest submission and previous submissions in kt CO_2 and percent)

	1990		2015		Main explanations
	kt CO_2.	%	kt CO_2	%	
Austria	0	0.0	15	4.0	The estimates of the LUC shares from cropland and grassland to settlements were adjusted and led to minor changes in the emissions of the settlement subcategory
Belgium	-47	-22.3	-201	-19.1	Flanders: new calculations using carbon stock change method (forest land converted to settlements), new value soil C settlements (conversions to settlements)
Bulgaria	-	-	4	0.5	Minor recalculations
Croatia	-2	-0.9	91	15.4	Recalculations in this category of land refers to the correction of activity data on land areas based on delivered CLC data for year 1990, as well as the data on land use changes from specially designed CLC 1990-2006 change databases, accordingly.
Cyprus	2	100.0	20	100.0	Not applicable (the results of calculations are reported for the first time)
Czech Republic	1	1.4	8	8.7	Updated activity data, revised inputs. revised attribution of land use categories qualifying for the IPCC category 4.E Settlements and corresponding activity data
Denmark	-	-	-	-	
Estonia	-	-	52	24.3	Updated activity data, growing stocks and dead wood volumes from the NFI were used for estimating carbon losses due to land conversion to Settlements.
Finland	0	0.0	-89	-11.4	New area estimates were calculated due to the

	1990		2015		Main explanations
	kt CO_2.	%	kt CO_2	%	
					updating of NFI data.
France	0	0.0	-0	-0.0	
Germany	-0	-0.0	-0	-0.0	
Greece	44	718.1	108	850.0	Complete reconstruction of the land use, land-use change matrices for the period 1990 –2016. Inclusion in the NIR of a complete set of both annual and 20-years land use, land-use change matrices for the period 1990 – 2016 following previous ERT's recommendation. Estimation and reporting for the first time on carbon stock changes in living biomass and soil oganic matter pools in cropland converted to settlements, following previous ERT's recommendation.
Hungary	0	0.4	1	0.3	Minor recalculations
Ireland	61	323.5	42	129.3	By a transcription error in the previous submission whereby emissions from mineral grassland soils converted to settlements were not reported in the 2017 submission. Minor revisions to the area of land converted to settlements are also a lesser contributory factor. The net effect of these recalculations is a approx. on average 160 per cent increase in emissions for each year of the timeseries 1990-2015
Italy	-0	-0.0	-0	-0.0	
Latvia	-147	-130.5	-1 563	-167.1	Recalculations are done due to recalculation of the NFI data based on repeated measurement of borders of the plots and their sectors, implementation of updated NFI data on carbon stock changes in living biomass, implementation of more accurate and research based estimates of land area of category Forest Land coverted to other land use category.
Lithuania	15	100.0	185	48.5	Recalculations were done due to national carbon stock values in mineral soils applied (national carbon stock values in mineral soils of forest land, cropland and grassland). Recalculations were done in category 4.E.2 Land converted to settlements carbon stock change (mineral soils). For more information see NIR Chapter 6.6.2 and Annex VIII). Other recalculations were done due to the errors found in previous calculation, it includes recalculation of carbon stock changes in biomass in land converted to settlements (category 4.E.2 Land converted to settlements carbon stock changes). Carbon stock changes in organic soils in land converted to settlements were estimated for the first time in this submission, taking into account the same share of organic soils as in the initial land use category.
Luxembourg	-	-	-	-	
Malta	-0	-0.1	0	0.1	Minor recalculations
Netherlands	-18	-2.0	-54	-3.3	Reported carbon stock gains and losses in biomass in this category were recalculated for the whole time series due to the methodological changes
Poland	100	26.6	108	6.6	AD correction (evaluation of biomass stock estimates with the assesment of green area's biomass increament)
Portugal	-	-	-	-	
Romania	-	-	154	4.2	CO_2 emissions were recalculated for 2015 year taking into account the updated AD
Slovakia	-0	-0.2	-0	-0.1	Recalculated values of carbon stock change in living biomass, corrected values of carbon fraction of dry matter for broadleaved forests.
Slovenia	-44	-11.3	-93	-26.3	Updated EFs for soil, use of default removal factor for CRW. The main recalculations in the Settlements, namely Land converted to Settlements were provided

	1990		2015		Main explanations
	kt CO_2.	%	kt CO_2	%	
					due to updated emission factors.
Spain	263	68.7	0	0.0	Incorporation of the provisional estimate of land use areas and changes in land use for the period 1970-1989, based on the available statistics
Sweden	-316	-10.8	-267	-10.2	Recalculations due to updated estimates of litter and mineral soils (areas and emission factors) and drained organic soils (areas). Living biomass and areas due to updated samples affecting the extrapolation estimates for 2014, and 2015.
United Kingdom	-12	-0.2	134	2.2	Updates to deforestation activity data.
EU28	-99	-0.3	-1 345	-2.9	
Iceland	-	-	-	-	
United Kingdom (KP)	-12	-0.2	134	2.2	Updates to deforestation activity data.
EU28+ISL	-99	-0.3	-1 345	-2.9	

Table 6. 47 4F Other land: Contribution of MS to EU-28+ISL Recalculations in CO_2 for 1990 and 2015 (difference between latest submission and previous submissions in kt CO_2 and percent)

	1990		2015		Main explanations
	kt CO_2.	Percent	kt CO_2	Percent	
Austria	-	-	-	-	
Belgium	-	-	-	-	
Bulgaria	-	-	-	-	
Croatia	-	-	-	-	
Cyprus	96	100.0	7	100.0	Not applicable (the results of calculations are reported for the first time)
Czech Republic	-	-	-8	-100.0	With the newly adopted attribution of lands, no emission estimates are applicable for category 4.F Other Land
Denmark	-	-	-	-	
Estonia	-	-	7	29.6	Updated activity data, growing stocks and dead wood volumes from the NFI were used for estimating carbon losses due to land conversion to Other Land.
Finland	-	-	-	-	
France	0	0.0	0	0.0	
Germany	-	-	-	-	
Greece	-	-	-	-	
Hungary	-	-	-	-	
Ireland	-	-	-	-	
Italy	-	-	-	-	
Latvia	-	-	-	-	
Lithuania	-	-	-1	-1.2	Recalculations were done due to national carbon stock values in mineral soils applied (national carbon stock values in mineral soils of forest land, cropland and grassland). Recalculations were done in category 4.F.2 Land converted to Other land carbon stock change (mineral soils). For more information see NIR Chapter 6.7.2 and Annex VIII). Recalculations were done due to the errors found in previous calculations, it includes recalculation of carbon stock changes in biomass in land converted to Other land (category 4.F.2 Land

	1990		2015		Main explanations
	kt CO_2.	Percent	kt CO_2	Percent	
					converted to Other land carbon stock changes).
Luxembourg	-	-	-	-	
Malta	0	0.4	-0	-0.2	Minor recalculations
Netherlands	-1	-3.6	-2	-1.3	Reported carbon stock gains and losses in biomass in this category were recalculated for the whole time series due to the methodological changes.
Poland	-	-	-	-	
Portugal	-	-	-	-	
Romania	-	-	33	4.1	CO_2 emissions were recalculated for 2015 year taking into account the updated AD
Slovakia	-2	-0.8	-0	-0.1	Recalculated values of carbon stock change in living biomass, corrected values of carbon fraction of dry matter for broadleaved forests.
Slovenia	-	-	1	2.5	The main recalculations in the Other land category in the NIR 2018 submission were provided due to updated emissions factors.
Spain	286	1 122.6	-	-	Incorporation of the provisional estimate of land use areas and changes in land use for the period 1970-1989, based on the available statistics
Sweden	265	100.0	-6	100.0	Recalculations due to updated estimates of litter and mineral soils (areas and emission factors) and drained organic soils (areas). Living biomass and areas due to updated samples affecting the extrapolation estimates for 2014, and 2015.
United Kingdom	-	-	-	-	
EU28	644	25.2	31	155.5	
Iceland	-	-	-	-	
United Kingdom (KP)	-	-	-	-	
EU28+ISL	644	25.2	31	155.5	

7 WASTE (CRF SECTOR 5)

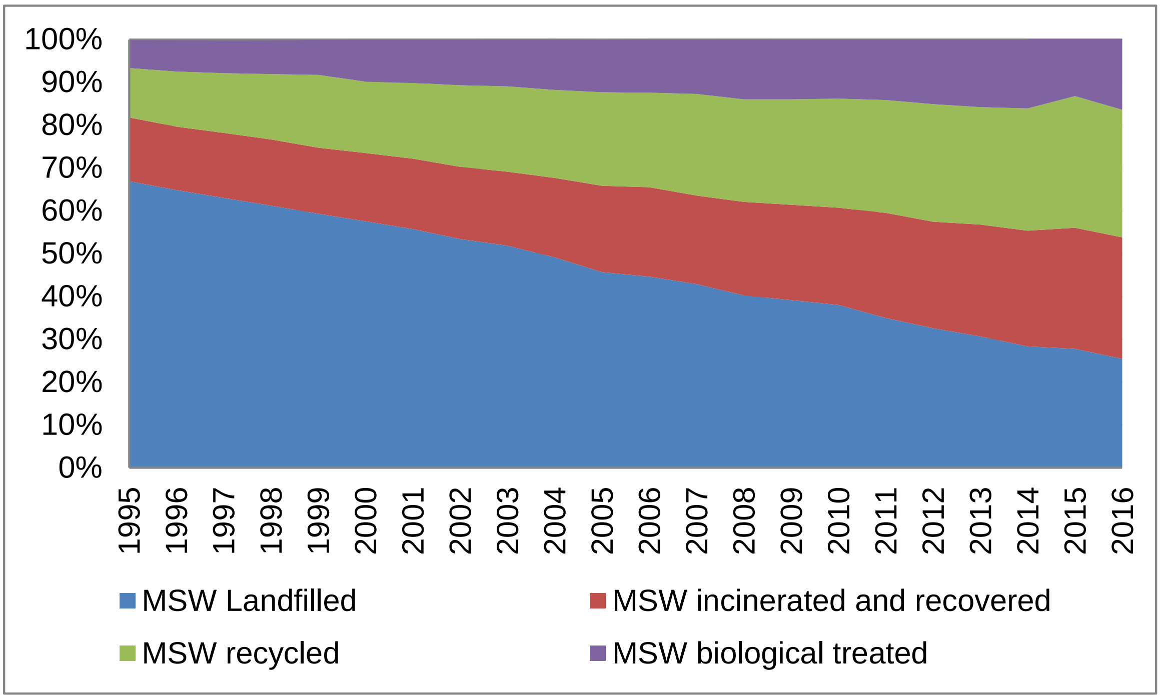
GHG emissions in the waste sector are generated from the treatment and disposal of liquid and solid waste. According to the IPCC 2006 Guidelines emission estimates in the waste sector need to be carried out for four subcategories:

- 5.A Solid waste disposal
- 5.B Biological treatment of solid waste
- 5.C Incineration and open burning of waste
- 5.D Wastewater treatment and discharge.

Of the above, the first three categories mainly refer to possible routes for treatment and disposal of solid. Solid waste can be recycled, landfilled, incinerated and biological treated. The decrease of total GHG emissions in the waste sector is mainly driven by the development of the different waste treatment routes. Figure 7.1 shows the share of the waste treatments over the time series 1995 to 2016 based on activity data for municipal waste. The figure is based on Eurostat data as there is a common definition for the reporting of municipal waste to Eurostat and information on waste recycling is also included. 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 treatment reported to Eurostat is broken down to five treatment types (recovery, incineration with energy recovery, other incineration, disposal on land and biological treatment) and in waste categories. Eurostat data shown in the figures below include only information for municipal waste treatment, while in the GHG inventory also industrial waste, sludge and hazardous waste are reported by some Member States under the categories solid waste disposal, biological treatment and waste incineration. However the Eurostat data is used to show the overall trend of waste treatment in the European Union.

Between 1995 and 2016 the amount of municipal waste landfilled is continuously decreasing in the EU Member States and Iceland and other waste treatment methods like recycling or biological treatment of waste are applied more. In 1995 67 % of waste has been landfilled, 15 % was incinerated, 12 % recycled and only 7 % of the waste has been composted or digested. In 2016 the share of waste landfilled decreased to 25 % of total waste treated while incineration including energy recovery increased to 28 %, recycling increased to 30 % and biological treatment of waste makes up 17 % of total municipal solid waste (MSW) treated in 2016.

Figure 7.1 Sector 5 Waste: Development of municipal waste treatment in the EU-28+ISL

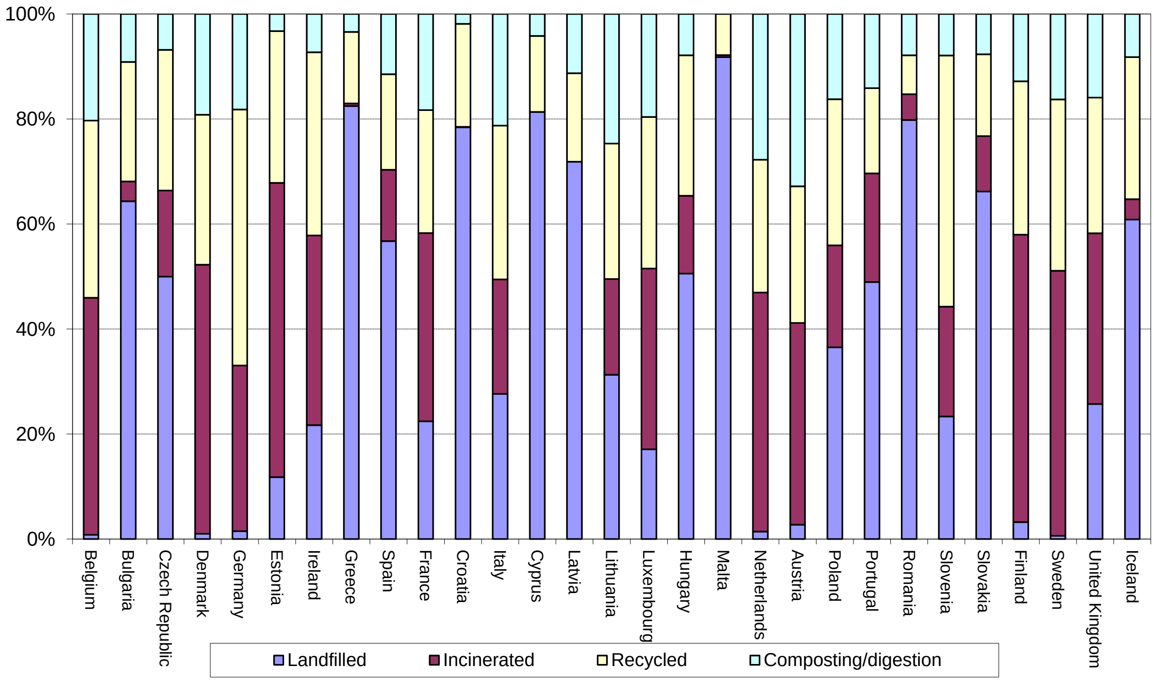


Note: Missing 2015 and 2016 data for Ireland, Portugal and the United Kingdom (MSW landfilled) has been gap filled by using 2014 value, Slovenia has been gap filled by using 2015 value
Source: EUROSTAT 2018, own calculation

Many Member States experienced a reduction of waste landfilled and an increase of recycling, composting and landfill gas recovery. These trends have already started before the Landfill Directive 1999/31/EC and the Directive on packaging waste 94/62/EC and 2008/98/EC, but are further supported by these directives.

The share of the single municipal waste treatment routes differs significantly among Member States in 2016 (comparison in Figure 7.2). The waste management practices and policies which determine the fraction of municipal solid waste (MSW) disposed to solid waste disposal sites (SWDS), the fraction of waste incinerated and the fraction of waste recycled or with biological treatment differ significantly between the Member States. For example, disposing municipal waste on SWDS is the predominant (>70%) municipal waste disposal route in Greece, Croatia, Cyprus, Latvia, Malta and Romania with correspondingly fewer quantities of waste incinerated, recycled or biological treated. In Belgium, Denmark, Germany, Estonia, the Netherlands, Austria, Finland and Sweden, 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 % compared to gas production from untreated waste. In the Netherlands (also in Belgium), waste policy also has the aim of reducing landfilling by introducing bans for the landfilling of certain categories of waste, e.g. by limiting the authorized organic fraction of landfilled waste and by raising the landfill tariff to shift waste streams to other treatment routes.

Figure 7.2 : Waste management practices in the EU-28+ISL (shares) in 2016



Note: In comparison to Inventory data Eurostat data only contains municipal solid waste and does not contain industrial waste and sludge
Source: EUROSTAT 2018, own calculations

7.1 Overview of sector

CRF Sector 5 Waste is the fourth largest sector in the EU-28+ISL, after energy, agriculture and industrial processes, contributing 3 % to total GHG emissions without LULUCF in 2016. Total emissions from waste decreased by 41 % from 236 Mt in 1990 to 139 Mt in 2016 (Figure 7.3). In 2016, emissions decreased by 1 % compared to 2015.

The strong decrease of emissions from the waste sector is mainly influenced by a strong decline of emissions in the waste sector from the United Kingdom, Germany, the Netherlands and Poland. Reductions from category 5.A solid waste disposal on land make up 88 % of total emission reductions in the waste sector (between 1990 and 2016). Emissions from the waste sector show a continuously decreasing trend during the last years, but as many Member States with large emissions from this sector already decreased emissions since 1990 by more than 70 % and most technical mitigation options are implemented in those big Member States, the declining emission trend is slowing down.

Figure 7.3 Sector 5 Waste: EU-28+ISL GHG emissions, 1990-2016

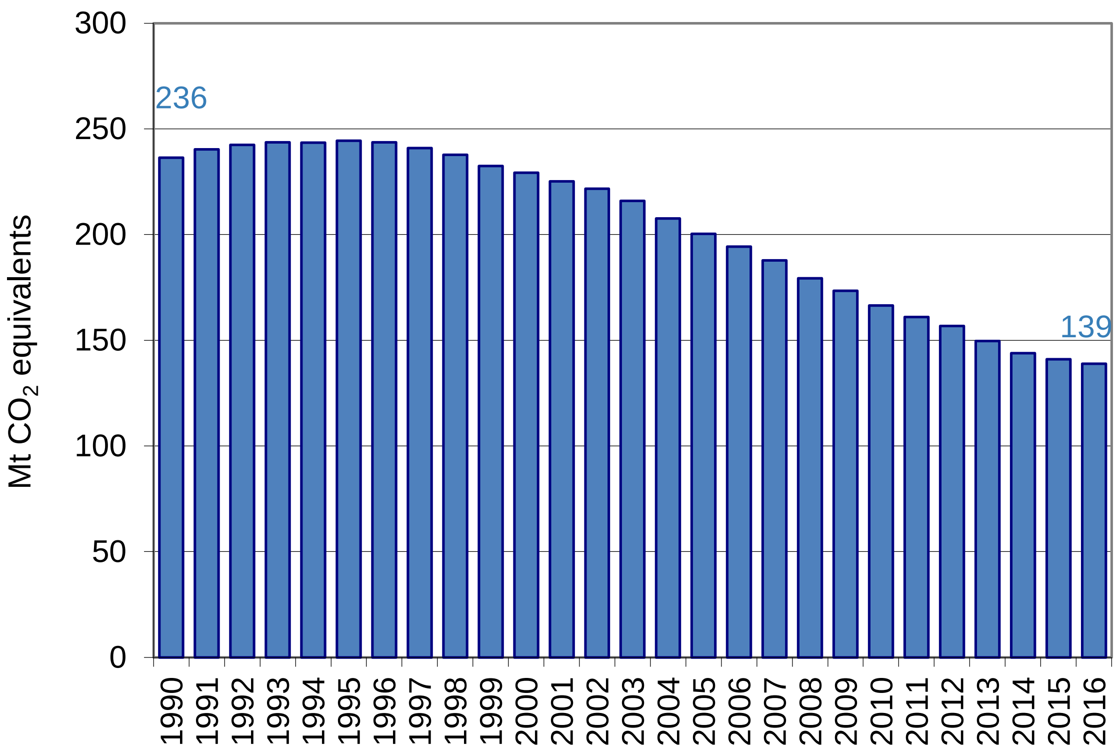


Figure 7.5 shows that CH_4 emissions from 5A1 Managed Waste Disposal on Land had the greatest decrease of all waste-related emissions, but still accounts for 62 % of waste-related GHG emissions in the EU-28+ISL in 2016.

Figure 7.4 Sector 5 Waste: Share of key source categories and all remaining categories in 2016

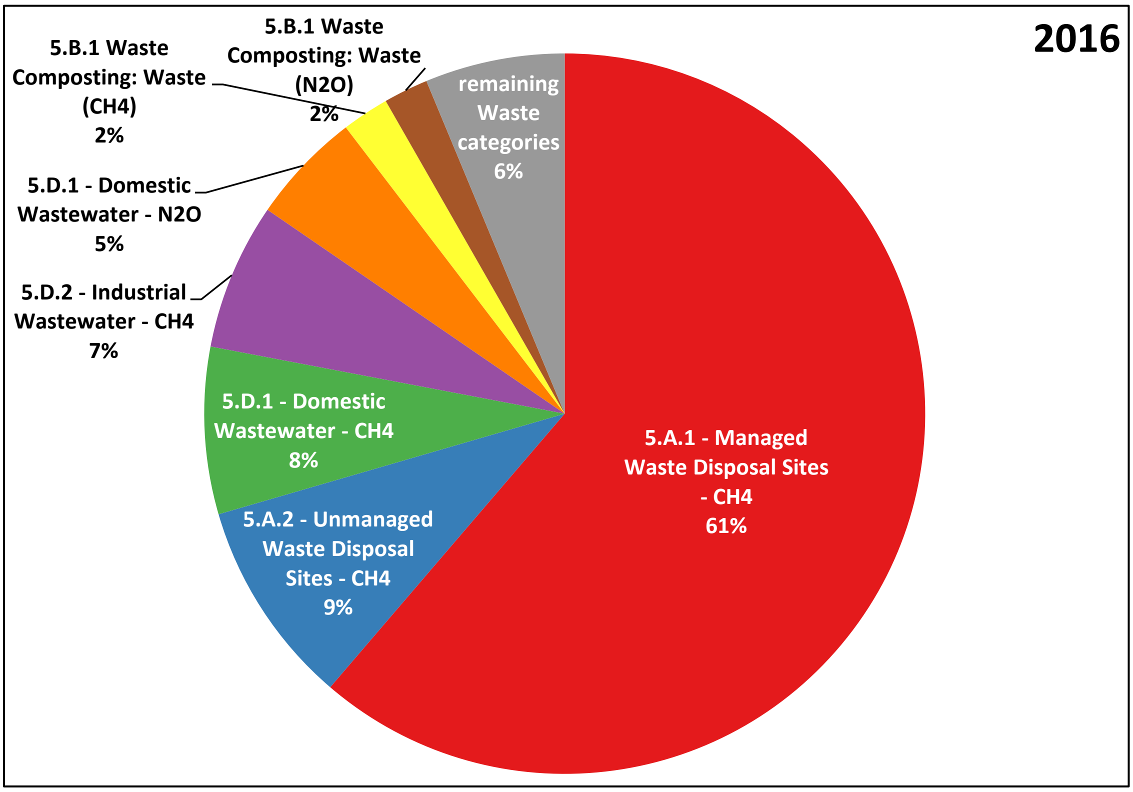
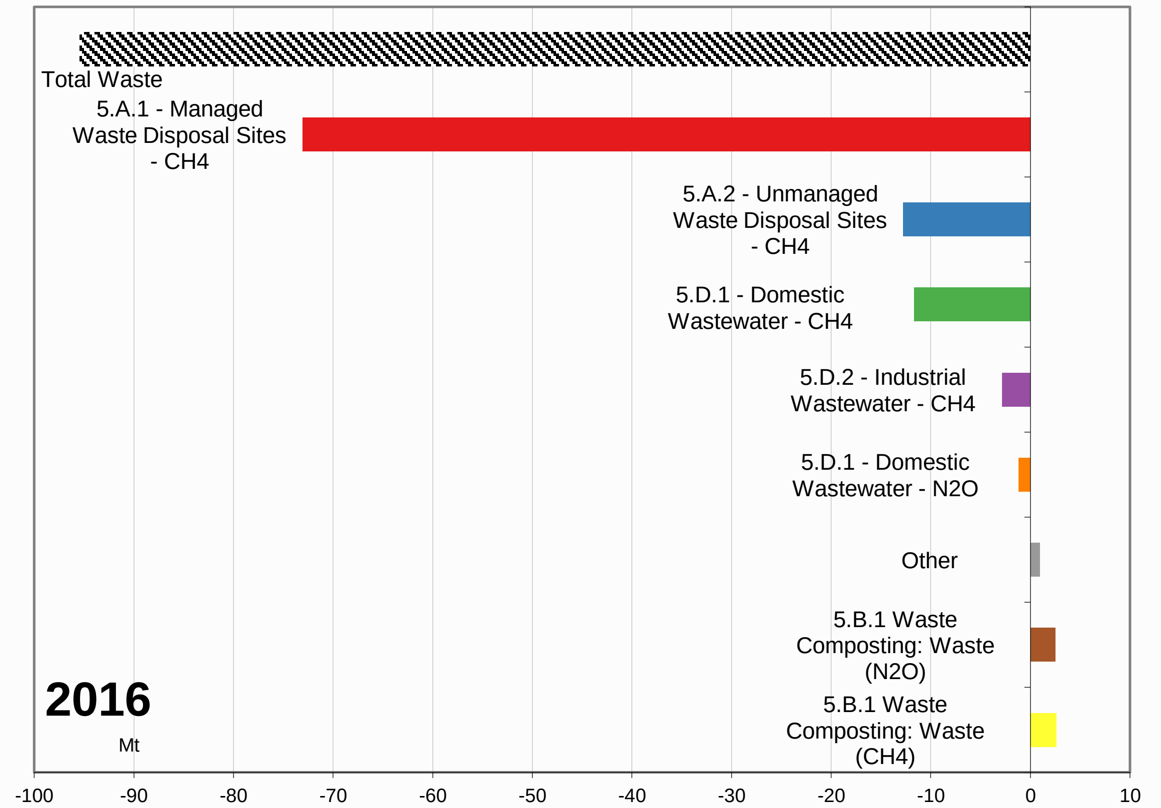


Figure 7.5 Sector 5 Waste: Absolute change of GHG emissions (in CO_2 equivalents) by large key source categories



7.2 Source categories and methodological issues

This chapter includes information on emission levels and emission trends for all 28 Member States plus Iceland for the EU key source categories. Additionally information for EU key source categories on national methods and circumstances which are available in the Member States' national inventory reports will be provided in the Annex III.

In this section we present information relevant for the EU-28+ISL key source categories in the sector 5 Waste. Source categories considered in detail are:

Table 7.1 Key source categories for level and trend analyses and share of MS emissions using higher tier methods

Source category gas	kt CO_2 equ.		Trend	Level		share of higher Tier
	1990	2016		1990	2016	
5.A.1 Managed Waste Disposal Sites: Waste (CH_4)	159159	86113	T	L	L	96 %
5.A.2 Unmanaged Waste Disposal Sites: Waste (CH_4)	25724	12962	T	L	L	100 %
5.B.1 Waste Composting: Waste (CH_4)	357	2972	T	0	0	27 %
5.B.1 Waste Composting: Waste (N_2O)	326	2814	T	0	0	28 %
5.D.1 Wastewater Treatment and Discharge: Domestic Wastewater (CH_4)	22192	10529	T	L	L	36 %
5.D.1 Wastewater Treatment and Discharge: Domestic Wastewater (N_2O)	8273	7085	0	0	L	15 %
5.D.2 Wastewater Treatment and Discharge: Industrial Wastewater (CH_4)	12085	9258	0	L	L	35 %

Almost all Member States report CH_4 emissions from solid waste disposal on managed and unmanaged landfills 5.A using a Tier 2 methodology. In all other source categories in the waste sector the share of Member States using a higher Tier method is much lower. For CH_4 and N_2O emissions from composting (5.B.1) as well as for CH_4 and N_2O emissions from domestic wastewater treatment (5.D.1) Germany mainly influences the share of higher tiers in this source categories because Germany has the highest share for these gases in these categories and is using a higher Tier. For CH_4 emissions from industrial wastewater Portugal contributes 15 % to the 35 % of CH_4 emissions that are reported in this sub-category using higher tiers.

Other source categories in the waste sector are not contributing to a key source and only information on total emissions from these categories is provided for completeness reasons (see chapter 4.2.8). Further information on emission trends and methodological information on other source categories from the waste sector are not provided.

7.2.1 Solid waste disposal on land (CRF Source Category 5A)

Source category 5A Solid waste disposal on land includes two key categories: CH_4 from 5A1 Managed waste disposal on land and CH_4 from 5A2 Unmanaged waste disposal on land, and contribute 2 % and 0.3 % to total GHG emissions in 2016, respectively. Methane is produced from anaerobic microbial decomposition of organic matter in solid waste disposal sites. Source category 5A1 includes CH_4 emission arising from waste disposal on managed solid waste landfills. Source category 5A2 comprises corresponding CH_4 emissions from unmanaged landfills. Under 5A3 CH_4 emissions from uncategorized landfills are reported, but only Estonia (1990-1993) and Poland (1990-2016) report emissions from this category. As this is no EU key category no further information on 5A3 is included in the following chapters.

The EU-28+ISL report CH_4 emissions from managed solid waste landfills in source category 5A1 or 5A2. The methane recovery that takes place in those managed or unmanaged solid waste landfills is also reported in CRF-table 5A but those amounts are not included in the reported CH_4-emissions, as prescribed by the IPCC guidelines. In the unmanaged solid waste landfills, mainly no CH_4-recovery is taken place. Only Ireland (1996-1998) and Latvia (2002-2016) report CH_4 recovery from unmanaged landfills for a few years in the time series.

Table 7.2 provides total greenhouse gas and CH_4 emissions by Member State from 5A Solid Waste Disposal on Land. CH_4 emissions from this category decreased by 46 % between 1990 and 2016 in the EU-28+ISL. Sixteen EU-28 Member States reduced their emissions from this source, while Croatia, Cyprus, the Czech Republic, Greece, Hungary, Italy, Latvia, Malta, Portugal, Romania, Slovakia, Spain and Iceland did not. In many of these Member States waste disposal changed from unmanaged to managed landfills during the time period 1990 and 2016 which leads to increasing CH_4 emissions from managed landfills.

Table 7.2 5A Solid Waste Disposal on Land: Member States' + ISL contributions to total GHG emissions and CH_4 emissions

Member State	GHG emissions in 1990 (kt CO2 equivalents)	GHG emissions in 2016 (kt CO2 equivalents)	CH4 emissions in 1990 (kt CO2 equivalents)	CH4 emissions in 2016 (kt CO2 equivalents)
Austria	3 644	1 212	3 644	1 212
Belgium	3 053	888	3 053	888
Bulgaria	4 945	3 007	4 945	3 007
Croatia	349	1 279	349	1 279
Cyprus	258	467	258	467
Czech Republic	1 979	3 671	1 979	3 671
Denmark	1 536	618	1 536	618
Estonia	214	161	214	161
Finland	4 328	1 640	4 328	1 640
France	12 594	11 447	12 594	11 447
Germany	34 250	8 375	34 250	8 375
Greece	2 243	3 187	2 243	3 187
Hungary	2 675	2 969	2 675	2 969
Ireland	1 318	768	1 318	768
Italy	12 206	13 621	12 206	13 621
Latvia	283	384	283	384
Lithuania	1 029	756	1 029	756
Luxembourg	92	50	92	50
Malta	41	150	41	150
Netherlands	13 679	2 782	13 679	2 782
Poland	10 816	8 102	10 816	8 102
Portugal	2 821	3 844	2 821	3 844
Romania	1 372	3 567	1 372	3 567
Slovakia	611	972	611	972
Slovenia	433	355	433	355
Spain	5 474	10 635	5 474	10 635
Sweden	3 422	908	3 422	908
United Kingdom	60 203	13 834	60 203	13 834
EU-28	**185 868**	**99 649**	**185 868**	**99 649**
Iceland	158	213	158	213
United Kingdom (KP)	60 367	14 000	60 367	14 000
EU-28 + ISL	**186 190**	**100 027**	**186 190**	**100 027**

Note: The first two column show total emissions from 5A reported in kt CO_2 eq. The last two columns show CH_4 emissions in kt CO_2 eq.. As only CH_4 emissions are reported under 5.A the figures in the columns are identical
Abbreviations explained in the Chapter 'Units and abbreviations'.

7.2.1.1 Managed waste disposal sites (CRF Source Category 5A1)

Table 7.3 provides information on emission trends of the key source CH_4 from 5A1 Managed Waste Disposal on Land by Member State. CH_4 emissions from this source account for 2 % of total EU-28+ISL GHG emissions. Between 1990 and 2016, CH_4 emissions from managed landfills declined by 46 % in the EU-28+ISL.

Twelve EU-28 Member States reduced their emissions from this source during that period, Croatia, the Czech Republic, Greece, Hungary, Italy, Poland, Portugal, Spain and Iceland did not. Bulgaria, Cyprus, Estonia, Ireland, Latvia, Malta, Romania and Slovakia did not report CH_4 emissions from managed landfills in 1990. In 2016, CH_4 emissions from managed landfills decreased by 2 % compared to 2015.

Table 7.3 5A1 Managed Waste Disposal on Land: Member States'+ ISL contributions to CH_4 emissions and information on method applied and emission factor

Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016		Method	Emission factor Informa-tion
	1990	2015	2016		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	3 644	1 294	1 212	1.4%	-2 432	-67%	-82	-6%	T2	CS,D
Belgium	3 053	940	888	1.0%	-2 165	-71%	-51	-5%	T2	D
Bulgaria	NO	990	1 034	1.2%	1 034	∞	44	4%	T2	CS,D
Croatia	17	1 056	1 147	1.3%	1 130	6547%	91	9%	T2	CS
Cyprus	NO	61	68	0.1%	68	∞	8	13%	T2	D
Czech Republic	1 979	3 654	3 671	4.3%	1 692	85%	17	0%	T1	CS,D
Denmark	1 536	652	618	0.7%	-918	-60%	-33	-5%	CS,T2	CS,D
Estonia	NO	184	161	0.2%	161	∞	-23	-13%	T2	D
Finland	4 328	1 766	1 640	1.9%	-2 688	-62%	-127	-7%	T2	CS,D
France	12 594	12 481	11 447	13.3%	-1 147	-9%	-1 034	-8%	T2	CS,D
Germany	34 250	8 950	8 375	9.7%	-25 875	-76%	-575	-6%	T2	CS
Greece	80	1 554	1 617	1.9%	1 537	1920%	63	4%	T2	CS,D
Hungary	2 675	3 041	2 969	3.4%	294	11%	-72	-2%	T2	D
Ireland	NO	742	768	0.9%	768	∞	26	3%	T2	CS,D
Italy	6 386	11 583	11 332	13.2%	4 945	77%	-251	-2%	T2	CS
Latvia	NO	269	282	0.3%	282	∞	14	5%	T2	D
Lithuania	879	725	684	0.8%	-195	-22%	-41	-6%	T2	D
Luxembourg	92	54	50	0.1%	-43	-46%	-5	-9%	T1	D
Malta	NO	123	133	0.2%	133	∞	9	8%	T2	PS
Netherlands	13 679	2 974	2 782	3.2%	-10 898	-80%	-192	-6%	T2	CS
Poland	4 657	4 861	4 749	5.5%	93	2%	-112	-2%	T2	CS,D
Portugal	744	3 000	3 015	3.5%	2 271	305%	15	0%	T2	CS,D
Romania	NO	1 369	1 505	1.7%	1 505	∞	135	10%	T2	CS,D
Slovakia	NO	585	606	0.7%	606	∞	21	4%	T2	CS,D
Slovenia	433	340	355	0.4%	-78	-18%	15	4%	T2	CS,D
Spain	4 324	9 952	9 912	11.5%	5 588	129%	-40	0%	T2	CS,D,OTH
Sweden	3 422	991	908	1.1%	-2 513	-73%	-83	-8%	T2	CS,D
United Kingdom	60 203	12 983	13 834	16.1%	-46 369	-77%	851	7%	T2	CS
EU-28	**158 976**	**87 176**	**85 763**	**100%**	**-73 213**	**-46%**	**-1 413**	**-2%**	**-**	**-**
Iceland	19	192	185	0.2%	166	882%	-6	-3%	T2	CS,D
United Kingdom (KP)	60 367	13 153	14 000	16.3%	-46 368	-77%	846	6%	T2	CS
EU-28 + ISL	**159 159**	**87 538**	**86 113**	**100%**	**-73 045**	**-46%**	**-1 424**	**-2%**	**-**	**-**

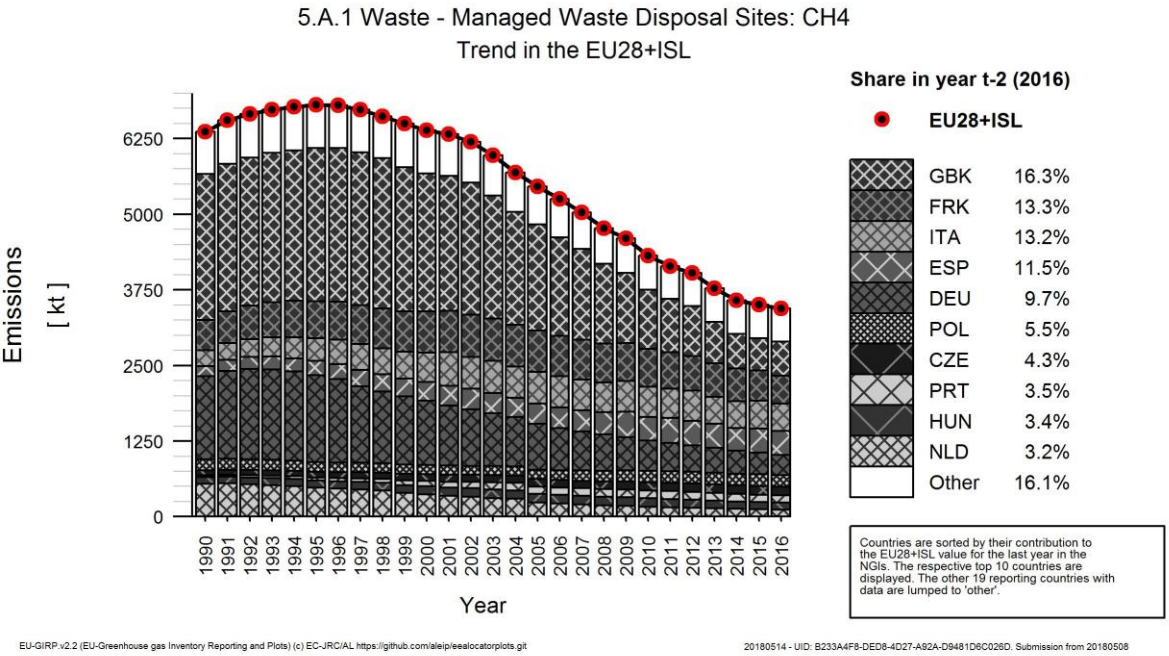
Presented methods and emission factor information refer to the last inventory year.
Abbreviations explained in the Chapter 'Units and abbreviations'.

Trends in Emissions and Activity Data

CH_4 emissions from solid waste disposal on managed land decreased considerably between 1990 and 2016 by 46 %. *Figure 7.6* shows the trend of emissions indicating the countries contributing most to EU-28 total.

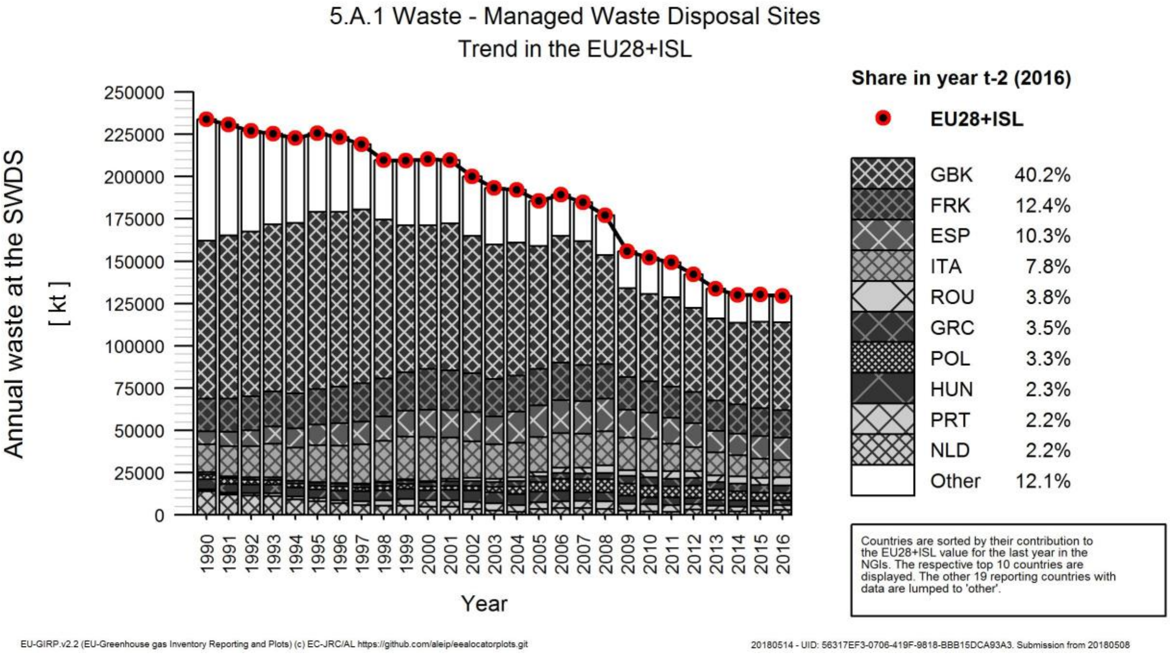
The Member States with highest emissions from this source in 2016 were the United Kingdom, France, Italy, Spain and Germany. These MS account for 64 % of EU-28+ISL CH_4 emissions from 5A1 in 2016. The largest reductions in absolute terms between 1990 and 2016 were reported by the United Kingdom and Germany. 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.

Figure 7.6 5A1 Managed waste disposal on land: CH_4 emissions (Trend in relevant MS)



A main driving force of CH_4 emissions from managed waste disposal on land is the amount of waste, especially of biodegradable waste going to landfills. According to the CRF Tables submitted in 2018 the yearly total amount of waste disposal on managed landfills declined by 45 % between 1990 and 2016 (see *Figure 7.7*). In addition, CH_4 emissions from landfills are influenced by the amount of CH_4 recovered and utilized or flared. The share of CH_4 recovery has increased significantly in EU-28+ISL since 1990 (see Figure 7.8).

Figure 7.7 5A1 Managed waste disposal on land: Waste disposal (Trend in relevant Member States)



In the following more information is provided for the Member States that are contributing most to the trend of this key category on the level of the EU-28 + ISL.

CH_4 emissions in **Spain**, contributing with 11.5 % to EU-28 emissions in 2016, increased almost continuously between 1990 and 2008 due to a growth of the annual municipal solid waste going to solid waste disposal sites. Key drivers are a growing population and the shift of waste disposal from unmanaged to managed landfills. Due to fluctuations in the amount of CH_4 recovery, CH_4 emissions show a fluctuating trend from 2008 onwards. CH_4 recovery and flaring of CH_4 has already been practiced in earlier years and increased significantly from 2002 onwards. The highest amounts of CH_4 recovery are found in 2014, while in 2015 and 2016 recovery rates declined again and CH_4 emissions increased in comparison to 2014. In 2016 CH_4 emissions from solid waste disposal decreased slightly by -0.4 % compared to 2015.

Portugal, contributing with 3.5 % to EU-28 emissions in 2016, showed an increasing trend of CH_4 emissions from solid waste disposal on managed landfills until 2011. Key drivers for this trend have been increased waste generation due to population growth and urbanization. Since 2004 the share of CH_4 recovery and flaring constantly increased and from 2012 onwards Portugal managed to slow down the increasing trend of CH_4 emissions from managed landfills. Between 2015 and 2016 CH_4 emissions from 5.A.1 increased slightly by 0.5 % again, which was caused by a decline in CH_4 recovery in 2016.

France, contributing with 13.3 % to EU-28 emissions in 2016, increased its emissions from managed solid waste disposal sites steadily until 2003; followed by a declining trend thereafter. Emissions followed the increased amount of municipal waste going to landfills until 2000, which decreased afterwards. Small amounts of CH_4 have been flared and recovered already in 1990, while the highest amount of CH_4 recovery can be found in 2016, which leads to a decrease in CH_4 emissions by 8 % between 2015 and 2016.

The **United Kingdom (KP)** has also a high share of CH_4 emissions from managed landfills among Member States contributing 16.3 % to EU-28 emissions in 2016. From 1996 onwards CH_4 emission decreased continuously due to a reduction of the amount of waste landfilled and also due to very high amounts of CH_4 recovery. Since 2012 the amount of CH_4 recovery shows a declining trend, which leads to an increase of CH_4 emissions by 7 % between 2015 and 2016.

Italy, contributing with 13.2 % to EU-28+ISL emissions in 2016, featured an increasing trend of CH_4 emissions from landfills until 2001 and a decreasing trend thereafter. This is driven, inter alia, by the increasing amount of waste landfilled until 2000 and a decrease thereafter. Also, CH_4 recovery has increased throughout the time series. The key drivers for the fall in emissions are the national policy diverting solid waste from landfill to waste incineration plants and waste diversion measures. Composting and mechanical and biological treatment have shown a remarkable rise due to the enforcement of legislation. In 2016 CH_4 emissions from solid waste disposal decreased by 2 % compared to 2015.

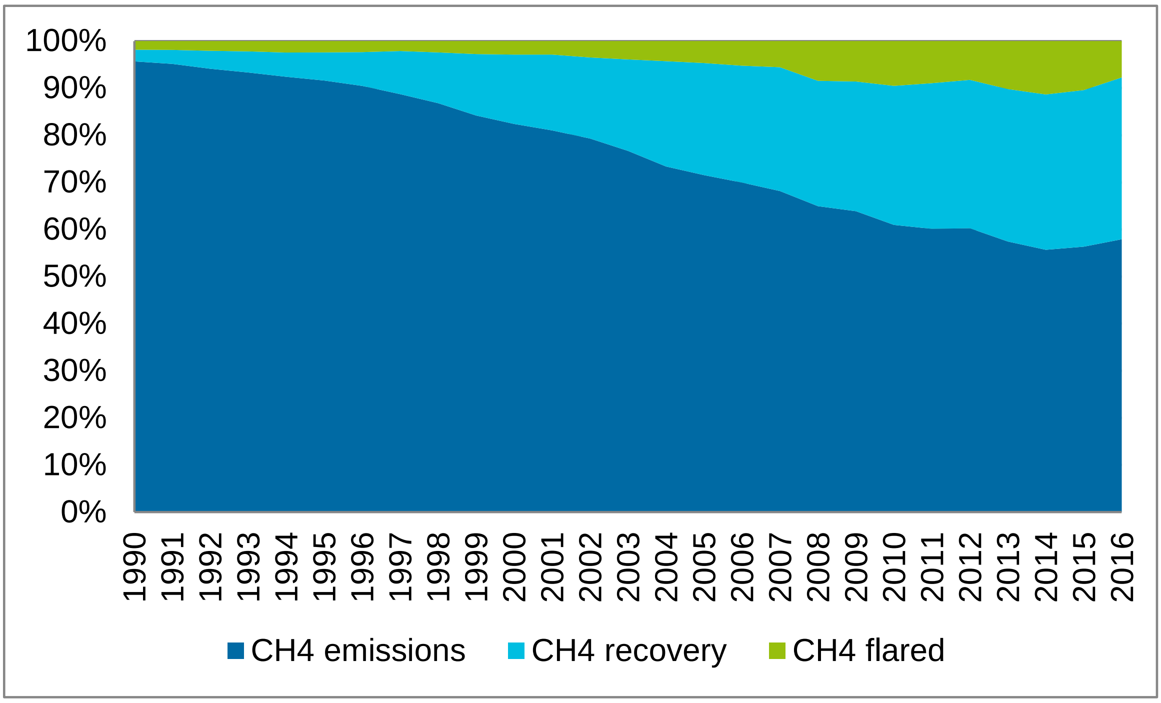
Germany, contributing with 9.7 % to EU-28 emissions in 2016, managed to reduce CH_4 emissions steadily until now from 1993 onwards. The amount of waste disposed on landfills shows a strong decrease from 1990 onwards, while in parallel CH_4 recovery increased. The highest share of CH_4 recovery could be found in 2002 and declined thereafter due to a decreasing amount of waste landfilled.

Methane recovery and flaring

Besides lower quantities of organic carbon deposited on landfills, the major determining factor for the decrease in net CH_4 emissions are increasing methane recovery rates from landfills and flaring of CH_4.

CH_4 recovery and flaring of CH_4 in EU-28+ISL increased from 4 % of total CH_4 generated in managed landfills in 1990 to 42 % of generated CH_4 from managed SWDS (only 5A1) in 2016 (Figure 7.8). Methane recovery is further promoted by the Landfill Directive, and monitoring programs are 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. Compared to 2015, CH_4 recovery and CH_4 flaring decreased by 5 % in 2016. This is caused by reduced amounts of waste landfilled and the ban of organic material in the landfilled waste.

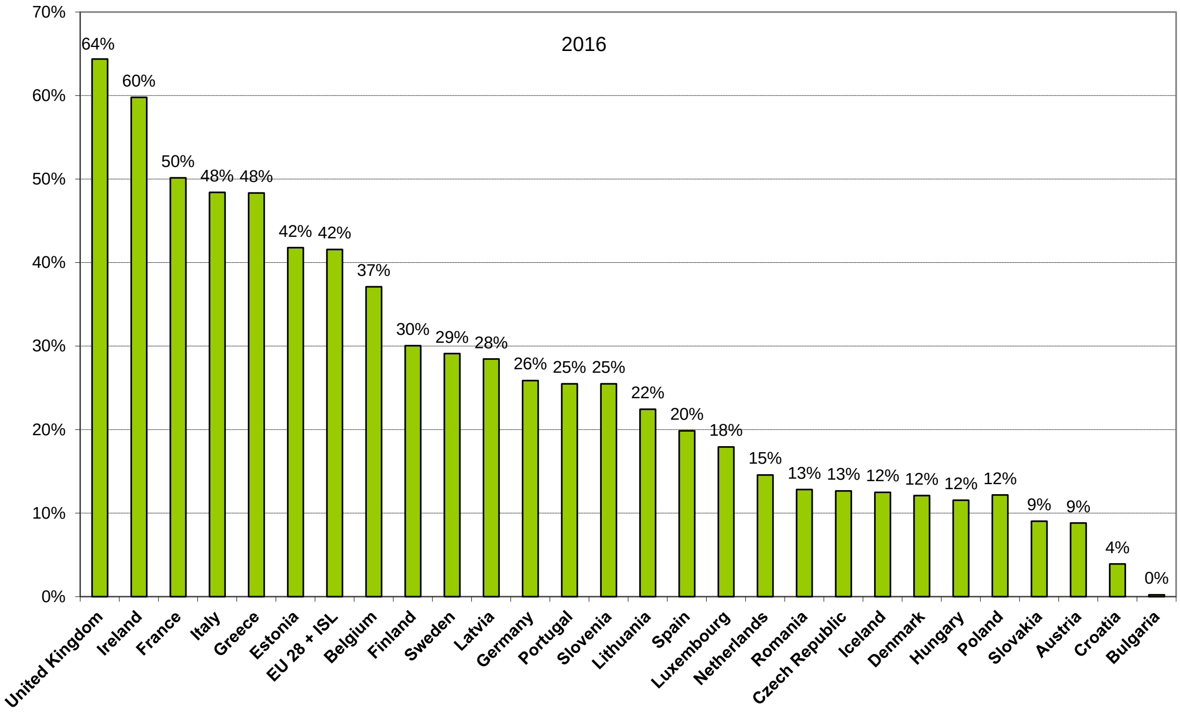
Figure 7.8   5A1 Managed Solid Waste Disposal: Development of the share of methane recovery, methane flared and CH_4 emissions on total CH_4 produced in managed landfills in the EU 28+ISL



Source: CRF 2018, Table 5A

The recovered CH_4 is the amount of CH_4 that is captured for energy use and is a country-specific value which has significant influence on the emission level. Additionally the amount of CH_4 flared is considered. The percentage of CH_4 recovered and flared, in Figure 7.9, varies among the Member States between 0.2 % in Bulgaria and 64 % in the United Kingdom and depends - amongst other - on the share of solid waste disposal sites where recovery installations exist. Cyprus and Malta do not report any data under 5.A CH_4 recovery and flaring in 2016. For 2011 - 2014 Malta reported a small amount of CH_4 flared and in 2013 and 2014 a small amount for CH_4 recovery.

Figure 7.9 5A1 Managed Solid Waste Disposal: Methane recovery rates and methan flared for 2016



CH_4 recovery and flaring in % = CH_4 recovery in Gg + CH_4 flared in Gg/ (CH_4 recovery in Gg + CH_4 flared + CH_4 emissions 5A1 in Gg)
CH_4 emissions from 5A2 unmanaged landfills are not included in this calculation
Source: CRF 2018 Table 5A

Compared to 2015 the methane recovery and flaring in 2016 increased for eleven Member States. In fifteen Member States the amount of CH_4 recovered and flared decreased in comparison to 2015.

Methodological issues

For key sources in the source category 5A it is good practice to use the First Order Decay (FOD) method to calculate the emissions and to display emission trends over time. According to Table 7.3 the Czech Republic and Luxembourg apply a Tier 1 method to estimate CH_4 emissions from solid waste disposal on managed landfills. Giving the IPCC 2006 Guidelines for National Greenhouse Gas Inventories, the First Order Decay (FOD) method that accounts for the fact that the degradable organic components decay slowly over decades, has to be applied for all Tier levels. The Tier 1 method applies mainly default parameters and default activity data. The Tier 2 FOD method requires data on current as well as historic waste quantities, composition and disposal practices for several decades. Historical waste disposal data for 10 years or more should be based on country-specific statistics, surveys or other similar sources. In the following, a short overview of the most important parameters and methodological aspects of the FOD method is 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 carbon in that waste. Further methodological information for all EU Member States and Iceland is provided in the Annex III of this submission.

Municipal Waste landfilled

The amount of waste disposed on SWDS depends on the total amount of waste generated and the share of waste disposed. The total amount of waste disposed can be calculated by using total population numbers, waste generation rate per capita and the share of waste disposed. The FOD method requires historic data on waste generation and the share of waste landfilled over decades but it is difficult to achieve consistent time series for the activity data over such long periods.

Member States that do not have historic data on waste generation and waste disposal available use the default IPCC values for the waste generation rate per capita and the share of waste disposed and apply inter- or extrapolation methods to create a time series. Recent data on waste generation and waste disposal is available in most EU-28 Member States and Iceland and is not estimated based on the per capita waste generation rate and a share of waste landfilled, but on direct measurements.

The data sources used for generating time series of activity data by the Member States and Iceland are summarized in the Annex III.

Industrial waste

Data on industrial waste may be difficult to obtain in many countries and there are only very few default values available. Only industrial waste that contains organic or fossil carbon fractions needs to be included in the inventory. Many Member States do not provide any information on industrial waste landfilled, while other Member States report that industrial waste is not reported separately and included under municipal solid waste. Further information on the reporting of industrial waste by the Member States and Iceland is summarized in the Annex III.

Sludge

Some countries dispose of sludge from domestic and industrial wastewater plants in landfills. The amount of sludge from domestic wastewater might be included under municipal waste or sludge from industrial wastewater may be included under industrial waste. Double counting needs to be avoided by reporting a consistent amount of sludge that is disposed of on SWDS; only sludge that goes along with solid waste has to be accounted under this category. All other sludge that is composted, incinerated, treated in wastewater plants or applied to agricultural land should be accounted under other categories. There is no IPCC default activity data available. If no country-specific activity data is available on the amount of sludge that is disposed of, composted, incinerated or spread on agricultural land, all emissions from sludge are included under wastewater treatment.

Waste composition

The amount of methane generated on SWDS depends strongly on the waste composition. Disposing waste with no or hardly degradable carbon (e.g. metal or plastics) does not contribute to CH_4 emissions, but the disposal of paper or food waste with large degradable organic carbon fractions leads to high CH_4 emissions. The composition of the waste landfilled is strongly influenced by waste management practices, such as recycling or composting. This leads also to varying waste compositions along the time series. Based on the information provided in the CRF tables and the NIR it is not possible to conduct a time series for waste composition in the EU-28+ISL. Country specific information on waste composition is provided in the Annex III.

Landfill gas recovery

Member States use different methods to determine CH_4 recovery. Several Member States combine different methods and sources to estimate the amounts of CH_4 recovered for flaring or for energy purposes, while other Member States are using only one method. Data on landfill gas recovery can be based on measured plant specific data, questionnaires and survey or can be taken from the energy statistics. Further information on CH_4 recovery in the single Member States is provided in the Annex III of this submission.

Emission factors and parameters

Besides information on the amount of waste landfilled and the waste composition further parameters are relevant for the calculation of CH_4 emissions from waste disposal. The fraction of degradable organic carbon (DOC) dissimilated in the individual waste fractions and the methane generation rate constant that reflects the years which the degradable organic carbon needs to decompose are the most relevant parameters for calculating CH_4 emissions. Further parameters included in the calculation are the methane correction factor (MCF), the fraction of DOC that decomposes the fraction of CH_4 in generated landfill gas, methane recovery rate and the oxidation factor.

Fraction of Degradable Organic Carbon (DOC): There are default IPCC values for DOC of the different waste fractions available (paper, food waste etc.). Some countries have conducted own chemical analysis on the DOC value of different waste fractions. The DOC content of total landfilled 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. Member States have MSW with widely differing waste compositions. If large amounts of organic waste is composted and waste is pretreated before disposed on landfills the average DOC is very low, even if still a high amount of waste is disposed. As waste composition varies over time and single DOC values are used for individual waste fractions the DOC-values also vary over time. A few examples: in the case of the United Kingdom, a detailed review of waste composition with regard to materials, moisture content and dissimiable degradable organic carbon was carried out. For Austria composting became a more important waste treatment method Consequently, considerable amounts of waste with high DOC are excluded from category 5A which results in a lower DOC for the remaining MSW. 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.

The restructured CRF tables do not include information on the average DOC anymore. Within this submission a table in the Annex III is provided that contains corresponding detailed information on the DOC values extracted from the NIR.

Methane generation rate constant: CH_4 is emitted on SWDS over a long period of time rather than instantaneously. The FOD model can be used to model landfill gas generation rate curves for individual landfills over time. One important parameter is the methane generation rate constant (also referred to as k-value or half-life value). It is determined by a large number of factors associated with the composition of waste and the conditions at the site. The restructured CRF tables do not include information on the methane generation rate constant anymore. Within this submission a table in the Annex III is provided that contains corresponding detailed information on the methane generation rate constant extracted from the NIR.

7.2.1.2 Unmanaged waste disposal sites (CRF Source Category 5A2)

CH_4 emissions from 5A2 Unmanaged Waste Disposal on Land account for 0.3 % of total EU-28+ISL GHG emissions in 2016. Between 1990 and 2016, CH_4 emissions from this source decreased by 50 % (Table 7.4). In 2016, CH_4 emissions from unmanaged landfills decreased by 6 % compared to 2015. Almost all Member States with unmanaged waste disposal feature a decreasing emission trend, due to a decreasing amount of municipal waste going to unmanaged waste disposal sites. Only Cyprus and Romania showed an increase of CH_4 emissions from unmanaged landfills between 1990 and 2016. In Cyprus CH_4 emissions from unmanaged landfills still slightly increased between 2015 and 2016 due to an increasing amount of solid waste disposal on unmanaged landfills until 2009. Between 2009 and 2016 the amount of solid waste disposed on unmanaged landfills in Cyprus decreased by 44 %. However, there is a small increase of waste disposal on unmanaged landfills in 2015 and 2016. Also Malta showed a small increase of CH_4 emissions from unmanged waste disposal between 2015 and 2016 due to an increase in waste disposal in former years. In Romania CH_4 emissions from unmanaged waste disposal sites increased until 2010, but showed a decreasing trend from 2010 onwards. Between 2010 and 2016 the CH_4 emissions decreased by 18 % in Romania.

Table 7.4 5A2 Unmanaged Waste Disposal on Land: Member states' contributions to CH_4 emissions and information on method applied and emission factor

Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016		Method	Emission factor Informa-tion
	1990	2015	2016		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	NO	NO	NO	-	-	-	-	-	NA	NA
Belgium	NO	NO	NO	-	-	-	-	-	NA	NA
Bulgaria	4 945	2 143	1 973	15.2%	-2 972	-60%	-171	-8%	T3	CS,D
Croatia	331	198	132	1.0%	-200	-60%	-66	-34%	T2	CS
Cyprus	258	398	399	3.1%	141	54%	1	0%	T2	D
Czech Republic	NO	NO	NO	-	-	-	-	-	NA	NA
Denmark	NO	NO	NO	-	-	-	-	-	NA	NA
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	IE	NO	NO	-	-	-	-	-	NA	NA
France	NO	NO	NO	-	-	-	-	-	NA	NA
Germany	NO	NO	NO	-	-	-	-	-	NA	NA
Greece	2 163	1 629	1 570	12.1%	-593	-27%	-58	-4%	T2	CS,D
Hungary	IE	IE	IE	-	-	-	-	-	NA	NA
Ireland	1 318	IE	IE	-	-1 318	-100%	-	-	NA	NA
Italy	5 820	2 396	2 290	17.7%	-3 530	-61%	-106	-4%	T2	CS
Latvia	283	119	102	0.8%	-181	-64%	-17	-14%	T2	CS,D
Lithuania	150	78	71	0.6%	-78	-52%	-7	-9%	T2	D
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	41	13	17	0.1%	-24	-59%	4	31%	M	M
Netherlands	NO	NO	NO	-	-	-	-	-	NA	NA
Poland	5 066	2 590	2 400	18.5%	-2 665	-53%	-190	-7%	T2	CS,D
Portugal	2 076	889	829	6.4%	-1 248	-60%	-60	-7%	-	-
Romania	1 372	2 146	2 062	15.9%	690	50%	-84	-4%	T2	CS,D
Slovakia	611	382	366	2.8%	-245	-40%	-15	-4%	T2	CS,D
Slovenia	NO	NO	NO	-	-	-	-	-	NA	NA
Spain	1 150	762	723	5.6%	-427	-37%	-39	-5%	T2	D
Sweden	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom	NO	NO	NO	-	-	-	-	-	NA	NA
EU-28	**25 585**	**13 742**	**12 934**	**100%**	**-12 651**	**-49%**	**-808**	**-6%**	**-**	**-**
Iceland	139	30	28	0.2%	-111	-80%	-2	-6%	T2	CS,D
United Kingdom (KP)	NO	NO	NO	-	-	-	-	-	NA	NA
EU-28 + ISL	**25 724**	**13 772**	**12 962**	**100%**	**-12 762**	**-50%**	**-810**	**-6%**	**-**	**-**

Note: According to the MS NIR Ireland, Portugal and Malta apply a Tier 2 method to calculate CH_4 emissions from waste disposal on unmanaged landfills.
Presented methods and emission factor information refer to the last inventory year.
Abbreviations explained in the Chapter 'Units and abbreviations'.

Trends in Emissions and Activity Data

CH_4 emissions from unmanaged solid waste disposal sites decreased considerably between 1990 and 2016 by 50 %. *Figure 7.10* shows the trend of emissions indicating the countries contributing most to EU-28+ISL total. In comparison to the rather drastic decrease of the amount of waste disposed on unmanaged landfills (see *Figure 7.11*) CH_4 emissions from unmanaged landfills show only a moderate decrease during the time series.

Not all Member States reported emissions from this source since all waste disposal sites in the countries are managed (Austria, Belgium, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Luxembourg, the Netherlands, Slovenia, Sweden and the United Kingdom) or they are included elsewhere (Hungary, Ireland). Bulgaria, Greece, Italy, Poland and Romania are responsible for about 79 % of the total EU-28+ISL emissions from unmanaged waste disposal sites. Italy, Bulgaria and Poland show large absolute reductions between 1990 and 2016. In Italy and Poland waste is not disposed on unmanaged landfill sites anymore (in Italy since 2000, in Poland since 2012), while in Bulgaria the amount of waste disposed on unmanaged landfills decreased by 94 % between 1990 and 2016.

Figure 7.10 *5A2 Waste disposal on unmanaged landfills: CH_4 emissions (Trend in relevant MS)*

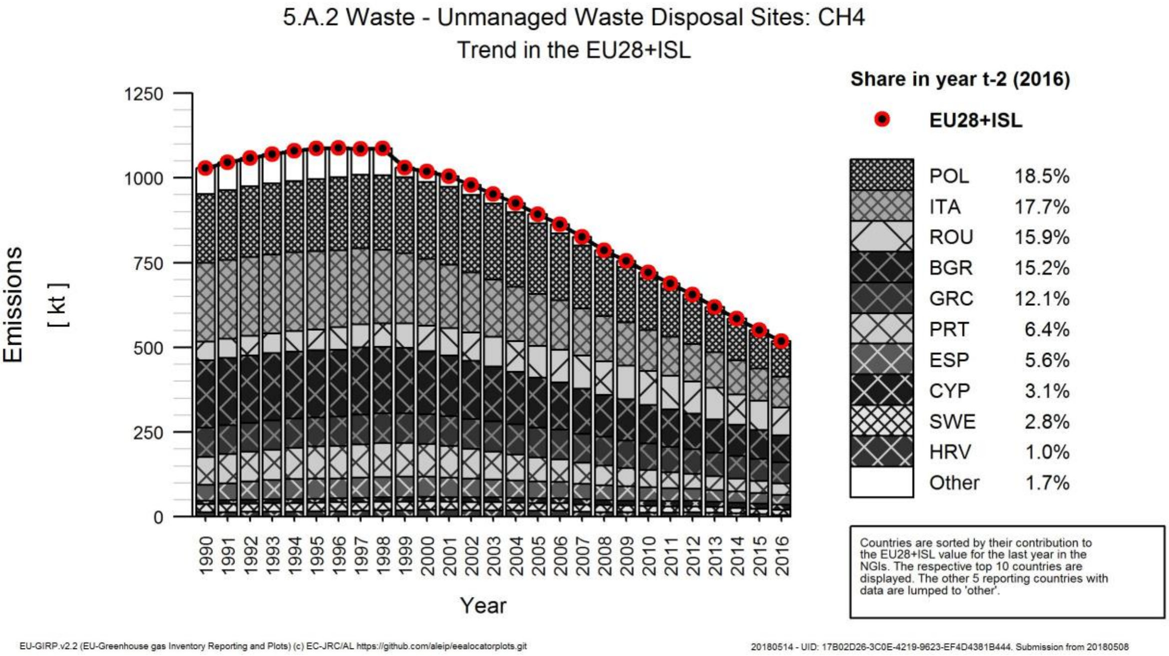
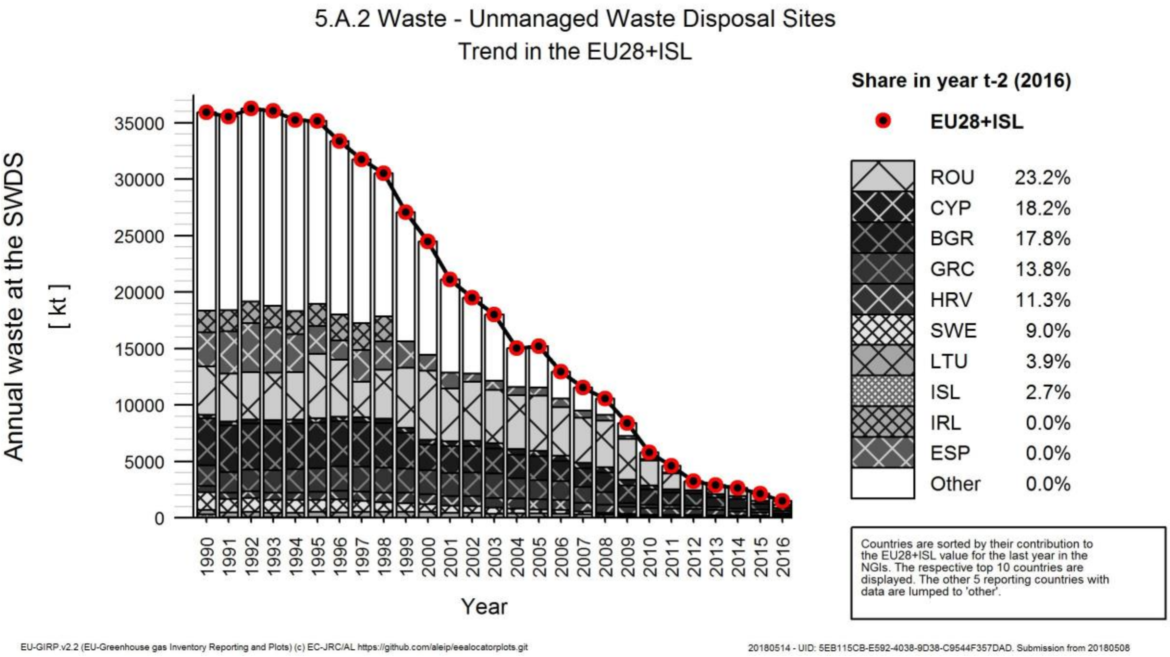


Figure 7.11 shows the relevant trends for the amount of waste disposed on unmanaged landfills. The highest reductions in waste disposal between 1990 and 2016 are found for Italy, Bulgaria and Poland. In Bulgaria, Croatia, Cyprus, Greece, Iceland, Lithuania, Romania and Slovakia solid waste disposal on unmanaged landfills is still practiced, but the amount of waste disposed is considerably decreasing since 1992. While in the year 1992 almost 36.2 Mt have been disposed on unmanaged landfills only 1.5 Mt were disposed in 2016. However, emissions are still produced from the waste disposed in the past.

Figure 7.11 5A2 Waste disposal on unmanaged landfills: Total waste disposed on unmanaged landfills (Trend in relevant MS)



Italy, contributing with 17.7 % to EU-28 emissions in 2016, managed to reduce CH_4 emissions from solid waste disposal on unmanaged landfills already from 1992 onwards. The reduction of emissions from unmanaged waste disposal on land 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 landfilling is forbidden, but the enforcement of these measures was concluded only in 2000. Thus the share of waste disposed on uncontrolled landfills gradually decreased, and in the year 2000 it is assumed to be zero; nevertheless emissions still occur due to the waste disposed in the past years.

Bulgaria is contributing with 15.2 % to EU-28 CH_4 emissions from unmanaged landfills. From 1997 CH_4 emissions are declining, due to a reduction of waste disposed on unmanaged landfills. In Bulgaria waste disposal on unmanaged landfills is still practiced, but the amounts of waste landfilled are very small.

Poland's CH_4 emissions from the disposal of solid waste on unmanaged landfills contribute 18.5 % to EU-28 emissions from this source category in 2016. Since 2001 the emissions show a decreasing trend. Key drivers for this decrease are the implementation of the landfill directive 1999/31/EC and the introduction of new waste treatment technologies that reduce the amount of waste disposed on unmanaged landfills.

Methodological issues

CH_4 emissions from unmanaged solid waste disposal sites were reported in thirteen Member States and Iceland in 2016 (Bulgaria, Croatia, Cyprus, Greece, Italy, Latvia, Lithuania, Malta, Poland, Portugal, Romania, Slovakia and Spain). Only seven of these Member States (Bulgaria, Croatia, Cyprus, Greece, Lithuania, Romania and Slovakia) and Iceland still dispose MSW to unmanaged SWDS, although in small quantities, while in all other countries waste disposals from the past still emits (see Table 7.4). 100% of all EU-28+ISL emissions from this category are calculated using higher tier methods.

CH_4 emissions from waste disposal on unmanaged landfills are calculated similar to CH_4 emissions from managed landfills, using the amount of waste disposed on unmanaged landfills. If no other data is available the same data on waste composition and the same parameters as used for managed landfills can be applied in the calculation. The Methane Correction Factor (MCF) is the relevant parameter that differentiates between managed and unmanaged landfills. The Methane Correction Factor reflects the way in which MSW is managed and the effect of management practices on CH_4 generation. According to the 2006 IPCC Guidelines, the MCF for unmanaged disposal of solid waste depends of the type of site – shallow or deep. The IPCC default MCF for deep unmanaged landfills is 0.8, while shallow unmanaged landfills have an MCF of only 0.4 as in shallow landfills more waste decomposes aerobically. Table 7.5 shows the different MCFs used by countries to estimate CH_4 emissions from waste disposal on unmanaged landfills in 2014. All Member States use a MCF between 0.4 and 0.8, except for Iceland (MCF = 0.2). Iceland refers to two landfill gas studies that found out that unmanaged landfills in Iceland have reduced CH_4 production in comparison to the default IPCC MCF value.

Table 7.5 5A2 Waste disposal on unmanaged landfills: MCFs applied by countries in 2016

Member State	MCF
Bulgaria	0.8
Croatia	0.8
Cyprus	0.4
Greece	0.8
Iceland	0.2
Italy	0.6
Latvia	0.7
Lithuania	0.4
Malta	0.6
Poland	0.8
Portugal	0.6
Romania	0.7
Slovakia	0.4
Spain	0.6

Source: CRF Table 5.A 2018, NIR 2018

7.2.1.3 Recalculations (CRF Source Category 5A)

Table 7.6 provides information on the contribution of Member States to EU recalculations in CH_4 emissions from 5A Solid Waste Disposal on Land for 1990 and 2015 and main explanations (as available in the national inventory reports) for the largest recalculations in absolute terms. Member States contributing most to the recalculations in the year 2015 for the sector 5.A in absolute terms are Spain, the United Kingdom, Poland, the Czech Republic and Portugal.

Table 7.6: 5A Solid Waste Disposal on Land: Contribution of member states to EU recalculations in CH_4 emissions for 1990 and 2015 (difference between latest submission and previous submission)

	1990		2015		Main explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
Austria	-	-	-	-	
Belgium	-	-	6	0.6	Flanders: small correction (new data) Recovery + 5.54 kton CO_2-eq (no changes in WAL and BRU)
Bulgaria	-	-	-1	-0.0	According to received updated Activity data from MOEW the emissions for 2015 have been recalculated.
Croatia	-	-	-	-	
Cyprus	-	-	-0	-0.0	Emissions from solid waste management (5A) were recalculated for 2015 due to revision of the activity data of solid waste production by the Statistical Service.
Czech Republic	**-**	**-**	**269**	**7.9**	Based on ARR recommendation industrial waste and sludge is included in SWDS. We included IW/S correction factor for the period 1995-2016 based on available CZSO data which increased emissions from this category.
Denmark	-	-	-3	-0.5	The recalculation of emissions from Solid Waste Disposal on Land is caused by an update in the activity data in the new waste reporting system 2010-2016.
Estonia	-	-	-4	-1.9	CH_4 emissions from SWD have been recalculated due to the updated amount of methane recovered from landfills in 2014–2015. Additional information on biogas combusted in Aardpalu landfill was included last year. In this submission, the second combustion unit, which incinerates the same amount as the first one (already included in the previous submission), has been included.
Finland	-	-	-	-	
France	450	3.7	-72	-0.6	Emissions evolve from 2014 following the update of the activity from 2013 (the waste deposited in year N begins to emit in year N + 1)
Germany	-	-	-	-	
Greece	-	-	26	0.8	Updated activity data as far as estimated composition of MSW generated for the period 1998 – 2016 and for MSW.
Hungary	-	-	-18	-0.6	Revised amount of disposed waste; Flaring is taken into account (subtracted)
Ireland	-	-	1	0.1	This year recalculations show a 0.1 per cent increase in emissions in 2015 due to a revision of flaring data.
Italy	-5 952	-32.8	-134	-1.0	According to the ESD review process parameters of the model have been updated (wet vs dry emission factors)
Latvia	-	-	-	-	
Lithuania	-0	-0.0	1	0.2	Calculated emissions slightly changed due to updated solid waste disposal data provided by the Lithuanian EPA.
Luxembourg	-4	-3.7	1	2.2	For the entire time-series from 1990-2016 the share of waste incinerated, directly deposited and deposited after biological treatment has been reviewed. The quantity of waste deposited has slightly changed due to this revision.
Malta	-	-	-	-	-
Netherlands	-0	-0.0	29	1.0	The main reason is that the value of the methane content of landfill gas does not decrease in the former transition period 2000-2004, but only since 2005. Emissions from waste that was landfilled in the period 2000-2004 have a higher amount of

	1990		2015		Main explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
					methane than in previous submissions.
Poland	-349	-3.1	-608	-6.7	new value of F factor for industrial, unmanaged and uncategorized waste disposal was applied
Portugal	92	3.4	180	4.9	1) Revision of urban waste composition, in order to take into account the outcomes from the last (2016) UNFCCC review report (Sept. 2017), which recommended to revise DOC values for the “non-food fermentable materials” and “wood” waste categories, which were reported as zero for the 1960s, 1970s and 1980s and included in “food waste” with a lower DOC value. New accounting includes the estimate of those fractions and the consideration of DOC content values of 20 and 43, for “non-food fermentable materials” and “wood”, respectively. Concerning Industrial waste, and as recommended also from the last UNFCCC review, the DOC values for several categories have been revised in order to fully apply the default DOC values from the 2006 IPCC Guidelines for also historical depositions. Furthermore some waste categories have been disaggregated (e.g. previously reported category “paper and textiles”) in order to consider diverse DOC defaults. 2) Revision of landfill biogas recovered amounts; previous data considered errousnly biogas recovered in biological treatment of waste (anaerobic digestion).
Romania	-	-	-5	-0.1	CH_4 emissions were recalculated for 2015 year taking into account the final data associated to the amount of waste.
Slovakia	-	-	6	0.6	Correction in methane recovery from SWDS.
Slovenia	-	-	-	-	
Spain	-	-	877	8.9	Information about the activity data for category 5A is provided by the focal point for year X-3, and data for year X-2 is replicated. Therefore, for 2018 Inventory edition, latest available AD for category 5A corresponds to year 2015. Estimation for that year included in 2017 Inventory is updated (recalculated) and AD for year 2016 replicates that of 2015.
Sweden	-	-	-0	-0.0	Minor correction.
United Kingdom	**-**	**-**	**873**	**7.2**	Changes due to MELMOD upgrade (move to 4 Devolved Administration specific models; incorporation of DA specific data)
EU28	-5 762	-3.0	1 424	1.4	
Iceland	16	11.2	39	21.5	Updated the IPCC FOD model with changes in data and parameters
United Kingdom (KP)	**-67**	**-0.1**	**854**	**6.9**	Changes due to MELMOD upgrade (move to 4 Devolved Administration specific models; incorporation of DA specific data)
EU28+ISL	-5 813	-3.0	1 444	1.4	

7.2.2 Biological treatment of solid waste (CRF Source Category 5B)

Source category 5B Biological treatment of solid waste includes the key sources CH_4 and N_2O from 5B1 Composting. Besides composting the source category 5B includes the subcategory 5B2 anaerobic digestion and also emissions from mechanical-biological treatment according to the IPCC 2006 Guidelines. The whole sector 5.B contributes only 0.2 % to EU+ISL total GHG emissions without LULUCF in 2016. Decomposition of biomass during biological treatment is much faster than on landfills and the CH_4 and N_2O emissions are estimated on an annual basis without the need for long time series as in the case of landfills. For composting the decomposition of the organic waste fraction takes place under aerobic conditions. In anaerobic digestion processes the decomposition takes place without oxygen. Further information on emission trends and methodologies is only provided for source category composting 5B1, as anaerobic digestion 5B2 is no EU key source.

Table 7.7 provides total GHG and CH_4 and N_2O emissions by Member State and Iceland from 5B Biological treatment of solid waste. Total emissions from this category increased considerably since 1990. Eleven countries (Bulgaria, Croatia, Cyprus, Czech Republic, Greece, Iceland, Ireland, Luxembourg, Malta, Romania and Slovenia) did not practice this kind of waste treatment in 1990. Due to landfill regulations etc. this type of waste treatment increased considerably during the last years and all countries report emissions from this category in 2016.

Table 7.7 5B Biological treatment of solid waste: Member States' contributions to total GHG emissions and CH_4 and N_2O emissions

Member State	GHG emissions in 1990 (kt CO2 equivalents)	GHG emissions in 2016 (kt CO2 equivalents)	N2O emissions in 1990 (kt CO2 equivalents)	N2O emissions in 2016 (kt CO2 equivalents)	CH4 emissions in 1990 (kt CO2 equivalents)	CH4 emissions in 2016 (kt CO2 equivalents)
Austria	36	180	23	98	13	83
Belgium	7	64	4	39	3	25
Bulgaria	NO	45	NO	19	NO	26
Croatia	NE,IE,NO	5	NO,NE,IE	2	NO,NE,IE	3
Cyprus	NO	7	NO	3	NO	4
Czech Republic	NE,IE	711	NE,IE	64	NE,IE	648
Denmark	52	457	12	100	40	357
Estonia	1	35	0	15	1	20
Finland	44	101	18	38	26	63
France	134	536	88	312	46	224
Germany	41	994	16	304	25	690
Greece	NO	31	NO	13	NO	18
Hungary	9	145	4	39	5	106
Ireland	NO	20	NO	8	NO	12
Italy	25	653	20	530	5	123
Latvia	41	56	17	23	24	33
Lithuania	0	59	0	21	0	38
Luxembourg	NA,IE,NO	26	NA,NO	5	NO,IE	20
Malta	NO	1	NO	NO,NA	NO	1
Netherlands	20	177	6	90	14	87
Poland	8	340	3	142	5	198
Portugal	9	38	4	14	5	25
Romania	NO	60	NO	25	NO	35
Slovakia	111	159	46	66	65	93
Slovenia	NO	13	NO	5	NO	7
Spain	132	656	55	261	77	395
Sweden	12	126	5	34	7	92
United Kingdom	9	1 723	4	656	5	1 068
EU-28	**692**	**7 421**	**326**	**2 927**	**366**	**4 494**
Iceland	NO	4	NO	2	NO	2
United Kingdom (KP)	9	1 725	4	656	5	1 069
EU-28 + ISL	**692**	**7 427**	**326**	**2 929**	**366**	**4 498**

Abbreviations explained in the Chapter 'Units and abbreviations'.

7.2.2.1 Waste Composting (CRF Source Category 5B1)

Emission and Trends

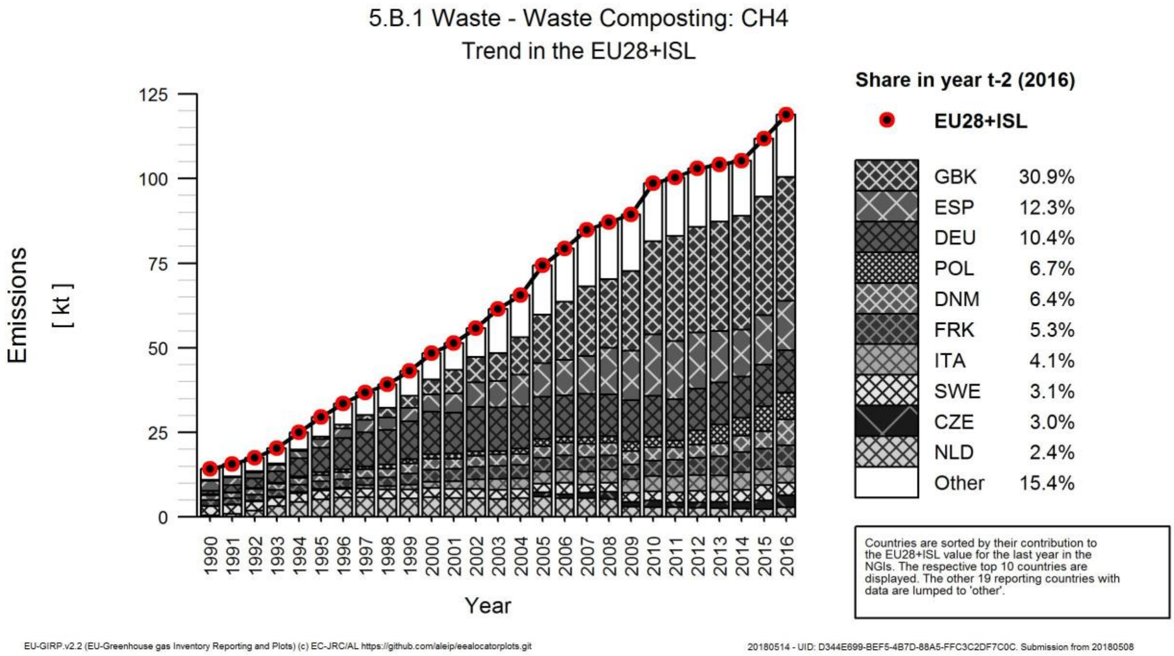
CH_4 emissions from 5B1 Composting account for 0.1 % of total EU-28+ISL GHG emissions in 2016. Between 1990 and 2016, CH_4 emissions from this source increased considerably from 357 kt CO_2 equivalents to 2972 kt CO_2 equivalents in 2016 (Table 7.8). Malta reports emissions from composting only in the period 1993 - 2006. All Member States that practice composting feature an increasing emission trend from 1990 onwards. Nevertheless between 2015 and 2016 nine Member States experienced a decrease in CH_4 emissions from composting. Total CH_4 emissions from composting increased by 6 % between 2015 and 2016.

Table 7.8: 5B1 Waste Composting: Member States contributions to CH_4 emissions and information on method applied and emission factor

Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016		Method	Emission factor Informa-tion
	1990	2015	2016		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	13	58	60	2.0%	47	360%	2	4%	T2	CS
Belgium	3	25	25	0.9%	23	878%	0	0%	T1	CS
Bulgaria	NO	31	26	0.9%	26	∞	-5	-15%	T1	D
Croatia	IE,NE	6	3	0.1%	3	∞	-3	-55%	T1	D
Cyprus	NO	4	4	0.1%	4	∞	0	-1%	T1	D
Czech Republic	NE	62	89	3.0%	89	∞	27	43%	T1	D
Denmark	35	127	191	6.4%	157	452%	64	51%	CS,T1	CS,OTH
Estonia	1	15	20	0.7%	20	2905%	5	36%	T1	D
Finland	26	61	54	1.8%	28	110%	-8	-13%	T1	D
France	44	153	157	5.3%	113	260%	4	3%	T2	CS
Germany	25	310	310	10.4%	284	1123%	0	0%	T2	CS
Greece	NO	14	18	0.6%	18	∞	5	35%	D	D
Hungary	5	48	55	1.8%	50	997%	7	15%	T1	D
Ireland	NO	12	12	0.4%	12	∞	0	-4%	T1	D
Italy	5	118	120	4.1%	116	2512%	2	2%	D	CS
Latvia	24	26	33	1.1%	9	36%	7	26%	D	D
Lithuania	0	13	30	1.0%	30	14509%	17	126%	T1	D
Luxembourg	NO	7	8	0.3%	8	∞	1	15%	T1	D
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	14	58	72	2.4%	58	424%	14	24%	T2	CS
Poland	5	184	198	6.7%	194	3957%	15	8%	T1	D
Portugal	5	19	19	0.6%	14	277%	0	-1%	T1	D
Romania	NO	37	35	1.2%	35	∞	-1	-4%	T1	D
Slovakia	65	114	93	3.1%	28	43%	-21	-18%	T1	D
Slovenia	NO	7	7	0.3%	7	∞	0	3%	T1	D
Spain	77	365	365	12.3%	288	375%	0	0%	T1	D
Sweden	7	42	48	1.6%	41	571%	6	14%	T1	D
United Kingdom	5	876	917	30.8%	911	16624%	41	5%	T1	D
EU-28	**357**	**2 791**	**2 969**	**100%**	**2 611**	**731%**	**178**	**6%**	**-**	**-**
Iceland	NO	2	2	0.1%	2	∞	0	7%	T2	CS,D
United Kingdom (KP)	5	877	918	30.9%	912	16644%	41	5%	T1	D
EU-28 + ISL	**357**	**2 794**	**2 972**	**100%**	**2 615**	**732%**	**178**	**6%**	**-**	**-**

Presented methods and emission factor information refer to the last inventory year.
Abbreviations explained in the Chapter 'Units and abbreviations'.

Figure 7.12 5B1 Waste Composting: CH_4 emissions (Trend in relevant MS)



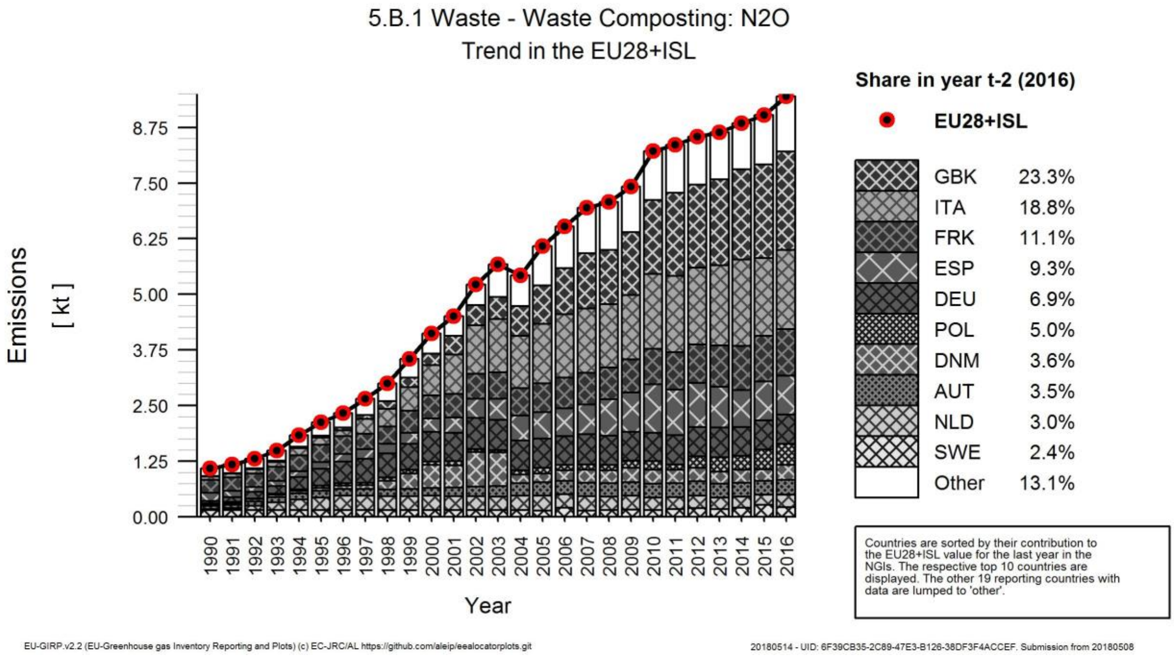
N_2O emissions from 5B1 Composting account for 0.1 % of total EU-28+ISL GHG emissions in 2016. Between 1990 and 2016, N_2O emissions from this source increased considerably from 326 kt CO_2 equivalents to 2814 kt CO_2 equivalents in 2016 (Table 7.9). Between 2015 and 2016 total N_2O in EU 28+ISL emissions increased by 5 %.

Table 7.9: 5B1 Waste Composting: Member States contributions to N_2O emissions and information on method applied and emission factor

Member State	N2O Emissions in kt CO2 equiv.			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016		Method	Emission factor Informa-tion
	1990	2015	2016		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	23	94	98	3.5%	75	330%	4	4%	T2	CS
Belgium	4	39	39	1.4%	35	878%	0	0%	T1	CS
Bulgaria	NO	22	19	0.7%	19	∞	-3	-15%	T1	D
Croatia	IE,NE	4	2	0.1%	2	∞	-2	-55%	T1	D
Cyprus	NO	3	3	0.1%	3	∞	0	-1%	T1	D
Czech Republic	NE	45	64	2.3%	64	∞	19	43%	T1	D
Denmark	12	76	100	3.6%	88	729%	24	31%	CS,T1	CS,OTH
Estonia	0	11	15	0.5%	14	2905%	4	36%	T1	D
Finland	18	44	38	1.4%	20	110%	-6	-13%	T1	D
France	88	304	312	11.1%	224	255%	8	3%	T2	CS
Germany	16	195	195	6.9%	179	1123%	0	0%	T2	CS
Greece	NO	10	13	0.5%	13	∞	3	35%	D	D
Hungary	4	34	39	1.4%	36	997%	5	15%	T1	D
Ireland	NO	9	8	0.3%	8	∞	0	-4%	T1	D
Italy	20	521	530	18.8%	510	2512%	9	2%	D	D
Latvia	17	18	23	0.8%	6	36%	5	26%	D	D
Lithuania	0	9	21	0.8%	21	14509%	12	126%	T1	D
Luxembourg	NO	5	5	0.2%	5	∞	0	9%	T1	D
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	6	69	83	3.0%	77	1300%	15	22%	T2	CS
Poland	3	131	142	5.0%	138	3957%	11	8%	T1	D
Portugal	4	14	14	0.5%	10	277%	0	-1%	T1	D
Romania	NO	26	25	0.9%	25	∞	-1	-4%	T1	D
Slovakia	46	81	66	2.4%	20	43%	-15	-18%	T1	D
Slovenia	NO	5	5	0.2%	5	∞	0	3%	T1	D
Spain	55	261	261	9.3%	206	375%	0	0%	T1	D
Sweden	5	30	34	1.2%	29	571%	4	14%	T1	D
United Kingdom	4	626	656	23.3%	652	16624%	29	5%	T1	D
EU-28	**326**	**2 687**	**2 811**	**100%**	**2 485**	**762%**	**124**	**5%**	**-**	**-**
Iceland	NO	2	2	0.1%	2	∞	0	7%	T1	D
United Kingdom (KP)	4	627	656	23.3%	653	16644%	29	5%	T1	D
EU-28 + ISL	**326**	**2 689**	**2 814**	**100%**	**2 488**	**763%**	**125**	**5%**	**-**	**-**

Presented methods and emission factor information refer to the last inventory year.
Abbreviations explained in the Chapter ‘Units and abbreviations’.

Figure 7.13 5B1 Waste Composting: N_2O emissions (Trend in relevant MS)



Methodological information

According to the IPCC 2006 Guidelines CH_4 and N_2O emissions from composting are estimated by using the quantity of organic waste processed by composting and the respective emission factor. The application of a Tier 2 method requires the use of a country specific emission factor based on representative measurements. The IPCC default emission factor for CH_4 emissions from composting is 10 g CH_4/kg waste treated on a dry weight basis and 4 g CH_4/kg based on a wet weight basis. The range of this emission factor is very high and varies between 0.08 and 20 g CH_4/kg waste treated. Most Member States apply the default EF for CH_4 emissions based on a wet weight basis, while Hungary, Lithuania, Sweden and the United Kingdom use activity data in kt dry matter in the CRF tables (see Table 7.10). Only Austria, Belgium, Denmark, France, Germany, Italy, and the Netherlands apply country specific EFs. For Finland and Luxembourg the EF reported in the CRF Table 5.B. and summarized in Table 7.10 and Table 7.11 are higher than for the other MS as they include composting of sludge, which is mainly reported on a dry weight basis. In most cases country specific EFs are much lower than the IPCC default EF. The use of country specific EFs for CH_4 emissions from composting shows that CH_4 emissions are lower than the IPCC default EF if the facility is well operating.

Table 7.10 5B1 Composting: EFs applied by Member States in 2016 in g CH_4/kg waste treated

Member States	EF CH_4 emissions	Member States	EF CH_4 emissions
Austria	1.82	Italy	1.63
Belgium	0.75	Latvia	4.00
Bulgaria	4.00	Lithuania	10.00
Croatia	4.00	Luxembourg	9.66
Cyprus	4.00	Malta	NO
Czech Republic	4.00	Netherlands	0.82
Denmark	4.09	Poland	4.00
Estonia	4.00	Portugal	4.00
Finland	5.82	Romania	4.00
France	0.78	Slovakia	4.00
Germany	1.40	Slovenia	4.00
Greece	4.00	Spain	4.00
Hungary	10.00	Sweden	11.43
Iceland	4.00	United Kingdom	10.00
Ireland	4.00		

Source: CRF Table 5.B 2018

The IPCC default emission factor for N_2O emissions from composting is 0.6 g N_2O/kg waste treated on a dry weight basis and 0.24 g N_2O/kg based on a wet weight basis. The range of this emission factor is very high and is between 0.2 and 1.6 g N_2O/kg for dry waste treated and 0.06 and 0.6 g N_2O/kg for wet waste. Most Member States apply the default EF for calculating N_2O emissions from composting based on a wet weight basis**,** while Hungary, Lithuania, Italy, Sweden and the United Kingdom use activity data in kt dry matter in the CRF tables (see Table 7.10). Only Austria, Belgium, Denmark, France, Germany and the Netherlands apply country specific EFs. For Finland and Luxembourg the EF reported in the CRF Table 5.B. and summarized in Table 7.10 and Table 7.11 are higher than for the other MS as they include composting of sludge, which is mainly reported on a dry weight basis. In most cases country specific EFs are much lower than the IPCC default EF. The use of country specific EFs for N_2O emissions from composting shows that N_2O emissions are lower than the IPCC default EF if the facility is well operating.

Table 7.11 5B1 Composting: EFs applied by Member States in 2016 in g N_2O/kg waste treated

Member States	EF N_2O emissions	Member States	EF N_2O emissions
Austria	0.25	Italy	0.60
Belgium	0.10	Latvia	0.24
Bulgaria	0.24	Lithuania	0.60
Croatia	0.24	Luxembourg	0.55
Cyprus	0.24	Malta	NO
Czech Republic	0.24	Netherlands	0.08
Denmark	0.18	Poland	0.24
Estonia	0.24	Portugal	0.24
Finland	0.35	Romania	0.24
France	0.13	Slovakia	0.24
Germany	0.07	Slovenia	0.24
Greece	0.24	Spain	0.24
Hungary	0.60	Sweden	0.69
Iceland	0.24	United Kingdom	0.60
Ireland	0.24		

Source: CRF Table 5.B 2018

Further methodological information for all Member States is provided in the Annex of this submission.

7.2.2.2 Recalculations (CRF Source Category 5B)

Table 7.12 and Table 7.13 provide information on the contribution of Member States to EU recalculations in N_2O and CH_4 from 5B Biological treatment of solid waste for 1990 and 2015 and main explanations (if available in Member States' inventories) for the largest recalculations in absolute terms.

Table 7.12: 5B Biological treatment: Contribution of Member States to EU recalculations in N_2O for 1990 and 2015 (difference between latest submission and previous submission)

	1990		2015		Main explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
Austria	-	-	-	-	
Belgium	-	-	-	-	
Bulgaria	-	-	-	-	
Croatia	-	-	-	-	
Cyprus	-	-	-	-	
Czech Republic	-	-	-	-	
Denmark	-	-	-37	-32.4	Updated activity data for composting in the period 2010-2016 have resulted in decrease in the emission increases from compost in the years 2010 to 2015 from 0.2% in 2010 to 13% in 2015.
Estonia	-	-	-	-	
Finland	-	-	-	-	
France	-	-	-27	-8.3	In the 2017 submission, the activity data was the amount of incoming waste in the composting sites. In the 2018 submission the revised activity data has been corrected to subtract the rejections and only take into account the actually composted quantities

	1990		2015		Main explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
Germany	-	-	-23	-6.9	The activity data for the current reporting year must be estimated as the official Waste statistics with one year delay appears. Regular recalculations are therefore always required for the previous year.
Greece	-	-	1	8.0	Updated AD fort he year 2015.
Hungary	-	-	-	-	
Ireland	-	-	1	7.1	A revised composting activity data for 2015 were was incorporated into the inventory resulting in a 7.1 per cent increase in emissions from this sub-category.
Italy	-	-	-	-	
Latvia	-	-	-	-	
Lithuania	-3	-94.9	-5	-35.5	Calculated emissions are recalculated due to updated waste composting data provided by the Lithuanian EPA.
Luxembourg	-	-	-4	-43.6	Revised AD.
Malta	-	-	-	-	
Netherlands	-1	-8.6	-1	-1.9	Compared with the previous submission, minor errors in the data were corrected in this submission and final statistics is used.
Poland	-	-	-	-	
Portugal	-	-	-	-	
Romania	-	-	2	8.3	N_2O emissions are recalculated for 2015 year taking into account the final data associated to the amount of composted waste.
Slovakia	-	-	-	-	
Slovenia	-	-	-	-	
Spain	-	-	13	5.1	As with other categories for which the SGR is the focal point, they have recalculated the emissions of the year 2015 by having its own updated information of that year. As mentioned, this is due to the time lag between the reference year for the waste data and the last year reported by the Inventory.
Sweden	-	-	-	-	
United Kingdom	-	-	-26	-4.0	Correction to household composting data; new WRAP report regarding organics in the UK for 2014 and 2015, published in spring of 2017
EU28	-3	-1.0	-107	-3.7	
Iceland	-	-	-0	-20.0	Update of N_2O emission factor from 0.3 g N_2O/(kg waste composted) to 0.24 g N_2O/(kg waste composted) in accordance to the 9th corrigenda of the 2006 IPCC Guidelines.
United Kingdom (KP)	-	-	-27	-4.1	Correction to household composting data; new WRAP report regarding organics in the UK for 2014 and 2015, published in spring of 2017
EU28+ISL	-3	-1.0	-109	-3.7	

Table 7.13: 5B Biological treatment: Contribution of Member States to EU recalculations in CH_4 for 1990 and 2015 (difference between latest submission and previous submission)

	1990		2015		Main explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
Austria	-	-	-	-	
Belgium	-	-	-	-	
Bulgaria	-	-	-	-	
Croatia	-	-	-	-	
Cyprus	-	-	-	-	
Czech Republic	-	-	-	-	
Denmark	2	5.1	50	26.8	Updated activity data for composting in the period 2010-2016 have resulted in decrease in the emission increases from compost in the years 2010 to 2015 from 0.2% in 2010 to 13% in 2015. For manure-based biogas

	1990		2015		Main explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
					production recalculations through the time series has resulted in an increase in the methane emission of 35% throughout the time series.
Estonia	-	-	-	-	
Finland	-	-	-	-	
France	-	-	-38	-15.5	In the 2017 submission, the activity data was the amount of incoming waste in the composting sites. In the 2018 submission the revised activity data has been corrected to subtract the rejections and only take into account the actually composted quantities.
Germany	-	-	-86	-11.1	The activity data for the current reporting year must be estimated as the official Waste statistics with one year delay appears. Regular recalculations are therefore always required for the previous year.
Greece	-	-	1	8.0	Updated AD for the year 2015.
Hungary	-	-	0	0.1	Slightly revised biomass production data
Ireland	-	-	1	7.1	A revised composting activity data for 2015 was incorporated into the inventory resulting in a 7.1 per cent increase in emissions from this sub-category.
Italy	-	-	-1	-0.8	Update of AD for the year 2015.
Latvia	-	-	-	-	
Lithuania	-4	-94.9	-7	-26.2	Calculated emissions are recalculated due to updated waste composting data provided by the Lithuanian EPA.
Luxembourg	-	-	-3	-13.5	Revision of AD and EF.
Malta	-	-	-	-	
Netherlands	0	0.5	-0	-0.3	Compared with the previous submission, minor errors in the data were corrected in this submission and final statistics is used.
Poland	-	-	-	-	
Portugal	-	-	-	-	
Romania	-	-	3	8.3	CH_4 emissions are recalculated for 2015 year taking into account the final data associated to the amount of composted waste.
Slovakia	-	-	-	-	
Slovenia	-	-	-	-	
Spain	-	-	17	4.5	As with other categories for which the SGR is the focal point, they have recalculated the emissions of the year 2015 by having its own updated information of that year. As mentioned, this is due to the time lag between the reference year for the waste data and the last year reported by the Inventory.
Sweden	0	3.8	-0	-0.0	Correction of activity data.
United Kingdom	-0	-1.9	-47	-4.5	New WRAP data for non-household composting, correction to extrapolation for household composting.
EU28	-2	-0.4	-110	-2.5	
Iceland	-	-	-0	-0.0	
United Kingdom (KP)	-0	-1.9	-49	-4.6	New WRAP data for non-household composting, correction to extrapolation for household composting.
EU28+ISL	-2	-0.4	-112	-2.6	

7.2.3 Wastewater treatment and discharge (CRF Source Category 5D)

Source category 5D includes the CH_4 and N_2O emissions from domestic and industrial and other wastewater treatment and discharge. Methane and nitrous oxide are produced from microbial processes (anaerobic decomposition of organic matter, nitrification) in sewage systems and facilities.

N_2O is also indirectly released from disposal of wastewater effluents into aquatic environments[71]. According to the key category analysis CH_4 and N_2O emissions from 5D1 Domestic wastewater and CH_4 emissions from 5D2 Industrial wastewater are an EU key source and analysed in more detail in the following chapter. N_2O emissions from industrial wastewater are not contributing to an EU key source and are therefore not further analysed in this chapter.

Domestic wastewater includes the handling of liquid wastes and sludge from housing and commercial sources through wastewater collection and treatment, open pits/latrines, ponds, or discharge into surface waters. Industrial wastewater can also be released into domestic sewer systems and included under domestic wastewater. On the other hand it can be treated on site and then it will be accounted under the separate category 5D2 industrial wastewater.

Total emissions from wastewater handling, including N_2O and CH_4 emissions account for 0.6 % of total EU-28+ISL GHG emissions in 2016. Table 7.14 shows total GHG, CH_4 and N_2O emissions by Member State from 5D Wastewater Handling. Between 1990 and 2016, total emissions from wastewater handling decreased by 37 % in EU-28+ISL. All Member States except for France, Ireland and Iceland decreased their emissions from wastewater treatment and discharge between 1990 and 2016. Due to the implementation of new wastewater treatment technologies CH_4 emission decreased considerably by 42 % between 1990 and 2016, while N_2O emissions decreased moderately by 16 %.

[71] In most countries, indirect N2O emissions from disposal of wastewater effluents are the major source of N_2O emissions from wastewater handling, whereas direct N_2O emissions from wastewater treatment plants are small or not relevant.

Table 7.14 5D Wastewater handling: Member states' contributions to total GHG, CH_4 and N_2O emissions from 5D

Member State	GHG emissions in 1990 (kt CO2 equivalents)	GHG emissions in 2016 (kt CO2 equivalents)	N2O emissions in 1990 (kt CO2 equivalents)	N2O emissions in 2016 (kt CO2 equivalents)	CH4 emissions in 1990 (kt CO2 equivalents)	CH4 emissions in 2016 (kt CO2 equivalents)
Austria	217	187	96	164	121	24
Belgium	973	294	138	103	835	191
Bulgaria	3 011	1 017	198	142	2 812	875
Croatia	634	555	67	88	567	467
Cyprus	128	78	12	16	116	62
Czech Republic	1 124	1 063	234	197	890	865
Denmark	205	176	109	65	96	111
Estonia	151	87	39	30	113	57
Finland	300	253	79	83	221	170
France	2 256	2 598	722	403	1 534	2 195
Germany	4 062	1 033	1 423	458	2 639	575
Greece	2 620	1 311	279	327	2 341	984
Hungary	1 086	356	148	76	938	280
Ireland	136	147	75	97	61	50
Italy	4 488	3 839	1 266	1 351	3 222	2 488
Latvia	375	285	53	32	322	253
Lithuania	538	182	67	44	471	138
Luxembourg	16	10	9	7	7	3
Malta	27	7	10	5	17	2
Netherlands	481	292	172	72	309	220
Poland	4 501	1 261	723	760	3 778	501
Portugal	2 599	2 566	200	250	2 399	2 316
Romania	3 652	2 213	505	529	3 146	1 683
Slovakia	596	349	130	49	466	300
Slovenia	238	174	39	37	199	137
Spain	3 370	2 376	863	963	2 507	1 413
Sweden	263	234	226	205	38	29
United Kingdom	4 963	4 089	765	696	4 197	3 393
EU-28	**43 012**	**27 034**	**8 648**	**7 252**	**34 364**	**19 782**
Iceland	8	13	6	7	2	6
United Kingdom (KP)	4 987	4 124	780	716	4 207	3 408
EU-28 + ISL	**43 044**	**27 082**	**8 668**	**7 279**	**34 375**	**19 803**

Abbreviations explained in the Chapter 'Units and abbreviations'.

7.2.3.1 Domestic wastewater (CRF Source Category 5D1)

CH_4 emissions

CH_4 emissions from 5D1 Domestic Wastewater account for 0.2 % of total EU-28+ISL GHG emissions in 2016. Between 1990 and 2016, CH_4 emissions decreased by 53 % (Table 7.15). Key drivers for the large emission reduction are the introduction of wastewater treatment technologies and an increase of CH_4 recovery and flaring (see ***Figure 7.15***). In 2016, CH_4 emissions decreased by 5 % in comparison to 2015.

Table 7.15 5D1 Domestic and commercial wastewater: Member States' contributions to CH_4 emissions

Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016		Method	Emission factor Informa-tion
	1990	2015	2016		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	121	23	24	0.2%	-98	-81%	0	1%	T2	CS,D
Belgium	835	202	191	1.8%	-644	-77%	-11	-5%	CR,T1	CR,D
Bulgaria	591	592	565	5.4%	-26	-4%	-27	-5%	T2	D
Croatia	471	367	363	3.4%	-108	-23%	-4	-1%	T1	D
Cyprus	92	33	33	0.3%	-59	-64%	0	0%	T1	D
Czech Republic	527	446	443	4.2%	-84	-16%	-3	-1%	T1	CS,D
Denmark	96	109	111	1.1%	15	16%	2	1%	CS	CS
Estonia	113	49	49	0.5%	-64	-57%	-1	-1%	T1	D
Finland	194	147	146	1.4%	-48	-25%	-1	-1%	CS,T2	CS,D
France	1 444	2 084	2 087	19.8%	642	44%	3	0%	T1	D
Germany	2 630	544	531	5.0%	-2 098	-80%	-13	-2%	CS,D	CS,D
Greece	1 520	163	163	1.5%	-1 357	-89%	0	0%	D	D
Hungary	803	274	256	2.4%	-547	-68%	-18	-7%	T1	D
Ireland	61	52	50	0.5%	-11	-17%	-2	-3%	T1,T2	CS,D
Italy	1 702	1 082	1 049	10.0%	-653	-38%	-32	-3%	T1	D
Latvia	185	99	98	0.9%	-87	-47%	-1	-1%	D	CS
Lithuania	471	147	138	1.3%	-333	-71%	-9	-6%	T1	D
Luxembourg	7	4	3	0.0%	-4	-55%	0	-7%	T1	CS
Malta	17	2	2	0.0%	-15	-87%	0	-5%	-	-
Netherlands	203	184	195	1.9%	-8	-4%	11	6%	T2	CS,D
Poland	3 152	581	245	2.3%	-2 907	-92%	-336	-58%	T1	CS,D
Portugal	1 258	854	849	8.1%	-408	-32%	-5	-1%	T2	CS,D
Romania	2 768	1 548	1 497	14.2%	-1 272	-46%	-51	-3%	D	D
Slovakia	437	301	295	2.8%	-142	-32%	-6	-2%	CS,D	D
Slovenia	186	154	136	1.3%	-50	-27%	-18	-12%	T1	CS,D
Spain	788	239	239	2.3%	-549	-70%	0	0%	T1,T2	D
Sweden	31	23	24	0.2%	-8	-25%	0	2%	T2	CS
United Kingdom	1 477	728	726	6.9%	-751	-51%	-1	0%	CS	CS
EU-28	**22 180**	**11 031**	**10 508**	**100%**	**-11 672**	**-53%**	**-523**	**-5%**	**-**	**-**
Iceland	2	5	6	0.1%	3	167%	0	3%	T1	CS,D
United Kingdom (KP)	1 487	743	741	7.0%	-745	-50%	-1	0%	CS	CS
EU-28 + ISL	**22 192**	**11 052**	**10 529**	**100%**	**-11 663**	**-53%**	**-523**	**-5%**	**-**	**-**

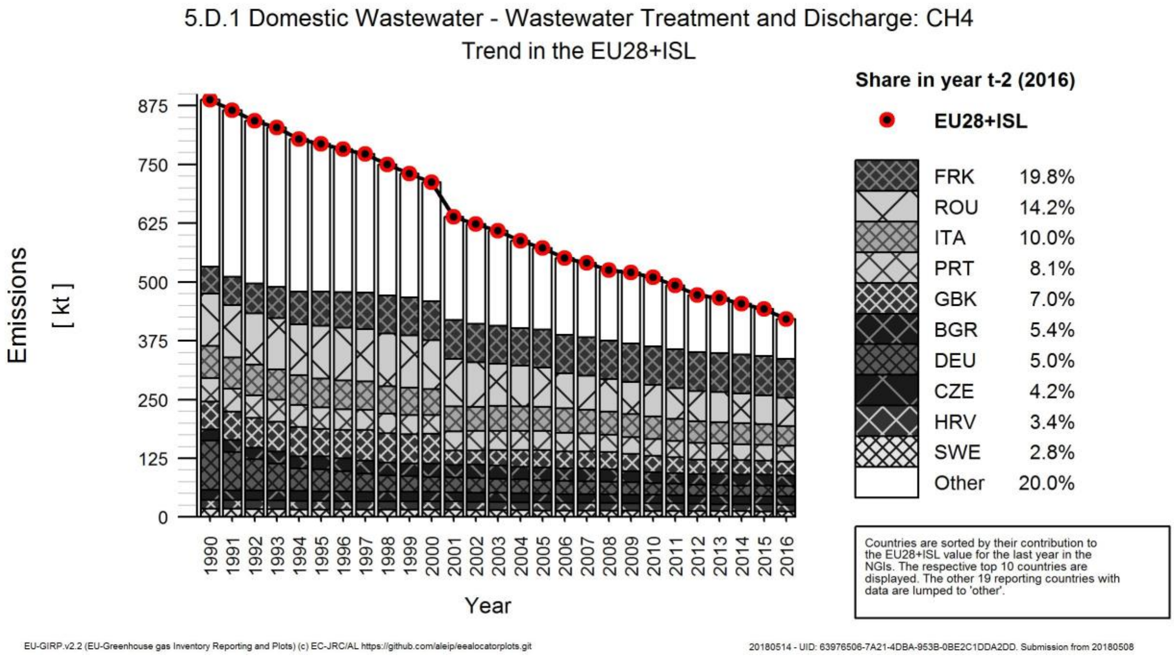
Note: According to the MS NIR Malta apply a Tier 1 method to calculate CH_4 emissions from domestic wastewater handling.
Presented methods and emission factor information refer to the last inventory year.
Abbreviations explained in the Chapter 'Units and abbreviations'.

Trends in Emissions and Activity Data for CH_4 emissions from domestic wastewater

CH_4 emissions from domestic wastewater treatment and discharge decreased considerably between 1990 and 2016 by 53 %. Figure 7.14 shows the trend of emissions indicating the countries contributing most to EU-28+ISL total.

Large decreases in absolute terms between 1990 and 2016 are reported by Germany, Greece, Poland and Romania, contributing together to only 23 % of EU-28+ISL emissions from source 5D1 in 2016, whereas France shows significant emission increases (Table 7.15). France is responsible for 19.8 %, Italy for 10.0 % and Romania for 14.2 % of EU-28+ISL emissions from this source in 2016. Although France increased its emissions between 1990 and 2016, the trend of EU-28+ISL emissions is dominated by the large emission reductions in Germany, Greece, Poland and Romania. Also Belgium, Italy, Spain and the United Kingdom achieved significant reductions in emissions compared to 1990.

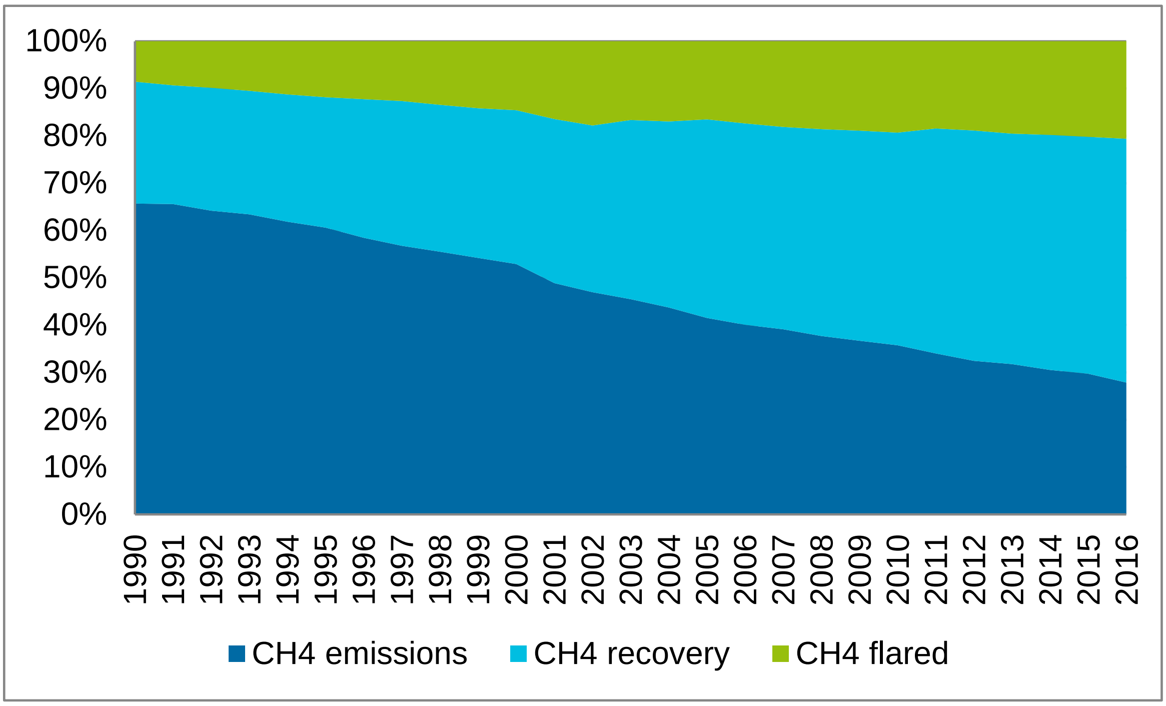
Figure 7.14 5D1 Domestic wastewater: CH_4 emissions (Trend in relevant MS)



The decreasing trend of CH_4 emissions from wastewater is not related to a decreasing quantity of wastewater and the amount of the total organic product in the wastewater. In fact the decrease is based on several reasons:

- Increased share of CH_4 flared or recovered (see *Figure 7.15*)
- Improvements of wastewater disposal routes
- Amount of sludge removed

Figure 7.15 5D1 Domestic wastewater: Share of CH_4 recovered or flared and CH_4 emissions on total CH_4 produced from domestic wastewater handling



Source: CRF 2018, Table 5D

In 2016 21 % of the CH_4-emissions generated by Domestic Wastewater Handling were flared and 52 % was recovered for energy purposes.

An important driver for CH_4 emissions from 5D Wastewater Handling are CH_4 emissions from 5D1 Domestic Wastewater in Germany, Greece, Poland and Romania in 1990. Therefore, more information about the development of CH_4 emissions from wastewater handling in these and other important countries is presented.

France's CH_4 emissions from domestic wastewater (5D1) show an increasing trend from 1990 to 2001 and remain at a rather constant level thereafter (with a slight increase since 2006). One driver influencing the trend is the share of population connected to different wastewater treatment systems. The share of the population connected to septic tanks increased from 1990 to 2000 (from 13 % in 1990 to 18 % in 2000), and remained almost constant thereafter (17 %). In the same period, the share of the population with direct discharge of wastewater decreased from 8 % in 1990 to 2 % in 2005. Wastewater treatment in collective systems increased slightly from 79 % in 1990 to 81 % in 2005. According to the NIR 2018 the share of wastewater treated in the different treatment routes is constant from 2005 onwards. Furthermore France applies CH_4 recovery for generated CH_4 from wastewater since 1990. CH_4 recovery peaks in 2014 and declines again in 2015 and remains constant in 2016.

CH_4 emissions from domestic wastewater are continuously decreasing from 1999 onwards in **Romania**. The amount of wastewater that underlies sufficient treatment increases over the years. About 57 % of the total wastewater has been treated appropriate, 13 % remained untreated and 30 % of total wastewater received only insufficient treatment in 2016. Between 2000 and 2016 public sewage systems have been expanded and modernized.

Germany's reduction in CH_4 emissions from domestic and commercial wastewater (5D1) occurred mainly between 1990 and 1998. The decrease of 95 % in that period was due to the legal requirement to connect households to decentralised wastewater treatment plants. The basis for legal requirements for the collection and treatment of domestic and commercial wastewater is the Council directive

91/271/EWG concerning urban wastewater treatment from 1991. Many wastewater plants had to be built in the former GDR after the German reunification, as most households were not connected to a sewage system, but used septic tanks.

The **Greek** CH_4 emissions from 5D1 decreased mainly between 1990 and 2007 (-89 %) due to the increased number of wastewater handling facilities with aerobic conditions. Domestic wastewater handling in aerobic treatment facilities shows a substantial increase since 1999.

Italian CH_4 emissions from domestic wastewater handling decreased slightly throughout the time series. In 1990 57 % of population was served by sewer systems and only 52 % of the population was served by wastewater treatment plants. In 2016 about 83 % of population is served by wastewater treatment plants.

CH_4 emissions from domestic wastewater handling in **Poland** decreased continuously throughout the time series. The share of rural population using septic tanks for domestic wastewater storage decreased from 97 % in 1990 to 59 % in 2016 and the share of urban populations using septic tanks decreased from 19 % to 9 % in the same period. Instead the treatment pathway using high nutrient removal increased for rural population from 0 % to 20.5 % and from 0 % for urban population to 82.5 % between 1990 and 2016.

Methodological information for CH_4 emissions from domestic wastewater

All wastewater generated by households as well as any wastewater not disposed of on site in industrial installations is reported as domestic wastewater. CH_4 emissions from wastewater occur under anaerobic conditions, they can originate during all stages from wastewater generation to final disposal. CH_4 emissions from domestic wastewater handling (5D1) are a significant emission source in category 5D and key source in the EU. The IPCC 2006 Guidelines introduce three different Tier methods to calculate CH_4 emissions from waste water handling. Input data needed to estimate CH_4 emissions from domestic wastewater handling is the amount of total degradable organic carbon (TOW) produced in a country. The TOW needs to be calculated based on the total population and the quantity of carbon discharged per person and day expressed in Biochemical Oxygen Demand (BOD). Many Member States apply the default value for BOD (0.6 kg CH_4/kg BOD) to estimate the total degradable organic carbon. Furthermore the country specific share of the different treatment pathways and systems of wastewater need to be identified. This is mainly done by analysing wastewater statistics and determining the share of population that is connected to the central sewage system and remaining wastewater that is treated in septic tanks or other wastewater treatment plants. The IPCC 2006 Guidelines provide default MCFs (methane correction factor) for each pathway, but also country specific MCFs can be applied. In the Annex III of this submission a table on Member States specific methodology is provided.

If methane is recovered and burned (see *Figure 7.15*), the emissions from wastewater need to be adjusted accordingly. If sludge is removed from the wastewater, a corresponding quantity needs to be deducted from the Total Organically Degradable Content (TOW). Emissions from sludge decomposition are reported under solid waste disposal, biological treatment, burning or in the AFOLU sector depending on the disposal method.

Further methodological information for all Member States is provided in the Annex III of this submission.

N_2O emissions

N_2O emissions from domestic wastewater treatment and discharge decreased moderately between 1990 and 2016 by 14 % (Table 7.16). *Figure 7.16* shows the trend of emissions indicating the countries contributing most to EU-28+ISL total.

Table 7.16 5D1 Domestic and commercial wastewater: Member States' contributions to N_2O emissions

Member State	N2O Emissions in kt CO2 equiv.			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016		Method	Emission factor Informa-tion
	1990	2015	2016		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	96	162	164	2.3%	68	70%	2	1%	CS	CS,D
Belgium	138	101	103	1.4%	-35	-26%	2	2%	D	D
Bulgaria	198	143	142	2.0%	-57	-29%	-1	-1%	T1	D
Croatia	67	88	88	1.2%	21	32%	1	1%	T1	D
Cyprus	12	16	16	0.2%	4	35%	0	1%	T1	D
Czech Republic	234	197	197	2.8%	-37	-16%	0	0%	T1	CS,D
Denmark	61	63	59	0.8%	-2	-4%	-4	-6%	CS	CS
Estonia	39	30	30	0.4%	-8	-22%	0	0%	T1	D
Finland	58	69	70	1.0%	12	21%	1	2%	CS,T1	D
France	681	368	369	5.2%	-312	-46%	1	0%	T1	D
Germany	1 392	433	433	6.1%	-959	-69%	0	0%	CS,D	CS,D
Greece	274	321	321	4.5%	47	17%	0	0%	D	CS
Hungary	148	83	76	1.1%	-71	-48%	-7	-8%	CS	D
Ireland	75	94	97	1.4%	22	29%	3	3%	T1	D
Italy	1 198	1 301	1 300	18.3%	101	8%	-1	0%	T1	D
Latvia	51	33	32	0.5%	-18	-37%	-1	-2%	D	D
Lithuania	67	45	44	0.6%	-23	-34%	-1	-1%	T1	D
Luxembourg	9	7	7	0.1%	-2	-19%	0	2%	T1	D
Malta	10	6	5	0.1%	-4	-46%	0	-7%	-	-
Netherlands	23	24	25	0.4%	2	10%	0	2%	T1	D
Poland	723	760	760	10.7%	38	5%	0	0%	T1	D
Portugal	200	246	250	3.5%	50	25%	5	2%	T2	CS,D
Romania	505	533	529	7.5%	24	5%	-3	-1%	D	D
Slovakia	119	47	47	0.7%	-72	-61%	0	-1%	CS,T2	D
Slovenia	39	37	37	0.5%	-2	-5%	0	0%	T1	D
Spain	863	960	963	13.6%	100	12%	2	0%	D	D
Sweden	208	196	196	2.8%	-11	-5%	0	0%	T1	CS,D
United Kingdom	765	685	696	9.8%	-69	-9%	11	2%	T1	D
EU-28	**8 253**	**7 047**	**7 059**	**100%**	**-1 194**	**-14%**	**12**	**0%**	**-**	**-**
Iceland	6	7	7	0.1%	1	19%	0	3%	T1	D
United Kingdom (KP)	780	704	716	10.1%	-64	-8%	12	2%	T1	D
EU-28 + ISL	**8 273**	**7 073**	**7 085**	**100%**	**-1 188**	**-14%**	**12**	**0%**	**-**	**-**

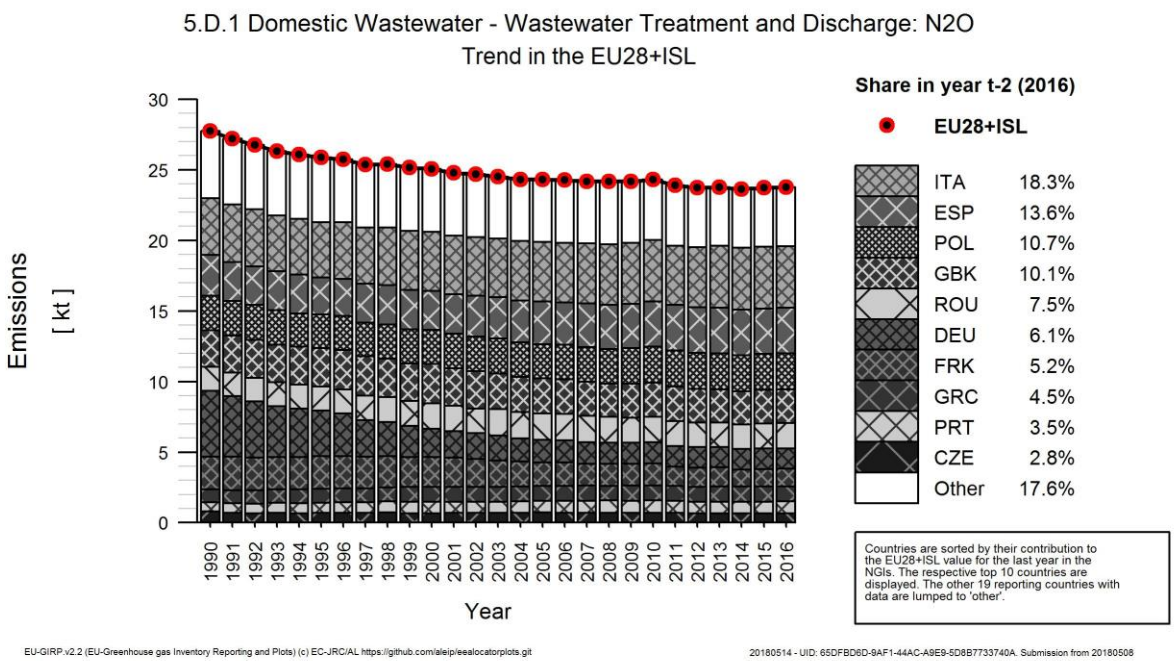
Note: According to the MS NIR Malta apply a Tier 1 method to calculate N_2O emissions from domestic wastewater handling.
Presented methods and emission factor information refer to the last inventory year.
Abbreviations explained in the Chapter 'Units and abbreviations'.

Trends in Emissions and Activity Data for N_2O emissions

According to the key category analysis N_2O emissions from domestic wastewater treatment are an EU key source. Between 1990 and 2016 N_2O emissions from domestic wastewater and discharge decreased only moderately by 14 %. *Figure 7.16* shows the trend of emissions indicating the countries contributing most to EU-28+ISL total.

Member States with large population have a high share of EU-28+ISL N_2O emissions from this source in general. In 2016 Italy is responsible for 18.3 %, Spain for 13.6 %, Poland for 10.7 % of EU-28+ISL N_2O emissions from wastewater treatment (see Table 7.16). Large decreases in absolute terms are reported by Germany and France between 1990 and 2016, as the amount of wastewater treated in advanced centralized wastewater treatment plants increased over the years.

Figure 7.16 5D1 Domestic wastewater: N_2O emissions (Trend in relevant MS)



Methodological information for N_2O emissions from domestic wastewater

Direct emissions of N_2O during processing only occur in countries with predominantly advanced centralized wastewater treatment plants with nitrification and denitrification steps. Indirect emissions come from wastewater treatment effluent discharged into aquatic environments. For direct emissions the quantity of wastewater treated in such facilities needs to be multiplied with a default emission factor. For indirect emissions, it is necessary to estimate the nitrogen in wastewater based on protein intake per person and correction factors to reflect non-consumed proteins and industrial/commercial co-discharged into the sewer system. If sludge is removed, a corresponding quantity of nitrogen needs to be deducted.

For the calculation of N_2O emissions from domestic wastewater no different tier levels are provided in the IPCC 2006 Guidelines and it is good practice to estimate N_2O emissions from domestic wastewater effluent by applying the methodology provided in the 2006 IPCC Guidelines. According to Table 7.16 only Austria, Denmark, Finland, Germany, Hungary, Portugal and Slovakia apply a country specific methodology.

Further methodological information for all Member States is provided in the Annex III of this submission.

7.2.3.2 Industrial wastewater (CRF Source Category 5D2)

CH_4 emissions from 5D2 Industrial Wastewater account for 0.2 % of total EU-28+ISL GHG emissions in 2016. Between 1990 and 2016, CH_4 emissions decreased by 23 %. Key drivers for the development of CH_4 emissions are primarily economic activities and the share of CH_4 flared or recovered. CH_4 emissions are related to production data in certain industries with high organic contents in the wastewater. Therefore the trend in CH_4 emissions is fluctuating throughout the time series based on the economic situation in the countries. In 2016, CH_4 emissions increased by 1 % in comparison to 2015 (see Table 7.17).

Table 7.17 5D2 Industrial wastewater: Member States' contributions to CH_4 emissions

Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-28+ISL Emissions in 2016	Change 1990-2016		Change 2015-2016		Method	Emission factor Informa-tion
	1990	2015	2016		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	NA	NA	NA	-	-	-	-	-	NA	NA
Belgium	NA	NA	NA	-	-	-	-	-	NA	NA
Bulgaria	2 221	289	310	3.4%	-1 911	-86%	21	7%	T2	D
Croatia	97	97	104	1.1%	7	7%	7	7%	T2	D
Cyprus	24	28	28	0.3%	4	18%	0	0%	T1	D
Czech Republic	363	414	422	4.6%	59	16%	8	2%	CS,T1	CS,D
Denmark	IE	IE	IE	-	-	-	-	-	NA	NA
Estonia	NO	10	8	0.1%	8	∞	-2	-19%	T1	D
Finland	27	26	24	0.3%	-2	-9%	-1	-6%	CS,T3	CS,D
France	90	108	108	1.2%	19	21%	0	0%	T1	D
Germany	9	43	44	0.5%	35	375%	1	2%	CS	CS
Greece	821	819	821	8.9%	0	0%	2	0%	CS,D	CS,D
Hungary	135	24	24	0.3%	-111	-82%	0	-1%	T1	D
Ireland	IE	IE	IE	-	-	-	-	-	NA	NA
Italy	1 520	1 400	1 438	15.5%	-82	-5%	38	3%	T1	D
Latvia	137	141	155	1.7%	18	13%	14	10%	D	CS
Lithuania	IE	IE	IE	-	-	-	-	-	NA	NA
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	IE	IE	IE	-	-	-	-	-	NA	NA
Netherlands	7	9	10	0.1%	2	33%	0	1%	T2	CS
Poland	627	248	256	2.8%	-370	-59%	8	3%	T1	CS,D
Portugal	1 141	1 505	1 467	15.8%	325	29%	-38	-3%	T2	CS,D
Romania	378	196	187	2.0%	-192	-51%	-9	-5%	D	D
Slovakia	29	6	6	0.1%	-24	-81%	0	1%	CS,T2	D
Slovenia	13	1	1	0.0%	-12	-92%	0	6%	T1	D
Spain	1 719	1 152	1 174	12.7%	-545	-32%	22	2%	T1	CS,D
Sweden	6	5	5	0.1%	-1	-22%	0	6%	T2	CS
United Kingdom	2 720	2 663	2 666	28.8%	-54	-2%	3	0%	T1	D
EU-28	**12 085**	**9 184**	**9 258**	**100%**	**-2 827**	**-23%**	**74**	**1%**	**-**	**-**
Iceland	IE	IE	IE	-	-	-	-	-	NA	NA
United Kingdom (KP)	2 720	2 663	2 666	28.8%	-54	-2%	3	0%	T1	D
EU-28 + ISL	**12 085**	**9 184**	**9 258**	**100%**	**-2 827**	**-23%**	**74**	**1%**	**-**	**-**

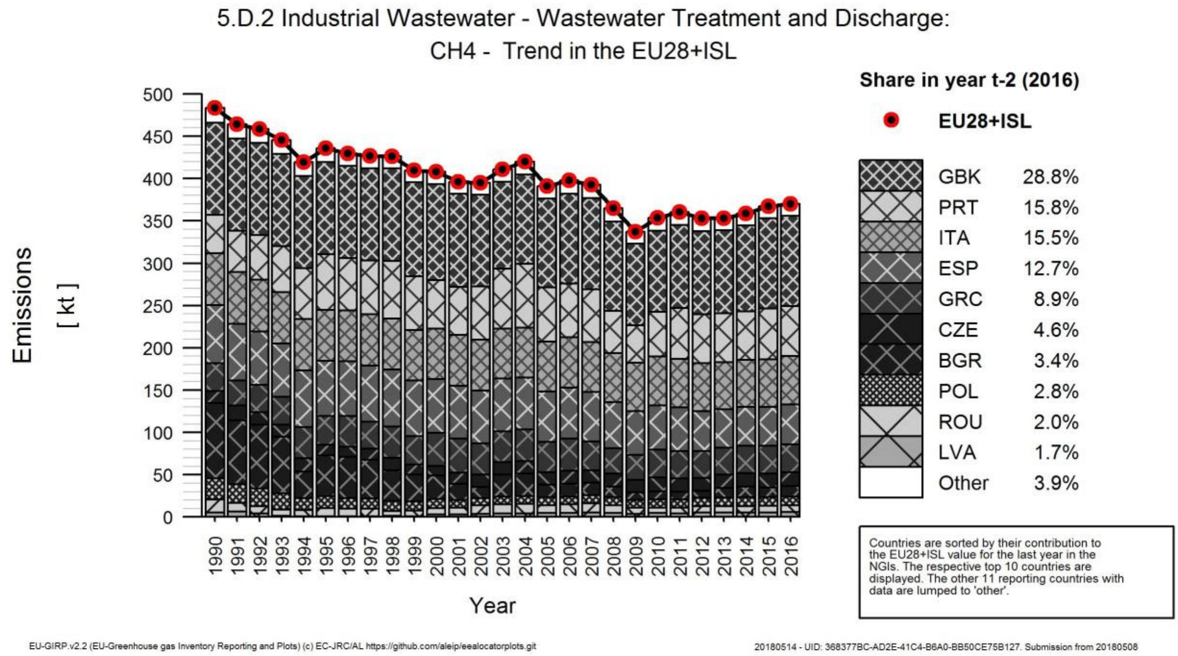
Presented methods and emission factor information refer to the last inventory year.
Abbreviations explained in the Chapter 'Units and abbreviations'.

Trends in Emissions and Activity Data

CH_4 emissions from industrial wastewater treatment and discharge decreased between 1990 and 2016 by 23 %. *Figure 7.17* shows the trend of emissions indicating the countries contributing most to EU-28+ISL total.

The largest decrease in absolute terms is reported by Bulgaria, followed by Spain and Poland contributing together to 19 % of EU-28+ISL emissions from source 5D2 in 2016, whereas Portugal shows large emission increases between 1990 and 2016 (Table 7.17). The United Kingdom is responsible for 28.8 %, Portugal for 15.8 % and Italy for 15.5 % of EU-28+ISL CH_4 emissions from this source in 2016. The emission trends in this sector are mainly influenced by the strong decrease in Bulgaria, Spain and Poland and increasing emissions in Portugal, while in other relevant countries CH_4 emissions are almost constant or slightly decreased (United Kingdom, Italy, Greece).

Figure 7.17 5D2 Industrial wastewater: CH_4 emissions (Trend in relevant MS)



Information for the trends of CH_4 emissions from industrial wastewater is provided for Bulgaria, Portugal, Italy, the United Kingdom and Spain.

Bulgaria decreased its CH_4 emissions from industrial wastewater until 2012 and remains rather constant in the following years, with a stronger decline in 2015 and a small increase in 2016 again. In 2003 and 2004 CH_4 emissions show a peak compared to the preceding years due to the discharge of industrial wastewater into several big tailing ponds by mining companies. The strong decrease of CH_4 emissions from industrial wastewater between 1990 and 2012 is caused by decreasing quantities of total industrial wastewater in the country, which decreased from 1 Mio m³ in 1990 to 0.12 Mio m³ in 2016. The increases in 2013 and 2014 are caused by an increasing amount of industrial wastewater while in 2015 and 2016 the amount decreases again, but the share of industrial wastewater treated on site increases.

CH_4 emissions from industrial wastewater in the **United Kingdom** are fluctuating throughout the time series 1990 and 2016 with lowest emissions during the economic break down in 2009 and 2010. Between 1990 and 2016 CH_4 emissions slightly decreased by 2 %. Given the high share of UKs CH_4 emissions in EU-28+ISL of 28.8 % the United Kingdom points out that this estimate is very conservative and likely to be over-estimated as there is a lack of data.

In **Italy,** CH_4 emissions from industrial wastewater decreased only slightly by 5 % between 1990 and 2016. This is caused by a decreasing amount of wastewater from industries. Main reductions in industrial wastewater load can be found in the pulp and paper and in the textiles industry.

Also **Portugal** shows fluctuating CH_4 emissions from industrial wastewater based on the economic development. In comparison to the base year 1990, CH_4 emissions from industrial wastewater increased by 29 % until 2016. The industries with the highest organic loads are wood and wood derivatives and the organic chemical industry. Industrial wastewater load from wood and wood derivatives showed an increasing trend until 2007 and fluctuations in the years after. Also wastewater from the organic chemical industry is fluctuating with a strong decline in the years of the economic crisis 2008-2010.

In **Spain**, CH_4 emissions from industrial wastewater decreased by 32 % until 2016 in comparison to 1990. Industries with high organic loads that have on-site wastewater treatment are the oil refining industry and the pulp and paper production industry. Other industries with high organic loads are the food- and drink processing industry and the organic chemical industry. Due to changes in production levels CH_4 emissions from this source are also slightly fluctuating throughout the time series in Spain.

CH_4 emissions from industrial wastewater in **Poland** decreased by 59 % between 1990 and 2016, due to a reduction in wastewater production by industries. Main reduction of wastewater production took place in the mining and quarrying industry, the iron and steel industry and in the wood and paper industry.

Methodological information

Emissions from industrial wastewater include all wastewater that is treated/disposed of on site and not sent to public sewers. The main sources for methane emissions from industrial wastewater are:

- pulp and paper manufacture;
- food and drink processing (e.g. meat and poultry processing, alcohol/starch production and dairy products); and
- Organic chemicals production.

Activity data is based on production output from the relevant industries and a Chemical Oxygen Demand per unit of output for each industry. Default IPCC values are provided and it is good practice to use them in the absence of national data.

CH_4 emissions from industrial wastewater handling are reported by 21 Member States, while Austria, Belgium report CH_4 emissions as not applicable, Luxembourg reports CH_4 emissions under 5D2 as not occurring and Denmark, Ireland, Iceland, Lithuania and Malta report CH_4 emissions from industrial wastewater elsewhere.

According to the IPCC 2006 Guidelines, the emission factor for determining CH_4 emissions from wastewater 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 treatment systems used.

7.2.3.3 Recalculations CH_4 and N_2O emissions (CRF Source Category 5D)

Table 7.18: 5D Waste water treatment: Contribution of member states to EU recalculations in CH_4 for 1990 and 2015 (difference between latest submission and previous submission)

	1990		2015		Main explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
Austria	-	-	-	-	
Belgium	-	-	-	-	
Bulgaria	-31	-1.1	24	2.8	Recalculations of CH_4 emissions from 5.D.1 for year 2015 due to revised Activity data. Recalculations of CH_4 emissions from 5.D.2 for the whole time series due to revised Activity data.
Croatia	**330**	**138.5**	**257**	**124.4**	Technical correction
Cyprus	2	1.5	29	88.2	Revision of population connected to sewer systems and wastewater treatment plants – therefore the population served by septic tanks has also been revised. (b) I for collected was revised from 1 to 1.25, which is the

	1990		2015		Main explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
					default for collected (IPCC2006, vol.5, pg. 6.14, eqn.6.3). (c) MCFj for collected has been revised from 0.3 to 0: this revision has been caused by the comment received by the review team during the EU review process of the 2017 submission. During the review it was discovered that the European Commission published a database on all waste water treatment plants which shows the status of compliance of those plants with EU legislation. This source also contains information on the Cypriot plants. See http://uwwtd.oieau.fr/Cyprus/uwwtps/compliance. According to this website, all but one of the Cypriot waste water treatment plants are fully compliant with UWWTD (Urban Waste Water Treatment Directive)-standards. Most important is the compliance on DOC5. DOC5 is the biodegradable part of the organic load into the waste water treatment plant. All experts in the TERT agree that when a plant is overloaded or not well managed, an increase in DOC5 is expected, before an increased methane emissions becomes apparent. The single plant that is not compliant with legislation in Cyprus still does comply with the DOC5-criterion. For the TERT the information provided on this website seems to prove that all Cypriot waste water treatment plants are well-managed and therefore a MCF=0 for collected waste water is justified.
Czech Republic	-	-	-	-	
Denmark	-	-	-0	-0.1	Minor correction.
Estonia	-	-	-	-	
Finland	-	-	-	-	
France	0	0.0	0	0.0	
Germany	-66	-2.5	-40	-6.4	revision of EF for wastewater treatment plants (5.D.1)
Greece	-	-	10	1.0	Updated AD.
Hungary	-	-	-75	-20.0	Same methodology, but revised shares of the different treatments (especially septic systems); revised protein consumption
Ireland	-	-	-1	-2.5	Methane emissions from biogas facilities were recalculated due to new activity data for the years 2013 to 2015. Emissions were reduced from 0.7 to 2.5 per cent for 5.D.1 for the period 2013 to 2015.
Italy	-	-	-10	-0.4	Minor recalculation is occurred due to update of population and activity data.
Latvia	0	0.0	5	2.2	Adjustment of activity data
Lithuania	-	-	-	-	
Luxembourg	-	-	-	-	
Malta	-0	-1.8	-	-	The calculation of emissions from wastewater was revised by replacing the population data used in this calculation with the standard population data used by the Inventory Agency. This population data is obtained from the latest version of the Ageing Report issued by the Economic and Financial Affairs Directorate of the European Commission.
Netherlands	-	-	-1	-0.7	Final statistics
Poland	-	-	-	-	
Portugal	-	-	1	0.1	Revision of AD
Romania	-	-	0	0.0	The CH_4 emissions from wastewater treatment and discharged were recalculated for 2015 year taking into account the final data associated to total number of population, data provided by National Institute of Statistics.
Slovakia	-	-	-1	-0.2	Correction of WW calulation in terms of QA/QC
Slovenia	39	24.6	63	68.5	Modification of the methodology, change of MCFs
Spain	-	-	-	-	
Sweden	3	7.1	0	0.0	Minor correction.
United Kingdom	-2	-0.0	-4	-0.1	small revisions to population data

	1990		2015		Main explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
EU28	274	0.8	258	1.3	
Iceland	0	4.2	-0	-1.7	Minor adjustments
United Kingdom (KP)	-14	-0.3	-17	-0.5	small revisions to population data
EU28+ISL	262	0.8	244	1.2	

Table 7.19: 5D Waste water treatment: Contribution of member states to EU recalculations in N_2O for 1990 and 2015 (difference between latest submission and previous submission)

	1990		2015		Main explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
Austria	-	-	1	0.4	For the year 2015, actual data for the nitrogen content in the effluent from waste water treatment plants became available (based on EMREG), which have been used to update the 2015 data.
Belgium	12	9.3	2	2.0	Flanders: correction calculations (entire time series); Wallonia: actualisation protein conusmption (FAO) and Brussels region: actualisation protein consumption (FAO)
Bulgaria	-	-	-	-	
Croatia	-0	-0.2	5	6.6	Technical correction
Cyprus	-	-	0	0.1	N_2O Emissions from advanced centralised wastewater treatment plants have been estimated for the first time and excluded from the N_2O total as indicated in BOX 6.1, pg. 6.26, vol.5 of the 2006 IPCC Guidelines.
Czech Republic	-	-	-	-	
Denmark	48	78.0	6	9.8	For wastewater treatment and discharge, recalculations occur throughout the time series due to the inclusion of direct N_2O emissions from separate industries.
Estonia	-	-	-	-	
Finland	-	-	-	-	
France	0	0.0	-55	-12.0	2015 update of capacities with so-called advanced treatments (nitrification-denitrification).
Germany	465	48.5	5	1.2	amongst others: revised FAOSTAT protein input data (5.D.1); implementation of revised IPCC method
Greece	-	-	-0	-0.0	Updated AD.
Hungary	-	-	6	7.7	Same methodology, but revised shares of the different treatments (especially septic systems); revised protein consumption
Ireland	-20	-21.4	-26	-21.4	Change in Fnon-com following ESD waste webinar from 1.4 to 1.1
Italy	-	-	2	0.1	Update of activity data
Latvia	24	82.8	14	73.0	Corrected use of factors and update of activity data
Lithuania	-	-	-	-	
Luxembourg	-	-	-0	-0.6	
Malta	-0	-2.1	-0	-0.7	The calculation of emissions from wastewater was revised by replacing the population data used in this calculation with the standard population data used by the Inventory Agency. This population data is obtained from the latest version of the Ageing Report issued by the Economic and Financial Affairs Directorate of the European Commission. Another change in the calculation of emissions from this category was the revision of the "per capita protein consumption". This parameter is obtained from the FAOSTAT food balance sheets, as stated in the FAOSTAT website, and checked annually for any reported revisions for the whole reporting period. Any such revisions lead inevitably to a replacement with the latest data available.
Netherlands	-	-	-0	-0.1	Final statistics
Poland	-	-	-	-	

	1990		2015		Main explanations
	kt CO_2 equiv.	%	kt CO_2 equiv.	%	
Portugal	-17	-7.7	-8	-3.3	Estimates have been revised in order to consider the default factor (1.25) for industrial and commercial co-discharged protein into the sewer system (FIND-COM) applied exclusively to collected (sewered) waste water. In the 2017 submission, this factor was erroneously applied also to septic tanks and latrines. The revisions led to a decrease of emissions. The changes fro 2013-2015 result also from an update of INE data for protein consumption for this period.
Romania	-	-	18	3.4	The N_2O emissions from wastewater treatment and discharged were recalculated for 2015 year taking into account the final data associated to total number of population, data provided by National Institute of Statistics.
Slovakia	-	-	-0	-0.0	N_2O Error in model estimating N in effluent was corrected. Instead of reported values on N in effluent in the period 2010 – 2016 the modelled values on N in effluent based on COD were reported in the CRF tables. This caused variations in the IEF. Time series were corrected by entering reported values on N in effluent. Emissions of N_2O were calculated and reported correctly.
Slovenia	-11	-21.4	-12	-23.7	Change of value on non-consumed protein discharged.
Spain	-	-	-	-	
Sweden	-	-	-	-	
United Kingdom	0	0.0	9	1.3	minor activity data and IEF changes due to minor revisions to the DA and UK population data
EU28	501	6.1	-34	-0.5	
Iceland	-0	-0.8	1	14.8	Updated protein consumption data
United Kingdom (KP)	-4	-0.5	5	0.7	minor activity data and IEF changes due to minor revisions to the DA and UK population data
EU28+ISL	497	6.1	-37	-0.5	

7.2.4 Waste – non key categories

Table 7.20 Aggregeted GHG emission from non-key categories in the waste sector

EU-28 + ISL	Aggregated GHG emissions in kt CO_2 equ.			Share in sector 5. Waste in 2016	Change 1990-2016		Change 2015-2016	
	1990	2015	2016		kt CO_2 equ.	%	kt CO_2 equ.	%
5.A.1 Managed Waste Disposal Sites: Waste (CO2)	0	0	0	0	0	0%	0	0%
5.A.2 Unmanaged Waste Disposal Sites: Waste (CO2)	0	0	0	0	0	0%	0	0%
5.A.1 Managed Waste Disposal Sites: Waste (CO2)	0.0	0.0	0.0	0.00%	0	0%	0	0%
5.A.2 Unmanaged Waste Disposal Sites: Waste (CO2)	0.0	0.0	0.0	0.00%	0	0%	0	0%
5.A.3 Uncategorized Waste Disposal Sites: Waste (CH4)	1 307.1	1 052.9	952.3	0.69%	-355	-27%	-101	-10%
5.A.3 Uncategorized Waste Disposal Sites: Waste (CO2)	0.0	0.0	0.0	0.00%	0	0%	0	0%
5.B.2 Anaerobic Digestion at Biogas Facilities: Waste (CH4)	8.3	1 443.2	1 525.6	1.10%	1 517	18212%	82	6%
5.B.2 Anaerobic Digestion at Biogas Facilities: Waste (N2O)	0.0	115.7	115.6	0.08%	116	100%	0	0%
5.C.1 Waste Incineration: Waste (CH4)	115.1	3.6	3.3	0.00%	-112	-97%	0	-9%
5.C.1 Waste Incineration: Waste (CO2)	5 158.4	3 002.0	3 285.0	2.36%	-1 873	-36%	283	9%
5.C.1 Waste Incineration: Waste (N2O)	193.8	183.6	186.0	0.13%	-8	-4%	2	1%
5.C.2 Open Burning of Waste: Waste (CH4)	430.4	395.5	398.1	0.29%	-32	-8%	3	1%
5.C.2 Open Burning of Waste: Waste (CO2)	97.3	35.5	35.5	0.03%	-62	-63%	0	0%
5.C.2 Open Burning of Waste: Waste (N2O)	372.1	340.1	340.4	0.24%	-32	-9%	0	0%
5.D.2 Wastewater Treatment and Discharge: Industrial Wastewater (N2O)	241.6	143.3	145.5	0.10%	-96	-40%	2	1%
5.D.3 Wastewater Treatment and Discharge: Other Wastewater (CH4)	98.2	15.9	15.4	0.01%	-83	-84%	0	-3%
5.D.3 Wastewater Treatment and Discharge: Other Wastewater (N2O)	153.4	48.2	48.2	0.03%	-105	-69%	0	0%
5.E Other Disposal: Waste (CH4)	46.3	28.2	34.3	0.02%	-12	-26%	6	22%
5.E Other Disposal: Waste (CO2)	20.3	15.0	44.7	0.03%	24	120%	30	197%
5.E Other Disposal: Waste (N2O)	0.0	73.1	74.2	0.05%	74	100%	1	2%

7.3 EU-28+ISL uncertainty estimates

Table 7.21 shows the total EU-28 and Iceland 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 5D and the lowest for CO_2 from 5C. With regard to the uncertainty on trend, CH_4 from 5B shows the highest uncertainty estimates, CH_4 from 5A, CO_2 from 5C and CH_4 from 5D the lowest. For a description of the Tier 1 uncertainty analysis carried out for the EU-28 and Iceland see Chapter 1.6.

Table 7.21 Sector 5 -Waste: EU-28 +ISL uncertainty estimates

Source category	Gas	Emissions Base Year	Emissions 2016	Emission trends Base Year-2016	Level uncertainty estimates based on MS uncertainty estimates	Trend uncertainty estimates based on MS uncertainty estimates
5.A Solid Waste Disposal	CO2	0	0		0.0%	
5.A Solid Waste Disposal	CH4	184 803	99 669	-46.1%	27.3%	0.1%
5.A Solid Waste Disposal	N2O	0	0		0.0%	
5.B Waste Water Handling	CO2	0	0		0.0%	
5.B Waste Water Handling	CH4	513	4 437	764.8%	86.2%	3.4%
5.B Waste Water Handling	N2O	462	2 951	538.3%	88.7%	2.1%
5.C Waste Incineration	CO2	5 405	3 474	-35.7%	14.0%	0.1%
5.C Waste Incineration	CH4	250	124	-50.5%	28.1%	0.3%
5.C Waste Incineration	N2O	208	179	-13.9%	100.5%	0.4%
5.D Wastewater treatment and discharge	CO2	0	0		0.0%	
5.D Wastewater treatment and discharge	CH4	33 600	19 813	-41.0%	47.4%	0.1%
5.D Wastewater treatment and discharge	N2O	8 077	7 072	-12.4%	913.5%	2.6%
5.E Other	CO2	20	17	-15.8%	300.2%	0.5%
5.E Other	CH4	3	27	770.5%	43.1%	2.2%
5.E Other	N2O	11	73	573.7%	59.2%	3.4%
Total - 5	**all**	**233 353**	**137 837**	**-40.9%**	**51.4%**	**14.8%**

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 of the EU-NIR because uncertainty estimates are not available for all source categories in each of this 28 EU Member Statesand Iceland;*

7.4 Sector-specific quality assurance and quality control

There are several activities for improving the quality of estimating and reporting GHG emissions from waste: Before and during the compilation of the EU GHG inventory, several checks are made of the Member States data in particular for completeness, 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 2005, the EU internal review was carried out for the first time. In 2012 a comprehensive review was carried out for all sectors and all EU Member States in order to Source category Gas Emissions fix the base year 2020 under the EU Effort Sharing Decision. (ESD review 2012). This review also covered the waste sector of the MS GHG inventories (peer review). In 2015, a few Member States volunteered to be reviewed under step 2 of the ESD trial review for the sector waste. In 2016, again a comprehensive review was carried out for all sectors and all EU Member States with a focus on the years 2005, 2008-2010, 2013 and 2014 in order to track progress of the EU Member States under the EU Effort Sharing Decision. (ESD review 2016).

In March 2016, during the WG1-meeting, a note/paper on wastewater treatment and discharge was discussed with the Member States. This note/paper reflects a number of concerns raised during the ESD 2015 trial review. In connection to the ESD review further capacity building activities between the ESD review team and EU sectoral experts have taken place via webinars and distribution of working papers on the main conclusions from the ESD reviews.

In September 2017 a capacity building webinar related to the waste sector was organized between the ESD review team and the Member States. Several aspects on solid waste disposal, biological treatment and wastewater treatment were discussed. A second webinar took place in November 2017 in order to discuss in more detail the different interpretations when using equations 6.1-6.3 of the IPCC 2006 guidelines (Volume 5, chapter 6) for calculating emissions from wastewater treatment. An elaborated spreadsheet, along with a brief explanation of the spreadsheet was presented and explained during the webinar.

7.5 Sector-specific improvements

After the implementation of the new IPCC guidelines in 2015 and the subsequent changes to the sector, chapters had to be re-written in 2016, and certain methodological changes had to be applied, which have been reviewed in the 2016 ESD review.

In 2016, 2017 an 2018, additional quality checks of the EU NIR chapter waste were carried out in order to improve the consistency between the CRF tables and the EU NIR and consistency of tables and figures with text in the EU NIR.

There are currently no UNFCCC review recommendations for the waste sector in the EU inventory and no big improvements planned. In future submissions methodological tables presented in Annex III will be revised and presented in a more harmonized way.

8 OTHER

Sector Other is not an EU key category (see Annex 1.1) and does not include any emissions in 2018.

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9 INDIRECT CO_2 AND NITROUS OXIDE EMISSIONS

9.1 Description of sources of indirect emissions in the GHG inventory

The CO_2 resulting from the atmospheric oxidation of CH_4, CO and NMVOC is referred to as indirect CO_2. Indirect CO_2 resulting from the oxidation of CH_4, CO and NMVOCs produced by fossil fuel combustion are included in the general methodological approach which assumes that all the carbon in the fuel (minus the portion that remains as soot or ash) is oxidized to CO_2 whereas actually a fraction of this carbon is initially emitted as CH_4, CO or NMVOC.

Other sources of indirect CO_2 emissions are not yet captured by the general inventory methodologies. According to the 2006 IPCC Guidelines such sources include:

- Fugitive emissions from energy use, e.g. NMVOC emissions from oil refineries, storage of chemicals at refineries, road traffic evaporative emissions from cars, emissions from gasoline distribution network and refueling of cars, ships and aircrafts, CH_4 emissions from natural gas transmission and distribution or coke production.
- Carbon from Non-energy products from fuels and solvent use in IPPU: The production and use of asphalt for road paving and roofing and the use of solvents derived from petroleum and coal are sometimes substantial sources of NMVOC and CO emissions which oxidise to CO_2 in the atmosphere. The resulting CO_2 input can be estimated from the emissions of these non-CO_2 gases.
- AFOLU emissions where non-CO_2 gases have been explicitly deducted (Such NMVOC emissions are considered as biogenic in MS reporting and resulting indirect CO_2 emissions are not included in MS GHG inventories).

Indirect N_2O emissions in the agriculture sector address nitrous oxide (N_2O) emissions that result from the deposition of the nitrogen emitted as nitrogen oxides (NO_x) and ammonia (NH_3). N_2O is produced in soils through the biological processes of nitrification and denitrification. One of the main controlling factors in this reaction is the availability of inorganic nitrogen in the soil and therefore deposition of nitrogen resulting from NO_x and NH_3 will enhance emissions.

The Revised 1996 IPCC Guidelines only estimated indirect N_2O emissions from agricultural sources of nitrogen. The 2006 IPCC Guidelines include guidance for estimating N_2O emissions resulting from nitrogen deposition of all anthropogenic sources of NO_x and NH_3 (in particular from sources in the energy and IPPU sectors).The 2006 IPCC Guidelines, Volume 5, also address indirect N_2O emissions which occur from the release of wastewater effluents into waterways, lakes or the sea.

The EU national total includes indirect CO_2 if these emissions were reported by MS. Both national totals, including and excluding indirect CO_2, are reported in the CRF tables. This is to ensure consistency with the scope of reported greenhouse gas emissions during the first commitment period. Indirect N_2O emissions reported in Summary 1 are not included in national totals.This chapter refers to the indirect emissions that are reported in Table 6 of the EU CRF tables. Indirect emissions may also be included in other sectors, such as indirect CO_2 in IPPU (i.e. under ‘2D Non-energy products from fuels and solvents‘) and indirect N_2O in the agriculture and LULUCF sectors (i.e. in CRF tables 3.D and 3.B.b or table 4(IV)). These emissions are dealt with in the corresponding sectoral chapters.

9.2 Methodological issues

Table 9.1 summarizes indirect CO_2 and nitrous oxide emissions reported from the EU countries [not directly included with other sectors]. Six countries provided values for indirect CO_2 emissions. The highest shares of the EU-28 total of indirect CO_2 emissions are held by the Czech Republic (51 %)

and Denmark (19 %). Seven countries reported indirect N_2O emissions in 2016, with Denmark, the United Kingdom, Romania and Italy accounting for more than 80% of the total EU-KP indirect N_2O emissions.

Indirect CO_2 is not an EU key category.

Table 9.1 Indirect CO_2 and N_2O emission for EU-28 in 2016

Member States	indirect CO_2 [kt CO_2 equ.]	Share in EU-28 [%]	indirect N_2O [kt CO_2 equ.]	Share in EU-28 [%]
Austria	NO,IE,NA	-	NO,NE,NA	-
Belgium	NO,NE	-	NO,NE	-
Bulgaria	NO	-	1 096	10%
Croatia	NO,NA	-	NO,NA	-
Cyprus	NO	-	NO	-
Czech Republic	765	51%	366	3%
Denmark	287	19%	5 652	50%
Estonia	NO,NE,IE	-	NO,NE	-
Finland	53	4%	179	2%
France	IE,NA	-	NO,NE	-
Germany	NO,NA	-	NO,IE	-
Greece	NO,NE	-	NO,NE	-
Hungary	NO,NE	-	NO,NE	-
Ireland	NO,NE,IE	-	NO,NE	-
Italy	NO	-	1 116	10%
Latvia	18	1%	NO,IE,NA	-
Lithuania	NO,NE,IE	-	NO,NE	-
Luxembourg	NO,NE	-	NO,NE	-
Malta	NO,NE	-	NO,NE	-
Netherlands	212	14%	NO,NE	-
Poland	NA	-	NA	-
Portugal	154	10%	NO,NE,NA	-
Romania	NO,NE	-	1 553	14%
Slovakia	NO,NE,IE	-	NO,NE,IE	-
Slovenia	NO,NE	-	NO,NE	-
Spain	NE,IE,NA	-	NE,NA	-
Sweden	NO	-	NO	-
United Kingdom	NO,NE	-	1 393	12%
EU-28	**1 490**	**100%**	**11 355**	**100%**
United Kingdom (KP)	NO,NE	-	121	1%
Iceland	NE	-	NE	-
EU-28+ISL	**1 490**	**100%**	**10 084**	**100%**

In general, the methodologies for the estimation of indirect emissions in EU countries are in line with the 2006 IPCC Guidelines.

For the estimation of indirect CO_2 emissions EU countries follow the basic principle proposed by the IPCC for calculating the CO_2 inputs from the atmospheric oxidation of CH_4, CO or NMVOC (2006 IPCC Guidelines, Volume 1, Chapter 7, p. 7.6):

From CH_4:	$Inputs_{CO2} = Emissions_{CH4} \bullet 44/16$	
From CO:	$Inputs_{CO2} = Emissions_{CO} \bullet 44/28$	
From NMVOC:	$Inputs_{CO2} = Emissions_{NMVOC} \bullet C \bullet 44/12$	
Where C is the fraction carbon in NMVOC by mass (default = 0.6)		

Some countries (i.e. CZ, DK) explicitly mention that the precursor gases emissions (CO, NO_x and NMVOC) used in the above equations are consistent with the the precursor gases emissions reported under the United Nations Economic Commission for Europe (UNECE) Convention on Long-Range Transboundary Air Pollution (CLRTAP) and the CH_4 emissions reported to the UNFCCC.

In general, emissions reported in table 6 refer to indirect emissions from energy, IPPU and waste, while some countries report the indirect CO_2 emissions in other categories too (mainly in IPPU category 2.D.3).

9.3 Uncertainties and time-series consistency

Indirect CO_2 emissions have decreased since 1990 in all countries. The highest percentage decrease has been noted in Finland, while in absolute terms the Czech Republic had the biggest share in the EU reduction, decreasing its indirect CO_2 emissions by more than 1.6 Mt. The main reason for the decrease in indirect CO_2 emissions is the decrease of the precursor gases emissions. The uncertainty of the indirect emission estimates is also based on the calculation of emissions from these gases.

9.4 Category specific planned improvements

The separate reporting of indirect CO_2 and nitrous oxide emissions (from sources other than agriculture and LULUCF)[72] to the UNFCCC under CRF Table 6 has been performed for the first time in 2015 and is in line with paragraph 29 of the UNFCCC reporting guidelines (Decision 24/CP.19). Following this reporting the EU team analysed the ways that Member States reported these emissions and presented the results in Working Group 1. The different approaches have been discussed and guidance was provided to Member States in order to improve the consistency in the reporting of these emissions.

[72] As explained in paragraph 9.1, methodologies for the indirect nitrous oxide emissions from agriculture and LULUCF were available in the 1996 IPCC Guidelines as well.

10 RECALCULATIONS AND IMPROVEMENTS

10.1 Explanations and justifications for recalculations

Table 10.1 to Table 10.2 provide an overview for the largest recalculations (>+/- 1000 kt CO_2 equiv.) in the year 1990 and 2015 for each EU-28 Member State. For explanations of the recalculations (including recalculations <+/- 1000 kt CO_2 equiv see the sectoral chapters of the EU NIR and the information provided by the Member States' submissions.

Recalculations presented are calculated from MS submissions used for the EU submission in May 2017 and MS submissions received until 8 May 2018.

Table 10.1 Main recalculations by source category for 1990

Category	MS	1990	
		kt CO_2 equiv.	%
1A1 Energy Industries CO_2	Italy	-1 698	-1.2
1A2 Manufacturing Industries and Construction CO_2	France	-4 015	-4.9
1A2 Manufacturing Industries and Construction CO_2	Italy	7 178	8.5
1A2 Manufacturing Industries and Construction CO_2	Netherlands	2 442	7.6
1A2 Manufacturing Industries and Construction CO_2	Romania	-1 226	-2.4
1A3 Transport CO_2	United Kingdom	5 377	4.7
1A3 Transport CO_2	United Kingdom (KP)	5 151	4.5
1A4 Other sectors CO_2	Czech Republic	2 538	8.6
1A4 Other sectors CO_2	France	2 674	2.8
2A Mineral products CO_2	France	-1 431	-8.7
2B Chemical industries CO_2	Romania	1 355	32.2
2C Metal industry CO_2	France	1 507	31.8
2C Metal industry CO_2	Netherlands	-2 223	-83.1
3A Enteric fermentation CH_4	France	1 003	2.7
3A Enteric fermentation CH_4	United Kingdom	-2 027	-7.2
3A Enteric fermentation CH_4	United Kingdom (KP)	-2 027	-7.2
3B Manure management CH_4	France	-1 768	-32.8
3B Manure management N_2O	United Kingdom	1 738	98.3
3B Manure management N_2O	United Kingdom (KP)	1 738	98.3
3D Agricultural soils N_2O	United Kingdom	-3 193	-19.0
3D Agricultural soils N_2O	United Kingdom (KP)	-3 193	-19.0
4A Forest land CO_2	France	-1 091	-2.8
4A Forest land CO_2	Latvia	-2 979	-19.8
4A Forest land CO_2	Spain	-11 919	-50.9
4A Forest land CO_2	Sweden	1 249	3.1
4A Forest land CO_2	United Kingdom	-6 905	-65.7
4A Forest land CO_2	United Kingdom (KP)	-6 905	-65.5
4B Cropland CO_2	Lithuania	-2 299	-43.8
4C Grassland CO_2	Latvia	1 053	116.9
4C Grassland CO_2	Lithuania	1 044	58.7
4C Grassland CO_2	Spain	-2 944	-1,263.6
4G Harvested wood products CO_2	Finland	-1 386	-88.5

Category	MS	1990	
		kt CO_2 equiv.	%
4G Harvested wood products CO_2	Poland	-1 956	-129.9
4G Harvested wood products CO_2	Romania	-1 208	-331.7
5A Solid waste disposal on land CH_4	Italy	-5 952	-32.8

Table 10.2 Main recalculations by source category for 2015

Category	MS	2015	
		kt CO_2 equiv.	%
1A1 Energy Industries CO_2	Finland	1 539	9.6
1A1 Energy Industries CO_2	Germany	1 347	0.4
1A1 Energy Industries CO_2	Netherlands	1 489	2.2
1A2 Manufacturing Industries and Construction CO_2	Finland	-1 498	-18.1
1A2 Manufacturing Industries and Construction CO_2	France	1 873	3.7
1A2 Manufacturing Industries and Construction CO_2	Italy	-1 640	-3.2
1A2 Manufacturing Industries and Construction CO_2	United Kingdom	2 356	4.4
1A2 Manufacturing Industries and Construction CO_2	United Kingdom (KP)	2 365	4.4
1A3 Transport CO_2	Germany	1 984	1.2
1A3 Transport CO_2	United Kingdom	3 263	2.8
1A3 Transport CO_2	United Kingdom (KP)	3 178	2.7
1A4 Other sectors CO_2	Czech Republic	1 080	9.8
1A4 Other sectors CO_2	France	1 103	1.3
1A4 Other sectors CO_2	Germany	2 608	2.1
2C Metal industry CO_2	Germany	-1 529	-8.6
2F Product uses as substitute for ODS HFC	Italy	2 204	18.0
3A Enteric fermentation CH_4	United Kingdom	-2 153	-8.9
3A Enteric fermentation CH_4	United Kingdom (KP)	-2 153	-8.9
3B Manure management CH_4	France	-1 931	-31.1
3B Manure management CH_4	Spain	-1 522	-18.0
3B Manure management N_2O	United Kingdom	1 398	95.2
3B Manure management N_2O	United Kingdom (KP)	1 398	95.2
3D Agricultural soils N_2O	United Kingdom	-3 107	-21.6
3D Agricultural soils N_2O	United Kingdom (KP)	-3 107	-21.6
4A Forest land CO_2	Finland	-2 546	-7.1
4A Forest land CO_2	France	-6 883	-12.7
4A Forest land CO_2	Romania	2 641	10.4
4A Forest land CO_2	Sweden	6 196	12.8
4A Forest land CO_2	United Kingdom	-8 218	-51.5
4A Forest land CO_2	United Kingdom (KP)	-8 218	-51.4
4B Cropland CO_2	Lithuania	-1 230	-30.1
4C Grassland CO_2	Ireland	1 176	20.7
4C Grassland CO_2	Lithuania	1 676	68.1
4C Grassland CO_2	Spain	-1 778	-125.4
4E Settlements CO_2	Latvia	-1 563	-167.1
4G Harvested wood products CO_2	Poland	1 332	24.9

Category	MS	2015	
		kt CO_2 equiv.	%
4G Harvested wood products CO_2	Romania	-8 037	-612.7

10.2 Implications for emission levels

Table 10.3 provides the differences in total GHG emissions between the latest submission and the previous submission in absolute and relative terms for EU-28 + ISL. The table shows that due to recalculations, total 1990 GHG emissions with indirect CO_2 excluding LULUCF have increased in the latest submission compared to the previous submission by 2 648 kt (0.05 %). EU-28 + ISL GHG emissions for 2015 increased by 9 405 kt (+0.2 %) due to recalculations.

Table 10.3 Overview of recalculations of EU-28 and Iceland total GHG emissions (difference between latest submission and previous submission in kt CO_2 equivalents)

	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Total CO_2 equivalent emissions including LULUCF (absolute in kt)	-25409	-17059	-7502	101	3347	3101	1852	-5153	-7023	-9239	-7588	-6054	-7015	-3412
Total CO_2 equivalent emissions including LULUCF (percent)	-0,5	-0,3	-0,2	0,0	0,1	0,1	0,0	-0,1	-0,2	-0,2	-0,2	-0,1	-0,2	-0,1
Total CO_2 equivalent emissions excluding LULUCF (absolute in kt)	2648	5490	7002	6191	6125	7185	4903	305	-404	-3171	-2980	-2393	3610	9405
Total CO_2 equivalent emissions excluding LULUCF (percent)	0,0	0,1	0,1	0,1	0,1	0,1	0,1	0,0	0,0	-0,1	-0,1	-0,1	0,1	0,2

Table 10.4 provides an overview of recalculations for the key categories for 1990 and 2015 (see Section 1.5 for information on identification of key categories). The table shows that the largest recalculations in absolute terms were made in the key category CO_2 from 1A4 ‘Other sectors’ for 1990 and 2015.

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 2015. Recalculations of more than 1 million tonnes of CO_2 equivalents were made in Bulgaria, the Czech Republic, France, Germany, Italy, Poland, Romania, Spain and the United Kingdom. Recalculations in relative terms of more than 2 % were made in Croatia, Malta and Iceland.

Table 10.4 Recalculations for the EU-28 and Iceland key source categories 1990 and 2015 (difference between latest submission and previous submission in kt of CO_2 equivalents and in percentage)

Greenhouse Gas Source Categories	Gas	Recalculations 1990		Recalculations 2015	
		(kt CO_2 equivalents)	(%)	(kt CO_2 equivalents)	(%)
1.A.1. Energy Industries	CO_2	- 1.943	-0,1%	2.568	0,2%
1.A.2. Manufacturing Industries	CO_2	4.885	0,6%	547	0,1%
1.A.3. Transport	CO_2	5.045	0,7%	4.802	0,5%
1.A.3. Transport	CH_4	- 71	-1,1%	- 31	-2,3%
1.A.3. Transport	N_2O	64	0,8%	27	0,3%
1.A.4. Other Sectors	CO_2	5.877	0,7%	5.565	0,9%
1.A.4. Other Sectors	CH_4	158	0,7%	103	0,6%
1.A.5. Other	CO_2	221	1,0%	- 121	-1,8%
1.B.1. Solid Fuels	CH_4	35	0,0%	35	0,1%
1.B.2. Oil and Natural Gas	CH_4	- 205	-0,3%	- 206	-0,6%
1.B.2. Oil and Natural Gas	CO2	22	0,1%	- 318	-1,4%
2.A. Mineral Industry	CO_2	- 464	-0,3%	283	0,3%
2.B. Chemical Industry	CO_2	1.475	2,6%	1.328	2,6%
2.B. Chemical Industry	Unspecified mix of HFCs and PFCs	-	0,0%	-	0,0%
2.B. Chemical Industry	N_2O	- 217	-0,2%	- 7	-0,1%
2.B. Chemical Industry	HFCs	-	0,0%	3	0,8%
2.C. Metal Industry	CO_2	- 669	-0,6%	- 2.159	-2,9%
2.C. Metal Industry	PFC	-	0,0%	-	0,0%
2.D. Non-energy products from fuels and solv	CO_2	- 199	-1,4%	68	0,7%
2.F. Product uses as substitute for ODS	HFC	2	27,9%	2.324	2,2%
3.A. Enteric Fermentation	CH_4	- 1.781	-0,7%	- 1.918	-1,0%
3.B. Manure Management	CH_4	- 1.454	-2,7%	- 2.966	-6,6%
3.B. Manure Management	N_2O	1.737	5,9%	2.033	9,7%
3.D. Agricultural Soils	N_2O	- 4.408	-2,2%	- 4.442	-2,7%
5.A. Solid Waste Disposal	CH_4	- 5.813	-3,0%	1.444	1,4%
5.B. Biological Treatment of Solid Waste	N2O	- 3	-1,0%	- 109	-3,7%
5.B. Biological Treatment of Solid Waste	CH_4	- 2	-0,4%	- 112	-2,6%
5.D. Waste Water treatment and discharge	CH_4	262	0,8%	244	1,2%
5.D. Waste Water treatment and discharge	N2O	497	6,1%	- 37	-0,5%

Note: Many of these source categories are more aggregated than the EU-28 + ISL key source categories identified in Section 1.5.

Table 10.5 Contribution of Member States to EU-28 recalculations of total GHG emissionswith indirect CO_2 and without LULUCF for 1990–2015 (difference between latest submission and previous submission kt of CO_2 equivalents)

	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015
Austria	-115	-85	-102	13	-128	-247	-121	28	60	5
Belgium	360	396	304	310	275	254	279	310	-68	141
Bulgaria	336	164	203	217	247	236	264	206	1076	265
Croatia	741	619	576	622	657	681	686	641	649	686
Cyprus	-30	-63	-55	-84	-155	-161	-181	-168	-153	-103
Czech Republic	1649	1815	780	432	942	617	-94	-1275	751	494
Denmark	51	63	-4	-50	125	136	249	178	208	171
Estonia	-5	-9	-8	-12	-12	-26	-37	-10	-15	8
Finland	19	131	147	195	-122	92	-64	-134	-217	-159
France	-705	-2.482	-1018	-472	69	-7	1427	2.657	662	931
Germany	720	2.513	2.011	1158	1033	-2.058	-2.222	-3.181	-1586	4.820
Greece	20	20	19	22	55	56	60	64	-265	-405
Hungary	-99	19	-66	-8	-62	-50	-76	-147	62	-81
Ireland	-612	-588	-521	-439	-459	-461	-388	-308	-442	-452
Italy	-1554	1542	1600	1403	-1058	236	1467	752	1953	-146
Latvia	285	228	175	145	172	117	60	48	43	15
Lithuania	67	-15	-130	-247	-74	-62	-8	-3	36	79
Luxembourg	56	45	50	48	17	8	18	13	10	6
Malta	-280	128	149	-40	-51	-74	-12	-11	-22	-2
Netherlands	-130	-232	-304	3	-731	-945	-941	-1170	-1060	-467
Poland	-601	-776	-992	-1281	-1000	-1038	-942	-851	-1139	-673
Portugal	347	414	860	707	681	692	733	805	882	662
Romania	476	-634	571	1373	1283	883	429	-127	-42	-215
Slovakia	-480	-412	-292	-246	-300	-205	-209	-250	-205	-363
Slovenia	33	8	-18	52	62	63	64	60	58	29
Spain	-172	-397	-16	-486	-879	-1510	-2.890	-955	112	148
Sweden	-122	-230	-49	-133	-143	-230	-183	-123	30	64
United Kingdom	3.026	3.826	3.634	3.645	-221	450	155	1071	2.706	4.399
EU-28	**3.281**	**6.009**	**7.503**	**6.847**	**221**	**-2.554**	**-2.478**	**-1.880**	**4.085**	**9.857**
Iceland	91	170	200	140	228	205	188	174	210	210
United Kingdom (KP)	2.301	3.138	2.933	2.849	-1074	-372	-535	385	2.021	3.737
EU-28 + ISL	**2.648**	**5.490**	**7.002**	**6.191**	**-404**	**-3.171**	**-2.980**	**-2.393**	**3.610**	**9.405**

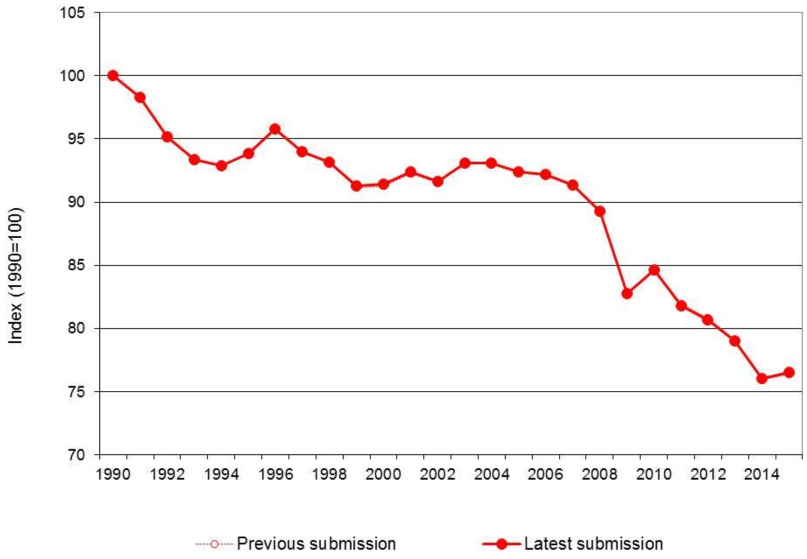
Table 10.6 Contribution of Member States to EU-28 recalculations of total GHG emissions with indirect CO_2 and without LULUCF for 1990–2015 (difference between latest submission and previous submission in percentage)

	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015
Austria	-0,1	-0,1	-0,1	0,0	-0,2	-0,3	-0,2	0,0	0,1	0,0
Belgium	0,2	0,3	0,2	0,2	0,2	0,2	0,2	0,3	-0,1	0,1
Bulgaria	0,3	0,2	0,3	0,3	0,4	0,4	0,4	0,4	1,9	0,4
Croatia	2,4	2,8	2,3	2,1	2,4	2,5	2,7	2,7	2,8	2,9
Cyprus	-0,5	-0,9	-0,7	-0,9	-1,6	-1,7	-2,1	-2,1	-1,8	-1,2
Czech Republic	0,8	1,2	0,5	0,3	0,7	0,4	-0,1	-1,0	0,6	0,4
Denmark	0,1	0,1	0,0	-0,1	0,2	0,2	0,5	0,3	0,4	0,4
Estonia	0,0	0,0	0,0	-0,1	-0,1	-0,1	-0,2	0,0	-0,1	0,0
Finland	0,0	0,2	0,2	0,3	-0,2	0,1	-0,1	-0,2	-0,4	-0,3
France	-0,1	-0,5	-0,2	-0,1	0,0	0,0	0,3	0,6	0,1	0,2
Germany	0,1	0,2	0,2	0,1	0,1	-0,2	-0,2	-0,3	-0,2	0,5
Greece	0,0	0,0	0,0	0,0	0,0	0,0	0,1	0,1	-0,3	-0,4
Hungary	-0,1	0,0	-0,1	0,0	-0,1	-0,1	-0,1	-0,3	0,1	-0,1
Ireland	-1,1	-1,0	-0,8	-0,6	-0,7	-0,8	-0,7	-0,5	-0,8	-0,8
Italy	-0,3	0,3	0,3	0,2	-0,2	0,0	0,3	0,2	0,5	0,0
Latvia	1,1	1,8	1,7	1,3	1,4	1,0	0,5	0,4	0,4	0,1
Lithuania	0,1	-0,1	-0,7	-1,1	-0,4	-0,3	0,0	0,0	0,2	0,4
Luxembourg	0,4	0,5	0,5	0,4	0,1	0,1	0,2	0,1	0,1	0,1
Malta	-11,8	5,0	5,6	-1,3	-1,7	-2,4	-0,4	-0,4	-0,7	-0,1
Netherlands	-0,1	-0,1	-0,1	0,0	-0,3	-0,5	-0,5	-0,6	-0,6	-0,2
Poland	-0,1	-0,2	-0,3	-0,3	-0,2	-0,3	-0,2	-0,2	-0,3	-0,2
Portugal	0,6	0,6	1,0	0,8	1,0	1,0	1,1	1,2	1,4	1,0
Romania	0,2	-0,4	0,4	0,9	1,1	0,7	0,3	-0,1	0,0	-0,2
Slovakia	-0,6	-0,8	-0,6	-0,5	-0,6	-0,5	-0,5	-0,6	-0,5	-0,9
Slovenia	0,2	0,0	-0,1	0,3	0,3	0,3	0,3	0,3	0,3	0,2
Spain	-0,1	-0,1	0,0	-0,1	-0,2	-0,4	-0,8	-0,3	0,0	0,0
Sweden	-0,2	-0,3	-0,1	-0,2	-0,2	-0,4	-0,3	-0,2	0,1	0,1
United Kingdom	0,4	0,5	0,5	0,5	0,0	0,1	0,0	0,2	0,5	0,9
EU-28	**0,1**	**0,1**	**0,1**	**0,1**	**0,0**	**-0,1**	**-0,1**	**0,0**	**0,1**	**0,2**
Iceland	2,6	5,2	5,2	3,6	4,9	4,6	4,2	3,9	4,7	4,6
United Kingdom (KP)	0,3	0,4	0,4	0,4	-0,2	-0,1	-0,1	0,1	0,4	0,7
EU-28 + ISL	**0,0**	**0,1**	**0,1**	**0,1**	**0,0**	**-0,1**	**-0,1**	**-0,1**	**0,1**	**0,2**

10.3 Implications for emission trends, including time series consistency

Figure 10.1 shows that due to the fact that both 1990 and 2015 emissions have been recalculated in the same order of magnitude the emission trend in the EU-28 + ISL did hardly change. In the previous submission the trend of GHG with indirect CO_2 and excluding LULUCF between 1990 and 2015 was - 23.6 %. In the latest submission the trend is - 23.5 %.

Figure 10.1: Comparison of EU-28 and Iceland GHG emission trends 1990–2015 (with indirect CO_2, 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

A list of recommendations and improvements is presented in

Table 10.7. The table focuses on UNFCCC recommendations from the review reports 2015 and 2016.

Table 10.7 Improvements made in 2017 and 2018 in response to UNFCCC review findings as indicated in Tables 3 of the ARR 2015 and ARR 2016

ID#		Issue and/or problem classification	Recommendation made in previous review report	ERT assessment and rationale	status of implementation (text will be included in NIR Table)
G.1	2015/2016	Activity data (15, 2014) Transparency	Provide justifications in the NIR as to why the use of international data sources to report AD at individual Party level would lead to strongly inaccurate reporting	Not resolved. During the review, the European Union explained that according to its QA/QC programme, member States are responsible for the quality of the AD, EFs and other parameters used for their inventories. Therefore, using international data sources for the European Union would imply that the data reported by the countries to international data sources are considered more accurate than those used by the national inventory compilers and would lead to inconsistencies with member States' inventories, which would contradict the QA/QC programme of the European Union. The ERT agrees with the explanation provided by the Party. The European Union further stated that it would include this information in the NIR of the 2017 GHG inventory submission	An explanation has been inclued in the Introduction chapter (in section 1.7.3).
G.3	2015/2016	Methods (14, 2014) Transparency	Work with member States in order to report consistent notation keys among member States for describing the completeness of the overall inventory	Addressing. The European Union explained that it conducts initial checks on its member States focusing on the notation key 'NE'. The European Union further explained that the recommendation will continue to be carried out after the 2016 reviews of member States submissions have been completed	The notation key checks are part of the routine initial checks performed on MS submissions every inventory year.
G.5	2015/2016	National registry (141, 2014) Transparency	Include in the NIR all information in response to the findings in the SIAR in accordance with decision 15/CMP.1, annex, chapter I.G	Not resolved. The Party's submission did not contain information related to the national registry, including the responses to previous recommendations of the ERT pertaining to the national registry	Missing information has been included in chapter 14
G.8	2016	Uncertainty analysis (33, 2014) Transparency	Describe any changes in overall uncertainty estimates in the NIR on an annual basis	Not resolved. During the review, the Party stated that the uncertainty estimates were conducted for the first time under the new UNFCCC Annex I inventory reporting guidelines and that any differences in the overall uncertainty can only be described from 2017 onwards	Description of changes in overall uncertainty estimates has been included in the NIR section 1.6 - General uncertainty evaluation Included in NIR 2018
E.2	2015/2016	1. General (energy sector) (40, 2014) Transparency	Present methodological summaries that are consistent among member States and categories, at least for the key categories	Addressing. The European Union provided summary tables in the NIR on methodologies and EFs used by each member State for key categories in the energy sector and summary information on methodological descriptions as an annex. However, summary tables for significant key categories, such as public electricity and heat production (1.A.1.a) and manufacture of solid fuels and other energy industries (1.A.1.c), were not provided	Tables on methodologies used and emision factory applied are now included in the NIR for categories 1A1a and 1A1c.
E.3	2015/2016	Feedstocks, reductants and other NEU of fuels (45, 2014) Transparency	Provide transparent information on recalculations for CRF table 1.A(d) in the NIR	Not resolved. The European Union did not provide transparent information on recalculations for CRF table 1.A.(d) and stated in the NIR that it will implement the recommendation from the previous review in its 2017 annual submission (p. 720 of the NIR)	The table on recalculations is inlcuded in Chapter 3.9

ID#		Issue and/or problem classification	Recommendation made in previous review report	ERT assessment and rationale	status of implementation (text will be included in NIR Table)
E.5	2015/2016	Feedstocks, reductants and other NEU of fuels (47, 2014) Comparability*	Continue with efforts to ensure the consistency of the reporting among member States, in particular with regard to the allocation of emissions between the energy and IPPU sectors	Not resolved. The ERT welcomes the intention of the European Union to consider the consistent allocation of emissions by all member States (see E.12 in table 5). The European Union further stated that, for key categories and largest contributing member States, it will document in the NIR the reasons why member States do not follow the allocation of emissions in accordance with the 2006 IPCC, in order to resolve the recommendation. The ERT agrees with the approach suggested by the European Union	Chapters 4.2.2.1 and 4.2.3.1 include explanations for those MS that do not allocate emissions from amonia production and iron and steel production respectively according to the IPCC guidelines. In addition, Chapter 4.2.4.1 includes a table making transparent the reporting of MS on non-energy-use of fuels und category 2D3.
E.6	2016	International bunkers and multilateral operations (44, 2014) Accuracy*	Use the most recent results from the collaboration with Eurocontrol to improve the accuracy of the emission estimates for the European Union and for the member States, ensuring consistency in the time series in accordance with the IPCC good practice guidance and report on the results of the collaboration in the NIR	Addressing. The data on fuel and emissions for the years 2005–2014 calculated by Eurocontrol were provided to each member State to support the inventory process for the 2016 submission and have been used by member States for checking purposes and/or emission calculations directly. However, the European Union did not describe in the NIR the results of the Eurocontrol collaboration	The results of the Eurocontrol collaboration and the use of Eurocontrol data in MS NIRs is included in chapter 3.4 of the EU NIR
E.7	2015/2016	1.A.1 Energy industries all fuels – CO_2 (48, 2014) Transparency	Continue to improve the QA/QC procedures to ensure consistency between the CRF tables and the NIR	Addressing. The European Union has made further efforts to eliminate inconsistencies between the CRF tables and the NIR. However, there are still inconsistent values between the CRF tables and the NIR, for example for CO_2 emissions from civil aviation (1.A.3.a), because the NIR was not updated whereas the CRF tables were updated based on the resubmission of CRF tables from member States	The EU has implemented QA/QC procedures checking the consistency between the NIR and CRF. All chapter are proof read by sectoral experts not involved in the compliationof the specific chapter between the April and the May submission.
E.8	2015/2016	1.A.3.a Domestic aviation – liquid fuels – CO_2 (49, 2014) Accuracy*	Promote the use of the results of the collaboration between the European Union and Eurocontrol to improve the accuracy of the inventory and report on the results of the collaboration in the NIR	Addressing. The data on fuel and emissions for the years 2005–2014 calculated by Eurocontrol were provided to each member State to support the inventory process for the 2016 submission and have been used by member States for checking purposes and/or emission calculations directly (see E.6). However, the European Union did not describe in the NIR the results of the Eurocontrol collaboration	The results of the Eurocontrol collaboration and the use of Eurocontrol data in MS NIRs is included in chapter 3.4 of the EU NIR
I.1	2015/2016	2. General (IPPU) (56, 2014) Transparency	Provide justifications in the NIR as to why the use of international data sources to report AD at the European Union level would lead to strongly inaccurate reporting	Not resolved. The ERT accepts the explanation provided by the European Union during the review and requests the European Union to include this information in its NIR (see G.1)	An explanation has been inclued in the Introduction chapter (in section 1.7.3).
I.7	2015/2016	2.A.1 Cement production – CO_2 (63, 2014) Transparency	Include the relevant information from the NIR of Poland in the NIR of the European Union rather than just referring to the NIR of the member State	Addressing. Annex III to the NIR contains a reference to the NIR of Poland where the EFs and AD used to estimate emissions from cement production in Poland can be found. However, the information provided in annex III to the NIR is not correct as it states that a tier 1 method and default EFs are used by Poland, whereas Poland uses plant-specific and country-specific AD and EFs	This will be corrected in Annex III

ID#		Issue and/or problem classification	Recommendation made in previous review report	ERT assessment and rationale	status of implementation (text will be included in NIR Table)
I.9	2015/2016	2.A.2 Lime production – CO_2 (64, 2014) Transparency	Provide more information for Italy about the methods used to estimate emissions from lime production for the entire time series; in particular, there should be transparent documentation on whether the method is based on the amount of calcium carbonate from raw material or on the amount of calcium and magnesium oxides in the lime produced for each of the periods	Not resolved. The European Union included in the NIR only the description of the collection of AD for estimating CO_2 emissions from lime production. The information on the method applied by Italy and on whether the method is based on the amount of calcium carbonate from raw material or on the amount of calcium and magnesium oxides is not provided in the NIR	Information from the Italian NIR will also be provided in Annex III of the EU NIR
I.11	2015/2016	2.B.1 Ammonia production – CO_2 (66, 2014) Transparency	Provide in the NIR adequate and transparent methodology overviews for France and Germany to enable the ERT to conduct a thorough review of the AD and EFs used in the ammonia production emission estimates of these countries	Not resolved. The description of the methodologies, type of feedstocks, AD and EFs used, including a reference as to where the information could be found in the respective member States' NIRs, was provided during the review but was not included in the NIR	To improve transparency on how the Member States allocate emissions between the Energy and IPPU sector, the NIR includes information on the approach taken by the six Member States with largest ammonia production emissions - including France and Germany which do make a split between energy and IPPU for ammonia production emissions.
I.12	2015/2016	2.B.1 Ammonia production – CO_2 (67, 2014) Consistency	Make efforts to ensure that Greece completes the ongoing work to obtain more accurate data on the amount of liquid fuel used as feedstock and the updated AD for the emission estimates	Not resolved. Greece did not implement the planned improvement to accurately determine the amount of liquid fuel used as feedstock in ammonia production in the period 1992–1999 (see section 4.6.6 of the 2016 NIR of Greece). Greece reported emissions from liquid fuel used for ammonia production under the energy sector for the periods 1990–1993 and 1995–1998, rather than under the IPPU sector (see section 4.6.1 of the NIR of Greece)	This issue has been raised during the initial checks and the situation is now described in section 4.6.1 of the Greek NIR. Further consultation with the MS is planned during initial checks in 2019.
I.15	2015/2016	2.B.7 Soda ash production – CO_2 (65, 2014) Consistency*	Work with Croatia to ensure the consistency of the time series of limestone and dolomite use	Not resolved. The time series of carbonate use in Croatia is inconsistent for limestone (1990–1999), dolomite (1997–2004) and soda ash (1990–1991)	HR NIR 2018: Soda ash production (2.B.7) This category does not exist in Croatia.
I.19	2015/2016	2.C.3 Aluminium production – CO_2 and PFCs (73, 2014) Transparency	Provide in the NIR adequate methodological overviews to enable the ERT to conduct a thorough review of the AD and EFs used in the aluminium production emission estimates provided by Greece, the Netherlands and Sweden	Not resolved. During the review, the European Union provided information on the methodology and EFs for the respective member States. However, this information is not included in the NIR of the European Union	The information is provided in chapter 4.2.3.2 of the NIR.
I.20	2015/2016	2.F. Product uses as substitutes for ozone depleting substances – HFCs, PFCs and SF_6 (74, 2014) Transparency	Endeavour to provide in the NIR summary overviews of methodologies used to estimate emissions from consumption of halocarbons and SF_6 for key categories based on the relevant methodological descriptions reported in the NIR's of member States	Not resolved. The ERT noted that the European Union provided, in annex III to the NIR, the description of the methodologies for estimating emissions from refrigeration and air-conditioning equipment (category 2.F.1). However, summary overviews of methodologies for the other key categories (2.F.2 and 2.F.4) were not included	While some information on the methodologies is provided in the NIR, it should be noted that the approaches used are quite different and vary between subcategories. To increase readability of the EU NIR not all descriptions of all MS methodologies are provided but can be retrieved from the respective NIRs.

ID#		Issue and/or problem classification	Recommendation made in previous review report	ERT assessment and rationale	status of implementation (text will be included in NIR Table)
I.21	2015/2016	2.F. Product uses as substitutes for ozone depleting substances – HFCs, PFCs and SF_6 (75, 2014) Transparency	Make the necessary corrections in the use of the notation keys to ensure the transparency of the reporting	Addressing. The ERT noted that the use of notation keys for reporting information on product uses as substitutes for ozone-depleting substances has been corrected by Denmark, Finland, the Netherlands and Spain. However, there are still instances where notation keys are incorrectly used; for example, Ireland still uses the notation keys “NE” and “NA” to report AD and emission estimates for refrigeration and air conditioning in CRF table 2(II)B-H	Process of updating is ongoing. Please note that notation keys represent a problem area of the CRF reporter software. Please also see status of issue G.3.
I.24	2015/2016	2.F.3 Fire protection – HFCs, PFCs and SF_6 (78, 2014) Accuracy*	Work with Greece in order to implement appropriate country-specific methodologies to estimate HFC and/or PFC emissions in accordance with the IPCC good practice guidance	Not resolved. During the review, the European Union stated that the implementation of a country-specific methodology is ongoing. However, the ERT noted that no information was provided in the NIR on the steps taken in resolving the recommendation. The ERT also noted from the information provided in annex III to the NIR that no changes have been made with regard to the methodology used by Greece	The implementation of this new country-specific methodology is still ongoing. Respective questions were asked during the initial checks and Greece confirmed that data collection and methodology development are being implemented.
I.25	2015/2016	2.F.6 Other applications (product uses as substitutes for ozone depleting substances) – HFCs, PFCs and SF_6 – (77, 2014) Transparency	Include an explanation in the annual submission on the reporting of the emissions from the processes related to the use of HFCs and SF_6 in the Netherlands and enhance the QC procedures to ensure that the information in the NIR of the European Union accurately reflects the information in the NIRs of member States	Not resolved. The NIR of the Netherlands indicates that emissions from foam-blowing agents (subcategory 2.F.2), fire protection (subcategory 2.F.3), aerosols (subcategory 2.F.4) and solvents (subcategory 2.F.5) are all included under the subcategory other (2.F.6) owing to the sensitivity of the information, as many processes related to the use of HFCs take place in only one or two companies (see section 4.7.1 of the NIR of the Netherlands). However, the reporting of information (e.g. notation keys) in tables 4.36 and 4.37 of the NIR of the European Union, on the contribution of each member State to HFC emissions from subcategories 2.F.2 and 2.F.3, respectively, does not reflect the information reported in the NIR of the Netherlands. Moreover, the ERT also noted that the notation keys used by the Netherlands in its CRF table 2(II) do not appear to be consistent with the information in the NIR of the Netherlands on how emissions from subcategories 2.F.2, 2.F.3, 2.F.4 and 2.F.5 are reported	This matter was addressed during the initial checks for several years. The Netherlands stated that a new methodology is being elaborated and will be implemented in the course of the year.

ID#		Issue and/or problem classification	Recommendation made in previous review report	ERT assessment and rationale	status of implementation (text will be included in NIR Table)
A.4	2015/2016	3.B.3 Swine – N_2O (90, 2014) Consistency*	Elaborate an explanation for the increase in the nitrogen excretion rate for swine for Sweden in the NIR	Not resolved. During the review, the European Union explained that the issue was raised and followed up during the annual review process under the European Union effort-sharing decisionf and the results therein indicate that: (1) the gap in the excretion rate between 2001 and 2002 is an outlier and not linked with events in 2002; and (2) the updated values for the swine nitrogen excretion rate for 2002 are relevant for 2002 and the following years, and it is likely that the values used for the previous years are underestimated; and (3) it would be recommended to keep 1990 with the current nitrogen excretion rate (if relevant) and interpolate this parameter between 1990 and 2002 in order to avoid the outlier. The ERT noted that the trend of nitrogen excretion rates for swine for Sweden (CRF table 3.B(b) of Sweden) still shows a stepwise increase in the nitrogen excretion rate from 7.7 kg N/head/year to 9.0 kg N/head/year between 2001 and 2002. The ERT further noted that information on this issue is not yet provided in the NIR	The issue has been resolved; data from SE does not show the time trend irregularities identified in the past.
A.7	2015/2016	3.D Direct and indirect N_2O emissions from agricultural soils – N_2O (92, 2014) Comparability*	Work with member States to ensure more consistent reporting of the area of organic soils between the agriculture and LULUCF sectors	Addressing. During the review, the European Union explained that member States' submissions were checked for consistency between the agriculture and LULUCF sectors and four issues were identified and included in the European Environment Agency Emission Review Tool.g However, in the submission of 9 September 2016, the ERT still observed a discrepancy in the total area of organic cultivated soils, which is reported in CRF table 3.D as 3,904.26 kha, and is reported as the total area of organic soils in CRF tables 4.B and 4.C as 5,689.18 kha for 2014 in the European Union submission of 9 September 2016. During the review, the European Union informed that the issue will be solved in the 2017 annual submission	The issue has been resolved, we do not find inconsistencies in 2017 and 2018
L.1	2016	4. General (LULUCF) (13, 2014) (27, 2013) (12, 2012) Completeness*	Continue efforts to improve the completeness of the reporting of emissions from all mandatory source categories in the LULUCF sector	Addressing. The ERT noted that multiple instances of the use of the notation key "NE" in the CRF tables from the 2014 GHG inventory submission have been addressed by the Party (see L.18, L.22 and KL.5, KL.8, KL.9, KL.10, KL.11 and KL.14 in table 5)	Issues were comunicated to MS, and some improvements have been implemented to increase the completeness and transparency of the reporting of carbon stock changes in AR. Further improvements are expected for future submissions..
	2015			Addressing. The ERT noted that multiple instances of the use of the notation key "NE" in the CRF tables from the 2014 GHG inventory submission have been addressed by the Party (see L.17, L.21 and KL.5, KL.8, KL.9, KL.10, KL.11 and KL.14 in table 5)	

ID#		Issue and/or problem classification	Recommendation made in previous review report	ERT assessment and rationale	status of implementation (text will be included in NIR Table)
L.2	2015/2016	4. General (LULUCF) (95, 2014) (76, 2013) (86, 2012) Completeness*	Work with member States with a view to reporting mandatory pools and categories which are currently not estimated in order to increase the completeness of the inventory	Addressing. See L.1	Issues were comunicated to MS, and some improviments have been implemented to increase the completeness, and transparency, of the reporting of carbon stock changes in AR. Further improvements are expected for future submissions..
L.4	2015/2016	4.A.2 Land converted to forest land – CO_2 (97, 2014) (80, 2013) Transparency	Improve the transparency of the reporting, including the provision of updated information from member States and internal QA/QC checks in order to ensure that the aggregated reporting is complete and consistent among member States	Not resolved. The ERT noted that there is no information in the NIR to confirm whether the European Union made progress with Italy on the methodological issue referred to in the 2013 and 2014 individual review reports of the European Union	Information on this regard has been included in the NIR. See section 6.2.1.3
L.6	2015/2016	4.B.2 Land converted to cropland – CO_2 (99, 2014) Transparency	Provide transparent explanations in the annual submission, indicating the key drivers for the changes in the trend and recalculations	Not resolved. The European Union has not provided the requested information in its NIR. During the review, the Party provided the requested information, but it is not included in the NIR	Information on this regard has been included in the NIR. See section 6.2.2.3 and 6.5
L.7	2015/2016	4.B.2 Land converted to cropland – CO_2 (100, 2014) (81, 2013) (92, 2012) Completeness*	Work with the member States to improve the completeness of their reporting and use higher-tier methods in order to enhance accuracy	Addressing. The ERT notes that the current reporting approach does not allow for the review of completeness under land converted to cropland by country and by pool. Nevertheless, the ERT notes that the notation key “NE” is still used for reporting information on mineral soils under land converted to cropland for Cyprus (see table 6.6 of the NIR)	Work has been done to ensure the completeness of the reporting of carbon stock changes under 4B2. Cyprus provides quantitative estimates of carbon stock changes for this subcategory in 2018
L.10	2015/2016	4.F.2 Land converted to other land – CO_2 (104, 2014) (85, 2013) Transparency	Include transparent explanations in the NIR for the inter-annual variations and work with the member States to improve the consistency of their reporting	Not resolved. The European Union has not provided the requested information in its NIR. During the review, the Party provided the requested information, but it is not included in the NIR	Information on this regard has been included in the NIR. See section 6.2.4.3
L.11	2015/2016	4 (V) Biomass burning – CO_2, CH_4 and N_2O (105, 2014) Transparency	Include the reasons for the use of the notation key “NE” where applicable and make efforts to increase the completeness of the reporting	Not resolved. The ERT notes that the information regarding the use of the notation key “NE” is not included in the NIR	Information on this regard has been included in the NIR. See section 6.2.5.5
KL.1	2015/2016	General (KP-LULUCF) (121, 2014) Transparency	Work with and support member States to improve consistency in the use of notation keys and further improve the transparency of future submissions	Not resolved. The ERT noted that consistency in the use of notation keys and transparency are still an issue (e.g. the notation key “NO” is used by some member States when the activity exists and there are no changes in management, while others consider the activity insignificant and use the notation key “NE”)	The EU has worked with MS to improve the consistency in the use of NK by its MS. Every year this isse is subject to a dedicated presentation during the annual JRC LULUCF workshop and during the WG-I meetings. More improvements are also exppected for future submissions.
KL.3	2015/2016	Deforestation – CO_2 (125, 2014) Transparency	Work with member States so that they use the appropriate notation keys and provide a synthesis in the NIR of the explanations and justifications provided by member States	Not resolved. The synthesis of explanations and justifications provided by member States on the use of notation keys was not included in the NIR	Information on this regard has been included in the NIR. See section 11.3.2

ID#		Issue and/or problem classification	Recommendation made in previous review report	ERT assessment and rationale	status of implementation (text will be included in NIR Table)
KL.5	2015/2016	Forest management – CO_2, (130, 2014) Completeness*	Work with member States to ensure that future reporting on forest management is complete and accurate	Not resolved. The information on member States' forest management is not complete (e.g. France underestimates unmanaged forests, while Cyprus and Malta do not report all pools and Hungary does not report the dead organic matter and soil organic carbon pools)	Issues were comunicated to MS, and some improviments have been implemented to increase the completeness, and transparency, of the reporting of carbon stock changes in FM. Further improvements are expected for future submissions..

Table 10.8 Improvements made in 2017 and 2018 in response to UNFCCC review findings as indicated in Tables 5 of the ARR 2015 and ARR 2016

ID#	year ARR	TACCC	Category	Provisional Main Finding	status of implementation (text will be included in NIR Table)
G.12	2015/2016	Yes. Adherence to UNFCCC Annex I inventory reporting guidelines	Key category analysis	The ERT noted that in table 11.4 of the NIR, the information on the key category analysis is not reported for many member States. Furthermore, the European Union did not report any information in CRF table NIR-3 on a summary overview for the key categories for KP-LULUCF activities. During the review, the European Union explained that information was not reported in CRF table NIR-3 owing to technical issues with the CRF Reporter for several member States. In addition, the Party also explained that all member States except three (Cyprus, Malta and Portugal) provided a key category analysis in their NIR. Furthermore, the European Union explained that the issue was already being addressed The ERT recommends that the European Union improve the collaboration with member States and provide complete reporting of the key categories for KP-LULUCF activities in CRF table NIR-3	Included in table 11.4 of the EU NIR and CRF table NIR-3
E.9	2015/2016	Accuracy	1. General (energy sector) – gaseous, liquid and solid fuels – CO_2, CH_4 and N_2O	The European Union has provided information in tabular format on the methods and EFs used by individual member States to estimate emissions from the energy sector (e.g. see tables 3.12, 3.14, 3.21–3.23, 3.25, 2.26, 3.28–3.30, 3.33, 3.35, 3.37–3.39 and 3.41–3.43 of the NIR). Based on this information, some member States use a tier 1 method for estimating emissions from some key categories of the European Union inventory. The ERT considers that if most of the key categories in the GHG inventory of the European Union are also key categories in the individual member States, then emissions from these key categories should be estimated using a tier 2 or higher methodology. During the review, the European Union informed that the consideration of the key category by member States should reflect the conclusions of the 3rd lead reviewers meeting conclusions and should consider the categories that are key at the level of the compiled inventory, and the contribution of individual national inventories to the total emissions in these key categories. Where estimates of individual national inventories represent a high proportion of emissions in a key category (e.g., the relative contribution of the estimates of these inventories ranked by level account for 60% – 75 % of emissions in the category), the ERT should assess whether these estimates were prepared using an appropriate (e.g. higher-tier) method The ERT recommends that the European Union work with its member States to improve the methodology used to estimate emissions from key categories by using a methodological tier for each member State in accordance with the decision trees in the 2006 IPCC Guidelines, the key category analysis of the European Union and the	In the second half of 2018 capacity builing activities are carried out and it is forseen to support countries in moving to higher tier methods for key categories.

ID#	year ARR	TACCC	Category	Provisional Main Finding	status of implementation (text will be included in NIR Table)
				importance of the contribution of member State emissions to total emissions at European Union level	
E.10/ E.11	2015/2016	Transparency	1. General (energy sector) – CO_2 and CH_4	The ERT noted that some member States (e.g. Romania, Slovakia and the United Kingdom) reported CH_4 recovery from coal mining, and oil and natural gas production. In the NIR, the European Union stated that CH_4 recovered is excluded from the category where it is recovered and emissions from its combustion are reported under the respective fuel combustion category. However, there is no clear description of the fuel combustion categories under which the emissions from the combustion of CH_4 recovered are included The ERT recommends that the European Union provide information in the NIR on the fuel combustion categories under which the emissions from the combustion of CH_4 recovered are included.	If member States have reported CH_4 recovery as include elsewere (IE) it has been explained in the EU NIR where it is reported, e.g. see table '1.B.1 Fugitive Emissions from Solid Fuels: Member States Contribution' in chapter 'Fugitive emissions from Solid Fuels (1.B.1)'
E.11	2016	Transparency		The ERT noted that information on emission trends, methodologies and EFs is missing for the following key categories: (1) CO_2 emissions from public electricity and heat production – peat (subcategory 1.A.1.a); (2) CH_4 emissions from residential – solid fuels (subcategory 1.A.4.b); and (3) CO_2 emissions from venting and flaring (subcategory 1.B.2.c). During the review, the European Union explained that these are new key categories and would be considered in detail in the 2017 GHG emissions inventory, as stated in footnote 18 to the NIR (p. 99) The ERT recommends that the European Union include in the NIR summary information on emission trends, methodologies and EFs for the following key categories: (1) CO_2 emissions from public electricity and heat production – peat (subcategory 1.A.1.a); (2) CH_4 emissions from residential – solid fuels (subcategory 1.A.4.b); and (3) CO_2 emissions from venting and flaring (subcategory 1.B.2.c)	1.A.1.a - peat, 1.A.4.b - solid fuels (CH_4), 1.B.2.c - CO_2: information on emission trends, methodologies and EFs are included
E.12	2015/2016	Transparency	Feedstocks, reductants and other NEU of fuels – all fuels – CO_2	The ERT noted that the European Union included in the NIR information on feedstocks and other NEU of fuels as provided by member States (table 3.119, p. 350), whereas the data reported in CRF table 1.A(d) on feedstocks, reductants and other NEU of fuels was taken directly from Eurostat. The ERT also noted that the information provided in the NIR is not consistent among member States and does not provide a transparent description of feedstocks, reductants and other NEU of fuels. During the review, the European Union confirmed that it is working on improving the transparency for the reporting of feedstocks, reductants and other NEU of fuels, but that this improvement is planned for the 2017 GHG inventory submission The ERT recommends that the European Union provide in the NIR information explaining why information reported in CRF table 1.A(d) on feedstocks, reductants and other NEU, is different from that reported by the Parties in order to ensure a transparent reporting of feedstocks, reductants and NEU of fuels	For the 2018 submission the EU has changed its approach: now all data used for CRF table 1A(d) is the sum of Member States submissions. This is described in Chapter 3.9. The whole chapter has been made more transparent.

ID#	year ARR	TACCC	Category	Provisional Main Finding	status of implementation (text will be included in NIR Table)
E.13	2015/2016	Transparency	1.A. Fuel Combustion-Sectoral Approach – all fuels – CO_2	The European Union reported for some key categories the mean and standard deviation of all reported IEFs of individual member States and the IEFs of member States that lie outside this range for the entire time series (e.g. figures 3.39, 3.44, 3.46, 3.48, 3.50, 3.55, 3.62, 3.69, 3.73 and 3.82 of the NIR) and compared the IEFs with the default EFs provided in the 2006 IPCC Guidelines. The ERT noted that in some instances it was not entirely clear how the EFs from the 2006 IPCC Guidelines shown in the NIR were selected, why the EFs did not correspond to the IEFs in the corresponding CRF tables of the European Union, and why some IEFs of individual member States lay far outside the IPCC default range. During the review, the European Union provided detailed information regarding the choice of default EFs from the 2006 IPCC Guidelines and explained why the mean values shown in the figures in the NIR (e.g. in figures 3.50, 3.73 and 3.82) were different from the IEFs provided in the CRF tables and why the IEFs of individual countries lay outside the IPCC default range The ERT recommends that the European Union report information regarding the choice of default EFs from the 2006 IPCC Guidelines and the reasons for particularly high or low IEFs of individual member States	The figures showing the default EF and standard deviation of all reported IEFs are amongst the set of figures used for quality checking MS submissions during the initial check phase. They are not included anymore in the EU NIR because they do not make transparent the magnitude of the IEF for every MS. Instead the NIR now inlcudes figures showing the IEFs of every Member State. The EU has provided explanations for additional high or low IEFs of individual MS. Examples are 1A1a, solid fuels, CO_2, Greece or 1A2f, other fuels, CO_2, Poland.
E.15	2015/2016	Comparability	1.A.3.b Road transportation – liquid fuels – CO_2, CH_4 and N_2O	Emissions from lubricants that are intentionally mixed with fuel and combusted in two-stroke engines should be accounted for in the energy sector and emissions from primary usage of lubricants (i.e. for lubrication or coating) should be accounted for in the IPPU sector in accordance with the 2006 IPCC Guidelines. However, there is no clear information in the NIR on how the European Union and each member State reported emissions from the use of lubricants under the transport (1.A.3) and/or lubricant use (2.D.1) categories. During the review, the European Union explained that it checks the allocation of emissions from use of lubricants between the transport and lubricant use categories for each member State, and only Belgium and Germany reported emissions from lubricants under the transport category, whereas other member States reported these emissions under the lubricant use category The ERT recommends that the European Union provide summary information on how each member State has reported the emissions from use of lubricants under the transport (1.A.3) and/or lubricant use (2.D.1) categories and work with the member States to report emissions from lubricants combusted in two-stroke engines under the transport category in accordance with the 2006 IPCC Guidelines	For Member States that have provided information in their NIR on how they have reported the emissions from use of lubricants, the recommendation is considered implemented. In cases, where no clear conclusion can be drawn on what is implemented by the Member States, additional actions are needed, which will take place in the next submission.
I.26	2015/2016	Transparency	2. General (IPPU)	The ERT noted that information on the methods used to estimate GHG emissions from the IPPU sector was provided in section 4 and in annex III to the NIR. However, the ERT noted that the identification of the tier methods and data sources was often inconsistent between the NIR and annex III to the NIR. For example, the information in table 4.4 of the NIR on the tier method and EF used by Denmark, France, Greece and Lithuania to estimate emissions from cement production is not consistent with the information provided in annex III to the NIR. Similar inconsistencies were identified for other categories of the IPPU sector The ERT recommends that the European Union provide consistent information on the methodologies used to estimate GHG emissions from the IPPU sector within the NIR, while also ensuring consistency with the NIRs of member States	This will be corrected in Annex III

ID#	year ARR	TACCC	Category	Provisional Main Finding	status of implementation (text will be included in NIR Table)
I.27	2015/2016	Transparency	2. General (IPPU)	The ERT noted that the information on the tier method complexity, as required by paragraph 50(b) of the UNFCCC Annex I inventory reporting guidelines was frequently not provided for the categories of several member States in annex III to the NIR. Often, the European Union identified only the general approach followed (e.g. country-specific, plant-specific) instead of the tier method used (i.e. tier 1, 2 or 3 of the 2006 IPCC Guidelines). The lack of information on the method used in these cases does not allow the ERT to assess whether the methods used for the key categories are in accordance with the 2006 IPCC Guidelines (see ID#s I.29 and I.30 below) The ERT recommends that the Party identify which tier method was used to estimate emissions under each key category of the IPPU sector, in accordance with the 2006 IPCC Guidelines, and provide the corresponding tier method when a country-specific method is used	This will be corrected in Annex III
I.28	2015/2016	Transparency	2.A.1 Cement production – CO_2	The European Union reported in the NIR that Poland used a tier 1 method and default EF to estimate CO_2 emissions from cement production. During the review, the European Union explained that Poland no longer uses a tier 1 method and that a tier 2 method has been used to calculate CO_2 emissions from cement production since 2005, when plant-specific data became available under the EU ETS, and that this information is provided in the NIR of Poland The ERT recommends that the European Union correct the information provided in the NIR on the method used by Poland to estimate CO_2 emissions from cement production	The correct information has been updated.
I.29	2015/2016	Transparency	2.A.1 Cement production – CO_2	The European Union reported in the NIR that Cyprus, Greece, Hungary, the Netherlands and Sweden used a country-specific method to estimate CO_2 emissions from cement production (see table 4.4 of the NIR), without specifying the corresponding level of complexity (IPCC tier) in accordance with decision 24/CP.19, annex I, paragraph 50(b). During the review, the European Union explained that member States' submissions are part of the European Union submission and that the information on the level of complexity of the methodology used may be found in the member States' submissions The ERT recommends that the European Union provide information in the NIR on the corresponding level of complexity (IPCC tier) of the country-specific methods used by Cyprus, Greece, Hungary, the Netherlands and Sweden to estimate emissions from cement production	This will be followed up in a future submission
I.30	2015/2016	Transparency	2.A.2 Lime production – CO_2	The ERT noted that the European Union did not report information on the methods and EFs used by Austria and France to estimate CO_2 emissions from lime production (see table 4.5 of the NIR). Moreover, the European Union used the notation key "NA" to report the method and CO_2 EF for Malta even though emissions occurred in the country in the period 1990–1998 (see p.64 of the NIR of Malta). Furthermore, the European Union reported that Greece, Hungary and Sweden used a country-specific method to estimate CO_2 emissions from lime production, without specifying the corresponding level of complexity (IPCC tier) of those methods The ERT recommends that the European Union provide information in the NIR on the methods and EFs used by Austria, France and Malta and the level of complexity (IPCC tier) of the country-specific methods used by Greece, Hungary and Sweden to estimate CO_2 emissions from lime production	The information on tier and emissions refer to the last inventory year.

ID#	year ARR	TACCC	Category	Provisional Main Finding	status of implementation (text will be included in NIR Table)
I.31	2015/2016	Comparability	2.A.2 Lime production – CO_2	The European Union used the notation key “IE” to report CO_2 emissions from lime production in the Netherlands (see table 4.6 of the NIR), without specifying where in the inventory the emissions have been included. During the review, the European Union explained that CO_2 emissions from lime production in the Netherlands are included under the energy sector (subcategory 1.A.2.e) because lime production in the Netherlands occurs only in four sugar industry plants and it is not possible to separate emissions from lime production from other emissions. The ERT considers that, in accordance with the 2006 IPCC Guidelines, emissions from lime production are to be reported under the IPPU sector The ERT recommends that the European Union work with the Netherlands to report CO_2 emissions from lime production under the lime production category (2.A.2) in accordance with the 2006 IPCC Guidelines	With reference to the notation key “IE” to report CO_2 emissions from lime production in the Netherlands, these are included in 2D2 Food industries. This information is provided in the EU NIR sector chapter.
I.32	2015/2016	Comparability	2.A.2 Lime production – CO_2	The ERT noted that the CO_2 IEFs for lime production for the United Kingdom (0.45 t/t), Latvia (0.55 t/t) and Croatia (0.58 t/t) for 2014 are significantly lower than the average value for the European Union (0.71 t/t) (see table 4.6 of the NIR). However, no information is provided in the NIR on why these IEFs are lower than the average value for the European Union. During the review, the European Union clarified that member States use different approaches to estimate emissions and, therefore, the IEFs are not comparable. The European Union further explained that the IEF may refer to tonnes of CO_2 per tonne of lime produced (i.e. in the case of Croatia and Latvia) but also tonnes of CO_2 per tonne of limestone consumed (i.e. in the case of the United Kingdom). Based on the response provided by European Union, the ERT considers that the CO_2 IEFs for lime production are not transparently reported in the NIR The ERT recommends that the European Union indicate in the NIR the units in which the AD and IEFs for the lime production category are reported (lime production or carbonate use) and report the comparison analysis of the IEFs used by member States, including the reasons for significant deviations from the average value for the European Union and from the default IPCC EFs, if such deviations occur.	Not all countries show production as the activity data for this emissions category. Gap-filled values are shown against Lime production for EU activity and the EU IEF.
I.33	2015	Comparability	2.A.3 Glass production – CO_2	The ERT noted that the CO_2 IEFs for glass production for Spain for 1990 and 2014 (130.67 and 107.08 t CO_2/t glass, respectively) are significantly higher than the average IEFs for the European Union for the same years (0.16 and 0.14 t CO_2/t glass, respectively) (see table 4.8 of the NIR). During the review, the European Union clarified that Spain had mistakenly introduced the AD for glass produced in the CRF Reporter by entering the data expressed in thousands of kt instead of kt, as requested by the CRF Reporter. The European Union further clarified that although there is a mistake in the IEFs for Spain, the CO_2 emission data are correctly reported The ERT recommends that the European Union report the correct CO_2 IEFs for glass production for Spain in the NIR and CRF tables	This has ben corrected. See section on 2.A.3 in the EU NIR
I.33/I. 34	2016/2015	Transparency	2.A.4 Other process uses of carbonates – CO_2	The ERT noted that CO_2 emissions from other process uses of carbonates is a key category (2.A.4). However, the European Union did not report information on the methodologies, assumptions, EFs and AD used to estimate CO_2 emissions from this category. During the review, the European Union provided a summary of the AD, EFs and CO_2 emissions for each member State for 1990 and 2014 The ERT recommends that the European Union report a summary description of the methodologies, assumptions, EFs and AD used to estimate emissions from other	A summary description of the methodologies, EFs and AD used to estimate emissions from 2.A.4 is included.

ID#	year ARR	TACCC	Category	Provisional Main Finding	status of implementation (text will be included in NIR Table)
				process uses of carbonates (2.A.4) for each member State	
I.34/I.35	2016/2015	Comparability	2.B.1 Ammonia production – CO_2	The ERT noted in the European Union submission of 9 September 2016 that the CO_2 IEF for ammonia production for Hungary (0.06 t CO_2/t ammonia) is significantly lower that the range of IEFs from other member States (1–2 t CO_2/t ammonia) During the review, the European Union explained that the AD for ammonia production reported by Hungary refers to the consumption of natural gas rather than ammonia produced as reported by other member States. The European Union further explained that, owing to the automatic aggregation performed by the European Union for its reporting in the CRF tables, natural gas consumption has been automatically and incorrectly added as ammonia production. Moreover, the European Union clarified that the IEFs reported in the NIR are not comparable between Hungary and other member States and that the average IEF for the European Union was estimated incorrectly The ERT recommends that the European Union correct the reporting of the AD, CO_2 emissions and CO_2 IEF for ammonia production for Hungary and recalculate the aggregated values for the European Union in the CRF tables, and correct the average CO_2 IEF for the European Union reported in the NIR	Not all countries show production as the activity data for this emissions category. Gap-filled values were calculated for EU ammonia production and the EU IEF for 2016.
I.35/I.36	2016/2015	Accuracy	2.B.1 Ammonia production – CO_2	The European Union reported that the Czech Republic used a tier 1 method and country-specific EF to estimate CO_2 emissions from ammonia production (see table 4.13 of the NIR). The ERT noted that CO_2 emissions from ammonia production is a key category for the Czech Republic. In addition, the ERT noted that the Czech Republic used a default CO_2 EF (3.273 t CO_2/t NH_3) from the 2006 IPCC Guidelines (volume 3, chapter 3, table 3.1, p. 3.15) instead of a country-specific EF as stated in the NIR. During the review, the European Union clarified that the Czech Republic was not able to use a higher-tier method because the Czech Statistical Office only reports information on the sector where the fuel was used (i.e. chemical and petrochemical industry), and does not disaggregate for specific production outputs The ERT recommends that the European Union work with the Czech Republic to move from a tier 1 to a higher-tier method to estimate CO_2 emissions from ammonia production, which is a key category, in accordance with the 2006 IPCC Guidelines	This is planned for future submission
I.37	2015	Transparency	2.B.2 Nitric acid production – N_2O	The ERT noted that the IEF for nitric acid production for 2014 reported by the European Union in the NIR is 0.00 t/t for most member States (see table 4.16 of the NIR). During the review, the European Union provided the IEFs for nitric acid production for each member State expressed in kg N_2O/t nitric acid The ERT recommends that the European Union report in the NIR the N_2O IEF for nitric acid production in a transparent manner by expressing the value in kg N_2O/t nitric acid production, instead of t N_2O/t nitric acid production	The IEFs are shown as kg N_2O per tonne of production as recommended by the ERT.

ID#	year ARR	TACCC	Category	Provisional Main Finding	status of implementation (text will be included in NIR Table)
I.36/I.38	2016/2015	Transparency	2.B.2 Nitric acid production – N_2O	The European Union reported that the AD used to estimate N_2O emissions from nitric acid production in Lithuania for 1990 and 2013 are 355 437 kt and 1 049 172 kt, respectively (see table 4.16 of the NIR). The ERT noted that the increase in nitric acid production in Lithuania would contribute to a significant increase in the average nitric acid production in the European Union. During the review, the European Union stated that the AD values reported for Lithuania were incorrect and provided the correct AD for 1990 (335.437 kt) and 2014 (1 140.746 kt) The ERT recommends that the European Union correct the AD for nitric acid production and recalculate the N_2O IEF for Lithuania	EU NIR Table 4.17 2B2 Nitric acid production: Information on methods applied, activity data, emission factors for N_2O emissions; has the correct the AD, emissions and IEF for Lithuania.
I.37/I.39	2016/2015	Comparability	2.B.3 Adipic acid production – N_2O	The ERT noted in the European Union submission of 9 September 2016 that the N_2O IEF for adipic acid production for 1990 reported in CRF table 2(I).A-H (3.25 t N_2O/t adipic acid) is significantly higher than the IPCC default EF (0.3 t N_2O/t adipic acid). During the review, the European Union explained that the IEF was calculated incorrectly, as much of the AD are confidential and it is not possible to apply gap-filling techniques. The European Union further explained that Germany, France, Italy, Poland, Romania and the United Kingdom produced adipic acid in 1990 but the four largest emitters reported the AD as confidential The ERT recommends that the European Union recalculate and report the European Union average N_2O IEF for adipic acid production, taking into account only N_2O emissions for which there are AD available and explain in the NIR the approach used to calculate the IEF	Adipic acid production is used as activity data but the information is confidential in France and Germany. Because the IEF is calculated automatically by the inventory software, where the activity data is not included but emissions are shown, then this will result in an apparently high IEF. The implied emission factors per tonne of adipic acid produced is only provided by Italy with 0.3 t/t for 1990 and 0.003 t/t for 2016. Activity data for categriy 2.B.3 cannot be gap filled due to the fact that only 20% of emission are calculated on the basis of the same activity data.
I.38/I.40	2016/2015	Accuracy	2.B.4 Caprolactam, glyoxal and glyoxylic acid production – N_2O	The ERT noted that the annual N_2O emissions from caprolactam production in the Czech Republic (0.25 kt N_2O) are the same throughout the whole time series. During the review, the European Union explained that, based on a study conducted at the plant (Bernauer and Markvart, 2014–2015), the N_2O emissions were approximately 0.25 kt N_2O, which is reported by the Czech Republic as a constant value for the whole time series. The European Union further explained that, according to the NIR of the Czech Republic, N_2O emissions from the production of caprolactam has been continuously measured as of 2012 as a consequence of the inclusion of caprolactam production in the scope of the EU ETS. The ERT considers that the reported N_2O emissions from caprolactam production are not accurate The ERT recommends that the European Union work with the Czech Republic to recalculate and report more accurate N_2O emissions from caprolactam production, taking into account the data collected under the EU ETS	This is planned for future submission
I.39/I.41	2016/2015	Transparency	2.B.8 Petrochemical and carbon black production – CO_2	The ERT noted that CO_2 emissions from petrochemical and carbon black production is identified as a key category (see p. 365 of and annex III to the NIR), but no information is provided on the methodologies, assumptions, EFs and AD used to estimate CO_2 emissions from petrochemical and carbon black production in, for example, the Czech Republic, France, the Netherlands, Romania, Slovakia and Spain. During the review, the European Union provided the required information The ERT recommends that the European Union include information on the methodologies, assumptions, EFs and AD used to estimate CO_2 emissions from petrochemical and carbon black production, which is a key category	A summary description of the methodologies, EFs and AD used to estimate emissions from 2.B.8 is included.

ID#	year ARR	TACCC	Category	Provisional Main Finding	status of implementation (text will be included in NIR Table)
I.40/I. 42	2016/2015	Comparability	2.B.8 Petrochemical and carbon black production – CO_2	The ERT noted that the IEF for ethylene production for France (0.0005 t CO_2/t ethylene) is significantly lower than the IPCC default EF (0.95–2.29 t CO_2/t ethylene). During the review, the European Union clarified that CO_2 emissions from fuel consumption in ethylene production in France were allocated to the energy sector The ERT recommends that the European Union include in the NIR the reasons why CO_2 emissions from fuel consumption in ethylene production in France were allocated to the energy sector and work with the member State to allocate CO_2 emissions from fuel use in ethylene production to the IPPU sector, under petrochemical and carbon black production, in accordance with the 2006 IPCC Guidelines	Planned for future submission
I.41/I. 43	2016/2015	Comparability	2.B.9 Fluorochemical production – HFCs	The ERT noted in the submission of 9 September 2016 that the European Union reported in CRF table 2(II)B-H CF4 emissions as a by-product of HCFC-22 production (213 t CF4 for 2013). The ERT notes that according to the 2006 IPCC Guidelines, only HFC-23 emissions are considered as a by-product of HCFC-22 production. During the review, the European Union clarified that CF4 emissions were reported under the subcategory production of HCFC-22 (2.B.9.a.1) by Italy and that the methodology used to estimate CF4 emissions is based on measured data of CF4 concentration in one chemical plant. In addition, the abatement system used in the plant collects the flow gases not only from HCFC-22 production but also from the production of other chemical substances where CF4 can also be formed. The ERT considers that it is not clear how CF4 emissions from the production of HCFC-22 occur The ERT recommends that the European Union explain in the NIR how CF4 emissions from the production of HCFC-22 occur and work with Italy to allocate CF4 emissions under the subcategory fluorochemical production – by-product emissions (other) (2.B.9.a.2) instead of the subcategory fluorochemical production – by-product emissions (production of HCFC-22) (2.B.9.a.1)	Included in EU NIR, chapter 4.1.2.5.
I.42/I. 44	2016/2015	Transparency	2.B.9 Fluorochemical production – HFCs and PFCs	The ERT noted in the submission of 9 September 2016 that emissions from unspecified mix of HFCs and PFCs reported under the subcategory fluorochemical production – by-product emissions (other) (2.B.9.a.2) decreased from about 5 567.08 kt in 1990 to 46.70 kt in 2013. However, a description of the methodology used and information to explain the trend was not provided in the NIR. During the review, the European Union explained that these emissions were reported by Germany and since there are less than three producers in Germany, the data are confidential The ERT recommends that the European Union provide a description of the methodology used and information explaining the trend of emissions of unspecified HFCs and PFCs reported under the subcategory fluorochemical production – by-product emissions (other) (2.B.9.a.2)	Included in EU NIR, chapter 4.1.2.5.

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I.43/I.45	2016/2015	Accuracy	2.C.1 Iron and steel production – CO_2	The ERT noted that Romania used a default EF (1.72 t CO_2/t steel, provided in volume 3, chapter 4, table 4.1, of the 2006 IPCC Guidelines) to estimate emissions from steel production in OHFs. The ERT further noted that CO_2 emissions from iron and steel production is a key category. The ERT also noted that the use of the IPCC default EF might include the CO_2 emissions from fuel combustion in OHFs and in pig iron production. During the review, the European Union confirmed that CO_2 emissions from fuel combustion in OHFs in Romania were estimated under the energy sector. The ERT notes that CO_2 emissions from fuel combustion in OHFs are double counted owing to the use of a tier 1 method. With regard to the risk of double counting of CO_2 emissions from pig iron production, the European Union provided no clarification The ERT recommends that the European Union work with Romania to move to a higher-tier method and ensure that double counting does not occur when estimating CO_2 emissions from iron and steel production	Following the 2016 review, the EU worked with Romania on this issue. In order to avoid double-counting, Romania re-calculated the time series in category 1.A.2 in the 2017 submission. This recalculation is described in Table 3.24 (page 152) of the 2017 EU NIR. The same approach is applied in the 2018 submission.
I.45/I.47	2016/2015	Transparency	2.C.1 Iron and steel production – CO_2	The ERT noted that the European Union used the notation key “NA” to report CO_2 emissions from sinter production in Italy for 2014, while also reporting 8 358 kt of sinter production as AD for the same year (see p. 409 of the NIR). During the review, the European Union clarified that sinter production in Italy is carried out at two integrated iron and steel production plants and that the emissions from sinter production are not reported separately but rather aggregated and reported under the category pig iron (2.C.1.b) The ERT recommends that the European Union use the notation key “IE”, instead of “NA”, when reporting on CO_2 emissions from sinter production in Italy in the NIR and specify where in the inventory these emissions are included	The notation key has been changed to IE. It is explained in the NIR (chapter 4.2.3.1) that Italy reports emissions from sinter production under 2.C.1.b Pig iron.
I.46/I.48	2016/2015	Accuracy	2.C.1 Iron and steel production – CO_2	In the NIR, the European Union reported that pig iron production in Slovakia for 1990 and 2014 is 17 kt and 24 kt, respectively (see figure 4.14, p. 411 of the NIR). The ERT noted that pig iron production in Slovakia is expected to be higher, taking into account its level of CO_2 emissions from iron and steel production. During the review, the European Union explained that, according to the Steel Statistical Yearbook 2015 of the World Steel Association, pig iron production in Slovakia for 2014 amounts to 3 838 kt. The ERT believes that this issue should be considered further in future reviews to confirm there is not an underestimation of emissions The ERT recommends that the European Union work with Slovakia to correct the reported AD for total pig iron production used to estimate CO_2 emissions from iron and steel production	Planned for future submission.
I.49	2016	Transparency	2.C.1 Iron and steel production – CO_2	The ERT noted that the European Union reported a CO_2 IEF for sinter production of 5.28 t CO_2/t and 5.35 t CO_2/t for 1990 and 2014, respectively, for Hungary (figure 4.14, p.409 of the NIR), which is significantly higher than the IPCC default EF (0.20 t CO_2/t sinter produced). During the review, the European Union explained that, in reference to CRF table 2(I).A-H of Hungary, the reported IEF refers to tonnes of CO_2 emissions per tonne of coke used for sinter and pellet production, not tonnes of CO_2 emissions per tonne of sinter production. Therefore, the ERT considers that the IEF for sinter production for Hungary reported by the European Union in its NIR is not relevant and comparable with the IEFs of other member States The ERT recommends that the European Union work with Hungary to estimate and report the CO_2 IEF, expressed in tonnes of CO_2 per tonne of sinter produced	Planned for future submission.

ID#	year ARR	TACCC	Category	Provisional Main Finding	status of implementation (text will be included in NIR Table)
I.47/I. 50	2016/2015	Transparency	2.C.3 Aluminium production – CO_2	The ERT noted that the European Union did not include in the NIR information on CO_2 emissions from aluminium production, but reported those emissions in the CRF tables The ERT recommends that the European Union include in the NIR information on the method, assumptions, EFs and AD used to estimate CO_2 emissions from aluminium production	The information has been included in the NIR (chapter 4.2.3.2).
I.48/I. 51	2016/2015	Transparency	2.C.7 Other (metal industry) – CO_2	The ERT noted that the European Union did not include in the NIR information on CO_2 emissions reported under the subcategory metal industry – other (2.C.7), but reported those emissions in CRF table 2(I). During the review, the European Union clarified that the CO_2 emissions reported under the subcategory metal industry – other (2.C.7) include: (1) all process emissions from the non-ferrous sector (including lead and zinc) in Belgium; (2) silicium production in Spain; (3) copper and nickel smelting in Finland; emissions from one plant producing copper, lead and zinc, and one metal recycling plant mainly producing lead by melting used batteries and recovering the lead in Sweden; and (4) emissions from anode burn-off during the anode baking process (used for aluminium production) in Slovenia The ERT recommends that the European Union include in the NIR information on the sources and amount of emissions reported under the subcategory metal industry – other (2.C.7)	The information has been included in the NIR (chapter 4.2.3.3).
I.49/I. 52	2016/2015	Transparency	2.D Non-energy products from fuels and solvents use – CO_2	The ERT noted that the European Union did not include in the NIR information on the methodologies, assumptions, EFs and AD used to estimate CO_2 emissions from non-energy products from fuel and solvent use, but reported the emissions in the CRF tables. The ERT also noted that CO_2 emissions from non-energy products from fuel and solvent use is a key category. During the review, the European Union clarified that it would include the required information in the NIR of the 2017 GHG inventory submission The ERT recommends that the European Union provide in the NIR information on the methodologies, assumptions, EFs and AD used to estimate CO_2 emissions from non-energy products from fuel and solvent use, which is a key category	The information has been included in the NIR (chapter 4.2.3.4).
A.8	2015/2016	Transparency	3. General (agriculture) – CO_2	The ERT noted that the European Union used the notation key "IE" to report indirect CO_2 emissions from the agriculture sector in CRF table 6 for the Netherlands and Slovakia. The ERT also noted that the European Union did not provide in the NIR any indication of where in the inventory these emissions have been included. During the review, the European Union clarified that indirect emissions of CO_2 from the agriculture sector are included in the IPPU sector in the case of the Netherlands. However, in the case of Slovakia, the ERT did not find any indication in the NIR of Slovakia that indirect CO_2 emissions are estimated, and concluded that the correct notation key for reporting indirect CO_2 emissions from the agriculture sector should be "NE" The ERT recommends that the European Union indicate in the NIR where in the inventory of the Netherlands indirect CO_2 emissions from the agriculture sector are included. The ERT also recommends that the European Union work with Slovakia to use the appropriate notation key to report indirect CO_2 emissions from the agriculture sector or explain where in the inventory Slovakia has reported these emissions	Planned for future submission.

ID#	year ARR	TACCC	Category	Provisional Main Finding	status of implementation (text will be included in NIR Table)
A.9	2015/2016	Transparency	3. General (agriculture) – CH_4	The ERT noted that the NIR does not include information on the methodology and CH_4 EFs used to estimate emissions from cattle, sheep and swine for Austria, France and Iceland (see tables 5.2, 5.3, 5.13 and 5.14 of the NIR). During the review, the European Union explained that information from specific member States was missing owing to problems encountered in the new CRF Reporter software and that member States would deliver complete information for the next GHG inventory submission The ERT recommends that the European Union compile and report information on the methodology and CH_4 EFs used to estimate emissions from cattle, sheep and swine for all member States	We are working with the countries in order to include all information about methodologies in their next submission
A.10	2015/2016	Transparency	3.A Enteric fermentation – CH_4 and N_2O	In table 5.54 of the NIR, the European Union reported the contribution of member States' recalculations to the total change in emissions from enteric fermentation, including background information on the recalculations. However, the ERT noted that no information was provided on the recalculations for France, Iceland and Luxembourg. During the review, the European Union explained that, according to the NIRs of the member States, Iceland did not perform any recalculations while the reason for the recalculation for Luxembourg was the change to the use of the 2006 IPCC Guidelines and the revision of AD. The recalculation by France corresponds to about 0.0% of emissions from enteric fermentation and was therefore deemed insignificant The ERT recommends that the European Union include in the NIR background information on the recalculations of emissions from enteric fermentation for all member States where differences between the latest and the previous submissions occur	This has been resolved: in the last NIR (2017) explanations on recalculations are included for all countries.
A.11	2015/2016	Transparency		In the NIR, the European Union stated that milk yield data for the Netherlands were not available (see p.451 of the NIR). However, in annex III to the NIR, the methodological description for the estimation of CH_4 emissions from dairy cattle in the Netherlands indicates that milk production per cow increased as a result of genetic changes (due to breeding programmes for milk yield) and the increase in feed intake and higher feeding quality of cattle diets, suggesting that milk yield data are available. During the review, the European Union explained that it is working with member States to ensure that the European Union submission includes correct information from member States. The European Union further explained that as the NIRs of the member States are provided to the European Union one month before the submission of the European Union, some minor inconsistencies between the 29 NIRs of the member States and the NIR of the European Union cannot be excluded. Moreover, the European Union explained that it introduced a new process in 2016 whereby the methodological tables are shared with the European Union member States during the consultation of the NIR of the European Union and revised information is taken into account to the extent possible in the final report The ERT welcomes the efforts of the European Union and its member States in implementing the new checking process for reporting methodological information and recommends that the European Union work with the Netherlands to include the Netherlands' milk yield for dairy cattle in the NIR of the European Union, as it is the case for all other member States	Information on milk yield in the NL is included in the EU NIR.

ID#	year ARR	TACCC	Category	Provisional Main Finding	status of implementation (text will be included in NIR Table)
A.12	2015/2016	Comparability	3.B Manure management – N_2O	The European Union used the notation key “IE” to report the contribution of the Netherlands to total N_2O emissions from manure management of cattle in the NIR (see table 5.26, p. 479), without specifying where in the inventory the emissions have been included. During the review, the European Union explained that the Netherlands reported in the documentation box of CRF table 3.B(b) that data on individual animals are not available and, therefore, the total N_2O emissions from liquid systems and solid storage and dry lot in the Netherlands are reported under the subcategory other livestock (3.B.4) The ERT recommends that the European Union work with the Netherlands to investigate whether N_2O emissions from manure management can be estimated and reported separately for each livestock category	This is resolved: the Netherlands have reported the amount of manure managed in each system in May 2018 submission
A.13	2015/2016	Transparency	3.B Manure management – N_2O	The European Union used the notation key “NE” to report the allocation of manure from each livestock species to each manure management system (see CRF table 3.B(a)). However, the ERT noted that no explanation is provided in the documentation box of CRF table 3.B(a) and in the NIR on why the notation key “NE” is used. During the review, the European Union explained that its reporting is the aggregated sum of the member States’ values and that it would consider whether the allocation of manure from each livestock species to each manure management system can be calculated and reported in future GHG inventory submissions The ERT recommends that the European Union include information on the use of the notation key “NE” to report the allocation of manure per livestock species and per manure management system and work with member States to calculate such allocations based on the data provided by member States	The allocation of livestock species to each manure management system, as well as methane conversion factors, has been implemented in CRF table 3.B(a) in the resubmission by 27 May 2018.
A.14	2015/2016	Transparency	3.B Manure management – N_2O	In its submission of 9 September 2016, the European Union used the notation key “IE” to report direct N_2O emissions from anaerobic lagoons (see CRF table 3.B(b)). However, no explanation is provided on where in the inventory the emissions have been included. During the review, the European Union explained that it reports the notation keys used by member States and that all member States except Spain used the notation key “NO” to report direct N_2O emissions from anaerobic lagoons. The European Union further explained that manure in Spain undergoes a series of concatenated processes which makes it impossible to associate them with any of the definitions of manure management systems considered in the 2006 IPCC Guidelines. Therefore, direct N_2O emissions from manure management in Spain were considered under the subcategory other management systems. The issue has been addressed and Spain has included the information in the 2017 inventory submission The ERT recommends that the European Union provide information on the use of the notation key “IE” by Spain to report direct N_2O emissions from anaerobic	This has been resolved. After discussions with Spain, in the last inventory submission (2017), they changed the way to allocate manure to the different manure management systems, which is now in line with the other countries and allowed the EU to properly fill Table 3.B(b) of the CRF. Now the notation key ‘IE’ was replaced by numbers.

ID#	year ARR	TACCC	Category	Provisional Main Finding	status of implementation (text will be included in NIR Table)
A.15	2015/2016	Comparability	3.B.1 Cattle – N_2O	The ERT noted significant inter-annual changes in the trend of the nitrogen excretion rate for non-dairy cattle for 1998/1999 (–27.3%) and 1999/2000 (37.5%) (see figure 5.49, p. 490 of the NIR). However, no information is provided in the NIR to explain such inter-annual changes. During the review, the European Union explained that the excretion rate for non-dairy cattle for 1999 is an outlier because the excretion rate for France was reported as zero for 1999 owing to a technical error and that France provided correct values in its latest GHG inventory submission The ERT recommends that the European Union correct the reporting of the nitrogen excretion rate for non-dairy cattle for 1999	This has been resolved. In the last NIR (2017), nitrogen excretion rate is reported correctly, including the values from France that were missing, and now no outliers can be observed.
A.16	2015/2016	Accuracy	3.B.3 Swine – CH_4	The European Union stated in the NIR that Cyprus, the Czech Republic, Greece, Slovakia and Slovenia use a tier 1 method and default EFs to estimate CH_4 emissions from swine manure management (see table 5.14, p.462 of the NIR). However, the ERT noted that CH_4 emissions from manure management is a key category. During the review, the European Union explained that it had already identified this issue for Cyprus and Greece during a review conducted under the framework of the European Union effort-sharing decision. The European Union further explained that for the Czech Republic and Slovakia, CH_4 emissions from manure management is not a key category and that Slovenia used a tier 2 methodology with default values for volatile solids and maximum Bo of the manure. The ERT noted that CH_4 emissions from manure management from swine for the Czech Republic and Slovakia is a significant subcategory as it contributes, together with manure management from cattle, to more than 60% of the emissions from the key category (3.B) The ERT recommends that the European Union work with Cyprus, the Czech Republic, Greece and Slovakia to move to a higher-tier method to estimate CH_4 emissions from manure management from swine	Efforts are on-going to make the Parties concerned move to a higher tier.
A.18	2015/2016	Transparency	3.I Other carbon-containing fertilizers – CO_2	In the European Union submission of 9 September 2016, the ERT noted significant inter-annual changes in the trend of CO_2 emissions from other carbon-containing fertilizers in CRF table 10, including for 1996/1997 (–36.0%) and 2003/2004 (49.7%). However, no information was provided by the European Union to explain the significant inter-annual changes. During the review, the European Union explained that the strong increase in emissions from other carbon-content fertilizers was due to an increase observed in Germany. During the review the European Union indicated that this will be solved in the 2018 annual submission The ERT recommends that the European Union include in the NIR information explaining the trend of CO_2 emissions from other carbon- containing fertilizers	The issue has been solved; no time trend issues are observed in 2018 submission any more

ID#	year ARR	TACCC	Category	Provisional Main Finding	status of implementation (text will be included in NIR Table)
L.12	2015/2016	Comparability	4. General (LULUCF) – CO_2	The ERT noted that several member States used the notation key “NO” to report carbon pools where there are no changes in the type of management and where net emissions are equal to net removals and therefore deemed carbon-neutral. For example, Bulgaria, Croatia, Denmark, Estonia, France, Greece, Italy, Latvia, Lithuania, Luxembourg, Romania and Slovakia used the notation key “NO” to report carbon stock changes in mineral soils under grassland remaining grassland. The ERT considers that in this situation it is not accurate to report that the carbon pool is not occurring. Instead, the ERT considers that, where a tier 1 method is applied to assume no net change for a specific carbon pool, the use of the notation key “NA” is consistent with decision 2/CP.19 because the pool does occur, however it does not result in net emissions or removals. During the review, the European Union explained that, despite the efforts implemented to harmonize the use of notation keys among member States and despite the implementation of decision 24/CP.19, there is no common understanding on the use of the notation keys for reporting information from carbon pools, and that different interpretations seem possible. The European Union further noted that, as it occurred in the past, and was recognized in the conclusions from the ninth meeting of GHG inventory lead reviewers, further guidance on the use of notation keys could be needed, specifically for the LULUCF sector The ERT recommends that the European Union use the notation key “NA” to report carbon stock changes from carbon pools where carbon stock changes are neutral (i.e. where net emissions are equal to net removals)	The EU has worked with MS towards the use of the notation key NA where carbon stock changes are considered neutral. During the JRC annual LULUCF workshop a dedicated presentation was given on this regard, and all MS have been requested to address the ERT's recommentadion.
L.13	2015/2016	Yes. Adherence to UNFCCC Annex I inventory reporting guidelines	4. General (LULUCF)	The ERT noted that no information is provided on the inventory improvement status and improvement plans in section 11.3.6 of the NIR. The ERT notes that the reporting of planned inventory improvements is a mandatory requirement under the UNFCCC Annex I inventory reporting guidelines. During the review, the European Union stated that the planned improvements were reported in chapter 10 of the NIR. However, the ERT noted that no information is reported on planned inventory improvements for the LULUCF sector or KP-LULUCF activities. Additionally, the ERT noted that some planned inventory improvements are already in progress The ERT recommends that the European Union include in the NIR information on planned inventory improvements for the LULUCF sector and KP-LULUCF activities	The information is now included in the NIR, sections 6..4.4 and 11.3.6
L.15/ L.16	2016/2015	Yes. Adherence to UNFCCC Annex I inventory reporting guidelines	4. General (LULUCF)	In the submission of 9 September 2016, the ERT noted that the information reported by the European Union is not consistent. Inconsistencies were found in: (1) land areas reported in CRF tables 4.1, 4.A–4.F and NIR-2 and table 11.3 of the NIR; and (2) net emissions reported in CRF table 4(KP) and table 11.5 of the NIR. In addition, inconsistencies were found between the European Union submission and the reporting by member States. For example, the European Union used the notation key “NO” to report on the change in area under forest management activity for France in CRF table NIR-2 for year 2013, whereas France reported in CRF table NIR-2 a change in area of 21 586,71 kha in the same year. During the review, the European Union explained that it relies on the data provided by member States. Additionally, the European Union stated that some member States’ submissions were affected by technical problems related to the CRF Reporter software, which consequently affected the European Union’s submission The ERT recommends that the European Union correct the inconsistencies in the reported areas in CRF tables 4.1, 4.A–4.F and NIR-2 and table 11.3 of the NIR	The EU has worked with MS in order to avoid such inconsistencies. During the JRC annual LULUCF workshop, a dedicated presentation was given on this issue, and all MS were requested to address the ERT's recomentadion.

ID#	year ARR	TACCC	Category	Provisional Main Finding	status of implementation (text will be included in NIR Table)
L.16		Consistency	4.A.1 Forest land remaining forest land– CO_2	In the submission of 9 September 2016, the ERT noted that 11 member States used the notation keys “NA”, “NE” or “NO” to report the net carbon stock changes in dead wood for the whole time series due to the fact that these member States used a tier 1 method, which results in zero carbon changes or carbon emissions from this pool (see ID# L.12 above). The ERT further noted that Malta, which also used a tier 1 method, reported the carbon stock changes as “zero”, rather than using a notation key. The ERT further noted that France reported the notation key “NO” for the period 1990–1999 using the tier 1 method from the 2006 IPCC guidelines and provided estimates for the period thereafter using a country-specific method. Lastly, the ERT noted that Luxembourg reported net carbon stock change estimates for the period 2001–2010 and “zero” or a notation key for the remainder of the time series. During the review, the European Union explained that the reporting of net carbon changes in dead wood is, in overall, considered consistent as member States either used a tier 1 (i.e. carbon-neutrality) or a country-specific method for the whole time series. In addition, the European Union provided detailed explanations on the reasons behind the lack of quantitative estimates for the whole time series in the cases of France and Luxembourg The ERT recommends that the European Union work with Luxembourg to improve the time-series consistency of net carbon stock changes in dead wood in forest land remaining forest land	The EU plans to address this issue in the 2019 submission.
L.17/ L18	2016/2015	Completeness	4.B.1 Cropland remaining cropland– CO_2	The ERT noted that France reported “zero” CO_2 emissions from cropland remaining cropland for the whole time series (see table 6.17 of the NIR). The ERT further noted that in CRF table 4.B, the gain in carbon stock changes in living biomass for France, estimated to be 1 331.94 kt C for 2014, equals the absolute value of the loss in the same year (–1 331.94 kt C), resulting in a carbon-neutral balance. During the review, the European Union explained that, owing to the lack of information on the accumulation of woody biomass in the cropland land-use category, France considers that the carbon stock gains in woody biomass in cropland remaining cropland are offset by the losses due to biomass harvest under that land-use category. The ERT notes that information on the accumulation of woody biomass can be found in the 2006 IPCC Guidelines. The further ERT notes that gains and losses of woody biomass are balanced during the cycle of planting, maturing, felling and replanting when changes in crops or management practices do not occur. However, if areas of woody crops are replaced by non-woody crops, there is a loss of living biomass. Moreover, based on FAOSTAT information, the area of vineyards in France has been steadily decreasing from 907,778 ha in 1990 to 771,530 ha in 2010, which suggests changes in crops The ERT recommends that the European Union work with France to estimate the carbon stock changes in living biomass, taking into account changes in woody biomass owing to changes in crops and management practices under cropland remaining cropland	Carbon stock changes in living biomass are now reported by France for the subcategory 4B1

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L.19/ L.20	2016/2015	Completeness	4.F Other land – CO_2	The ERT noted that some of the definitions for the categorization of other land included in the NIR (see table 6.6.28 of the NIR) do not follow the definitions included in the 2006 IPCC Guidelines. In particular, “natural grasslands not in use for agricultural purposes” in Ireland, “mineral soils on poorly productive forest land, which do not fulfil the threshold values for forest” in Finland, “standing water and canals and rivers and streams” in the United Kingdom and “shrub lands” in Portugal are defined as “other land”. During the review, the European Union explained that the 2006 IPCC Guidelines state that “countries will use their own definitions of these categories”. Additionally, the European Union explained that Ireland has included natural grassland in unmanaged grassland; therefore, the information provided in the NIR would have to be updated for the next GHG inventory submission. Moreover, the European Union stated that member States include under ‘other lands’ all those areas that do not fall under any other land use category. The European Union also explained why “mineral soils on poorly productive forest lands” in Finland are reported under ‘other lands’ and why soil organic carbon stock increased in ‘other lands’ in Portugal. The ERT notes that, in accordance with the 2006 IPCC Guidelines, the land-use category other land concerns unmanaged areas which are not included in inventory estimates. However, some member States included significant carbon pools under other land remaining other land that can be subject to variations which are not reported in the CRF tables and for which there is no clear indication in the NIR that they are unmanaged areas The ERT recommends that the European Union include in the NIR information on whether land areas reported under other land in Finland, Portugal and the United Kingdom are unmanaged, and if not, to work with these member States to report these areas and the associated CO_2 emissions and removals under the appropriate land-use categories as well as to update the information provided in the NIR regarding the definitions for the categorization of “other land” used by the member States	The requested information has been included in section 6.2.4.3. In addition, the information in table 6.28 has been updated.
L.20/ L.21	2016/2015	Comparability	4.G Harvested wood products– CO_2	In the European Union submission of 9 September 2016, the ERT noted that the annual stock change of HWP reported in CRF table 4.G under approach A (stock change approach) is not consistent with the net emissions/removals from HWP reported in the same table. The ERT also noted that no information is reported in CRF table 4.G under approach B (production approach), although it is stated in the NIR that the majority of member States used approach B to calculate emission/removal estimates for HWP (see pp.638–640 of the NIR). The ERT considers that the application of a single approach to the reporting of HWP among member States and Iceland would reduce the chance of omissions or double counting due to trade between member States. During the review, the Party confirmed the problems with the information reported in the CRF tables which do not allow for the reporting of information under approach A and approach B simultaneously. The European Union further confirmed that all member States used approach B and that information was incorrectly reported under approach A by Latvia, Lithuania and Romania The ERT recommends that the European Union correct the reporting of information on HWP in CRF table 4.G by reporting the information according to the approaches used by member States to estimate emissions/removals associated with HWP and correct the information on approaches used by member States to estimate emissions/removals associated with HWP in the NIR	The information is now correct in table CRF table 4.G and in the NIR. See table 6.38 for further details.

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L.21/ L.22		Completeness	4.G Harvested wood products– CO_2	In the European Union submission of 9 September 2016, the ERT noted that a number of member States do not report information on HWP for all or part of the time series. For example, estimates for HWP in CRF table 4.G were not provided for Cyprus for the whole time series and, for the period prior to 2000, were not provided for Belgium. During the review, the European Union explained that estimates are under preparation for Belgium and Cyprus and would be submitted when they become available. The Party also indicated that it would follow up on this issue prior to the next GHG inventory submission The ERT recommends that the European Union work with Belgium and Cyprus to ensure that the information on HWP in CRF table 4.G is complete for the whole time series	Cyprus report emissions for HWP in 2018. In addition, Belgium informed that work is in progress to report emissions/removals from HWP for the whole time series in future submission.
KL.6	2016/2015	Transparency	General (KP-LULUCF)	In its report to facilitate the calculation of the assigned amount, the European Union stated that the information on how the national system under Article 5, paragraph 1, of the Kyoto Protocol will identify land areas associated with activities under Article 3, paragraph 4, of the Kyoto Protocol and on how member States ensure that land that was accounted for in the first commitment period continues to be accounted for in the second commitment period is provided in the individual initial reports of the member States and Iceland or in their NIRs. The European Union further stated that the development of the methodological approach to identify land areas is part of member States' responsibilities The ERT noted that the report to facilitate the calculation of the assigned amount does not contain transparent information on how member States ensure that land that was accounted for in the first commitment period continues to be accounted for in the second commitment period The ERT recommends that the European Union provide summary information on how member States ensure that land that was accounted for in the first commitment period continues to be accounted for in the second commitment in its NIR	Information on this matter has been added in section 11.1.7 of the EU NIR

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KL.7	2016/2015	Transparency	General (KP-LULUCF)	In the European Union submission of 9 September 2016, the ERT notes some issues that challenge the accuracy and completeness of the European Union submission. Inconsistencies were found between different the CRF tables (e.g. areas in CRF table NIR-2 and in CRF tables 4(KP)A.I to 4(KP)B.5), between the NIR and the CRF tables (e.g. between table 11.3 of the NIR and CRF table NIR-2, and between table 11.5 of the NIR and CRF table 4(KP)), and between the values reported by the European Union and by member States (e.g. forest management activities for France were reported using the notation key "NO" in CRF table 4(KP)B.1, although quantitative data were available in the CRF tables of France). During the review, the European Union stated that technical issues with the CRF Reporter affected the overall quality of member States submissions and, consequently, the quality of the European Union submission as its submission relies on the data provided by member States. The European Union further stated that an error found in the aggregation process also explain some of these inconsistencies. The ERT noted that additional automated QA/QC checks may identify potential problems in the CRF tables that can be addressed prior to the Party's submission, in particular for completeness and consistency. For example, such checks may include comparisons between AD for summary and sectoral tables (e.g. CRF table NIR-2 and sectoral CRF tables 4(KP-I)A.1 to 4(KP-I)C) In those cases where the reported data were unclear, incomplete or inaccurate in the member States' submissions, the European Union was not able to provide clarifying and conclusive information during the review. For example, the Party did not provide information to clarify the inconsistency in the area between the sectoral tables (CRF tables 4.A–4.F and CRF tables 4(KP-I)A.1, 4(KP-I)A.2 and 4(KP-I)B.1–B.5) and the land matrix for the LULUCF sector and KP-LULUCF activities; the area of unmanaged forests in France; the approaches used to identify HWP from deforestation events in member States that report HWP from deforestation; or the background level of emissions from natural disturbances included in the FMRL The ERT recommends that the European Union correct the error found in its aggregation process to ensure the consistency of information among the European Union and its member States and ensure that issues identified during the aggregation process, that affect the accuracy and completeness of its submission, are resolved	Improvements in the aggregation process have been implemented in order to ensure the consistency of information among the European Union and its MS. Inconsitencies have been now resolved.
KL.8	2016/2015	Completeness	General (KP-LULUCF) – CO_2	The ERT noted that the information reported in table 11.5 of the NIR is not consistent with that reported in CRF tables 4(KP-I)A.1, 4(KP-I)A.2 and 4(KP-I)B.1 in the submission of 9 September 2016. In particular, the European Union used the notation key "NO" to report the net carbon stock changes for France and the Netherlands in CRF tables 4(KP-I)A.1, 4(KP-I)A.2 and 4(KP-I)B.1, although quantitative information is provided in table 11.5 of the NIR. During the review, the European Union explained that these issues resulted from errors in the automatic aggregation process of information provided by member States. The Party also explained that the Netherlands faced technical difficulties when using the CRF Reporter software for its submission The ERT recommends that the European Union correct the information on afforestation/reforestation, deforestation and forest management for France and the Netherlands by providing the correct estimates in CRF tables 4(KP-I)A.1, 4(KP-I)A.2 and 4(KP-I)B.1 and ensure that the information in these tables is consistent with that	Errors have been resolved in the CRF tables, ensuring the consistency with the EU NIR

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				reported in table 11.5 of the NIR	
KL.9	2016/2015	Completeness	Afforestation and reforestation – CO_2	In the European Union submission of 9 September 2016, the ERT noted that Cyprus and Malta used the notation key “NE” to report net CO_2 emissions/removals from afforestation and reforestation activities (see CRF table 4(KP-I)A.1). Additionally, Hungary used the notation key “NE” to report net CO_2 emissions/removals for the DOM and SOC pools from afforestation and reforestation activities (see CRF table 4(KP-I)A.1), demonstrating that the pools do not result in net CO_2 emissions The ERT recommends that the European Union work with Cyprus and Malta to estimate net CO_2 emissions/removals from afforestation and reforestation activities	Issues were communicated to MS, and some improviments have been implemented to increase the completeness, and transparency, of the reporting of carbon stock changes in AR. Further improvements are expected for future submissions.
KL.10	2016/2015	Completeness	Deforestation – CO_2	In the European Union submission of 9 September 2016, the ERT noted that Cyprus used the notation key “NE” to report net CO_2 emissions/removals from deforestation activity (see CRF table 4(KP-I)A.2) The ERT recommends that the European Union work with Cyprus to estimate net CO_2 emissions/removals from deforestation activity	Cyprus has included estimates for carbon stock changes for Deforestation in 2018
KL.11	2016/2015	Completeness	Article 3.4 activities – CO_2	In the European Union submission of 9 September 2016, the ERT noted that the United Kingdom used the notation key “NE” to report the net carbon stock changes in the litter and dead wood pools under cropland and grazing land management (see CRF tables 4(KP-I)B.2 and 4(KP-I)B.3). The ERT further noted that the United Kingdom used the notation key “NE” to report CO_2 emissions/removals from wetland drainage and rewetting activities (see CRF table 4(KP-I)B.5) The ERT recommends that the European Union work with the United Kingdom to estimate the net carbon stock changes in the litter and dead wood pools under cropland and grazing land management and CO_2 emissions/removals from wetland drainage and rewetting activities	The UK has communicated that research and methodological development programme is ongoing that will allow to ensure the completeness reporting of carbon stock changes for those activities. See section 11.3.3 for further details.
KL.12	2016/2015	Accuracy	Article 3.4 activities	In the European Union submission of 9 September 2016, the ERT noted that in CRF table NIR-2, the European Union reported areas where activities under Article 3, paragraph 4, of the Kyoto Protocol occur for member States that have not elected such activities. For example, the European Union reported cropland management and grazing land management areas for Romania, whereas this member State did not elect such activities. This misallocation of areas affects the total areas for activities under Article 3, paragraph 4. During the review, the European Union stated that it was aware of the issue and that it would be corrected in close collaboration with the affected countries for its next GHG inventory submission. The ERT noted that this issue was not listed among the planned improvements included in the NIR of the European Union The ERT recommends that the European Union ensure that the reporting under Article 3, paragraph 4, only includes the areas of those activities that were voluntary selected by the member States	In close cooperation with MS the EU has resolved this issue in 2018. Areas for non-elected activities are not excluded from the reporting.

ID#	year ARR	TACCC	Category	Provisional Main Finding	status of implementation (text will be included in NIR Table)
KL.14	2016/2015	Completeness	Forest management – CO_2	The ERT noted that Cyprus and Malta used the notation key “NE” to report net CO_2 emissions/removals from forest management activities. The ERT further noted that Greece and Hungary also used the notation key “NE” to report the net carbon stock changes in the litter, dead wood and organic soils pools (see CRF table 4(KP-I)B.1 of the submission of 9 September 2016) to indicate that these pools are not included in accounting as they do not result in net CO_2 emissions The ERT recommends that the European Union work with Cyprus and Malta to estimate net CO_2 emissions/removals from forest management activities	Issues were comunicated to MS, and some improviments have been implemented to increase the completeness, and transparency, of the reporting of carbon stock changes inFM. Further improvements are expected for future submissions.
KL.15	2016/2015	Transparency	Forest management– CO_2	In the European Union submission of 9 September 2016, the ERT noted that the overall technical correction to the FMRL for the European Union has not been included in the NIR, and the information included in CRF table 4(KP-1)B.1.1 is not complete with respect to all member States and is also not accurate. For example, information on the technical correction in CRF table 4(KP-1)B.1.1 is not complete for a number of member States (Belgium, Cyprus, the Czech Republic, Estonia, France, Germany, Iceland, Italy, Luxembourg, Malta, the Netherlands, Poland, Slovakia, Slovenia and Spain) and in some cases it is unclear from the information included in the NIR whether this is because there is no need for a technical correction for that member State, or for another reason. The value reported in CRF table 4(KP-1)B.1.1 for the value of the FMRL inscribed in decision 2/CMP.7 does not match the one provided in the appendix to the annex to decision 2/CMP.7. During the review, the European Union explained that the FMRL and the technical correction do not include information for all member States owing to problems with the automatic aggregation of information from member States. The European Union further explained that there is an error in the FMRL reported in table 11.21 of the NIR and in CRF table 4(KP-I)B.1.1 because the reported technical correction for Bulgaria represents the revised FMRL (FMRLcorr), not the value of the technical correction. The European Union further stated that owing to the incomplete information reported in the CRF tables of the member States, the FMRL reported in CRF table 4(KP-I)B.1.1 is also incorrect and does not match the FMRL inscribed in the appendix to the annex to decision 2/CMP.7. The ERT notes that changing the number of member States from 27 to 28 plus Iceland will also result in changes to the FMRL by means of technical corrections. However, the ERT noted that information on the European Union’s technical correction was not provided in the NIR. During the review, the Party indicated that such information would be provided in the next GHG inventory submission. The ERT notes that KP-LULUCF accounting is to be undertaken individually by the member States and Iceland, and that the European Union will neither issue nor cancel Kyoto Protocol units based on reported KP-LULUCF emissions. However, because the European Union has an FMRL inscribed in the appendix to the annex to decision 2/CMP.7, and because the Party has made an annual GHG inventory submission, the ERT considers that the requirements of annex II to decision 2/CMP.8 apply to the information reported by the European Union The ERT recommends that the European Union provide in the NIR and in CRF table 4(KP-1)B.1.1, as appropriate, accurate information on the value of the FMRL inscribed in decision 2/CMP.7 and the value of the technical correction for the European Union as a whole and for each of the member States plus Iceland, in accordance with the requirements of decision 2/CMP.8, annex II, paragraph 5(f) and	Detailed information on this matter has been included in the NIR, section 11.5.2.2, and in the CRF table to address the ERTs recommendation.

ID#	year ARR	TACCC	Category	Provisional Main Finding	status of implementation (text will be included in NIR Table)
				taking into consideration the changes made in the coverage of FMRL	
KL.16	2016/2015	Transparency	Forest management– CO_2	The ERT noted that the European Union did not include in its annual submission information on the background level of emissions associated with annual natural disturbances that have been included in the FMRL for the European Union, in accordance with the requirements of decision 2/CMP.7, annex, paragraph 33(a) During the review, the European Union explained that in most cases the average levels of past disturbances would be included automatically in the FMRL of the individual member States through the calibration procedure. The ERT notes that the background level of disturbance emissions is a specific calculated value for which summary information may be transparently reported in the NIR. The ERT further notes that the calculation of the background level in accordance with the Kyoto Protocol Supplement will not always equal the average levels of past disturbances, and the approach described by the European Union may lead to an expectation of net credits from the application of the natural disturbances approach. Furthermore, the approach described by the European Union may also result an inconsistency between the FMRL and the reporting on forest management. The ERT noted that many member States have applied the approach proposed by the European Commission Joint Research Centre (JRC) to calculate the FMRL. For these member States, the European Union has the opportunity to provide support to improve consistency and implement good practice, such as the tests contained in box 2.3.6 of the Kyoto Protocol Supplement The ERT recommends that the European Union provide transparent information on the background level of emissions associated with natural disturbances included in its FMRL and work with member States, in particular those that apply the JRC approach, in order to improve consistency between the FMRL and the reporting of forest management in relation to the treatment of natural disturbances, and to calculate a technical correction where required	Detailed information on this matter has been included in the NIR, sections 11.4.4 and 11.5.3 in order to address the ERTs recommendation.
KL.17	2016/2015	Accuracy	Cropland management– CO_2	In the submission of 9 September 2016, the ERT noted that the European Union used the notation key “NO” to report the area of organic soils in CRF table 4(KP-I)B.2 for Italy, while reporting a net carbon stock change in organic soils of 246.92 kt C for 2014 (2013). Likewise, an area of 10 704.36 kha of mineral soils is reported for Italy for 2014, while the net carbon stock change in mineral soils is reported using the notation key “NO”. During the review, the European Union explained that emissions from organic soils were incorrectly reported and that it would correct this problem in its next GHG inventory submission and confirmed that the reporting of net carbon stock changes in organic soils is correct and that “NO” is the correct notation key for reporting the net carbon stock changes in mineral soils The ERT recommends that the European Union correct the reporting of the area of mineral and organic soils for Italy in CRF table 4(KP-I)B.2	Error has been resolved. See CRF table for further details.
KL.18	2016/2015	Accuracy	Revegetation	The ERT noted that the European Union reported in CRF table 4(KP-I)B.4 of the submission of 9 September 2016 an area of 256 838 598 666 677 kha of mineral soils under revegetation activity in Iceland. During the review, the European Union explained that the area was incorrectly reported and that the correct area was 256.84 kha The ERT recommends that the European Union correct the reporting of the area of	Error has been resolved. See CRF table for further details.

ID#	year ARR	TACCC	Category	Provisional Main Finding	status of implementation (text will be included in NIR Table)
				mineral soils under revegetation activity in Iceland in CRF table 4(KP-I)B.4	
KL.19	2016/2015	Completeness	Harvested wood products – CO_2	The ERT noted that Belgium used the notation key "NE" to report net CO_2 emissions/removals from HWP for the years prior to 2000 (see CRF table 4(KP-I)C of the submission of 9 September 2016) The ERT recommends that the European Union work with Belgium to estimate net CO_2 emissions/removals from HWP	Belgium informed that work is in progress to report emissions/removals from HWP for the whole time series in future submission.
KL.20	2016/2015	Accuracy	Harvested wood products– CO_2	The ERT noted that a number of member States reported HWP from deforestation lands in CRF table 4(KP-I)C of the submission of 9 September 2016. The ERT notes that these HWP may be derived from trees regrown on previously deforested lands in accordance with the land classification hierarchy. The ERT further notes that any HWP originating from deforestation events should be reported using instantaneous oxidation consistent with decision 2/CMP.8, annex II, paragraph 2(g)(v). The ERT noted that most member States report aggregated HWP under forest management due to the lack of information to disaggregate HWP originating from different activities under Article 3, paragraph 3, of the Kyoto Protocol and forest management. Further, a number of member States reported annual deforestation occurring on afforestation/reforestation and forest management lands in CRF table NIR-2. This suggests that HWP statistics for afforestation/reforestation and forest management lands may include HWP from deforestation events occurring on those lands. In particular, a number of member States have reported deforestation occurring on afforestation/reforestation and forest management lands or reported HWP from deforestation lands, but did not provide information on the amount of harvest originating from deforestation events in CRF table 4(KP-I)C. During the review, the Party explained that most member States stated that HWP from deforestation are not estimated and, consequently, are not included in the accounting in CRF table 4(KP-I)C and, therefore, HWP are accounted for on the basis of instantaneous oxidation. The ERT considers that this is not a sufficient explanation to transparently demonstrate that HWP from deforestation events are not included in aggregate HWP AD. The European Union further explained during the review that there were only a few cases where explicit information was provided by the member States that reported HWP from regrowth on deforestation lands and how these HWP are distinguished from HWP from deforestation events. The European Union also explained that, owing to the complexity introduced by the CMP decisions on KP-LULUCF activities, the reporting of HWP by member States needs to be enhanced The ERT recommends that the Party work with member States to ensure that HWP from deforestation events are accounted for on the basis of instantaneous oxidation and report explicit information regarding HWP from deforestation events in CRF table 4(KP-I)C, in accordance with good practice requirements in the Kyoto Protocol Supplement (p.2.119)	The EU has worked with MS to ensure that HWP from deforestation events are accounted for on the basis of IO. During the JRC annual LULUCF workshop a dedicated presentation was given on this regard and all MS have been requested to address the ERT's recommentadion.

10.4.2 Improvements implemented in response to the internal peer review of the EU NIR

In 2017, a team of Member States' experts (Czech Republic - Eva Krtková and Beáta Ondrušová, energy, IPPU; Denmark - Ole-Kenneth Nielsen, waste, LULUCF; Finland - Pia Forsell, IPPU; Greece - Spyridoula Ntemiri, IPCC & general; Ireland (Paul Duffy - agriculture) reviewed the EU GHG NIR and provided suggestions for improvements.

Several of these recommendations have been implemented already in the current submission:

- Inclusion of outcome of completeness checks in the introduction chapter of the EU NIR, e.g. Table on NEs and Cs visible in the EU CRF
- Explanation of differences between EU KCA and CRF KCA have been included in the introduction chapter of the EU NIR
- Providion of overview table for each sector on emission trends, share and change for non key categories, which is performed on the same category level as the key category analysis
- Harmonization and improvement of the presentation and the consistency between sector chapters of emission trends
- Improvement of data presentation in graphs (e.g. trend in EU activity data, emissions and IEFs)
- More focus on methodologies in sectoral chapters and less on lengthy explanations on general emission trends
- Improvement of completeness of sectoral recalculation tables
- More detailed information on the implementation of improvements provided in Chapter 10
- Further consultation with Member States concerning changes in methodologies as presented in Annex III
- Annex III provides reference to the corresponding sections of Member States NIRs
- Improvement of formatting issues
  - Quality and readability of figures and tables
  - Harmonization of section headings
  - Consistent use of units

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:

- Include new key categories in the NIR giving detailed information like for other key categories
- Further implement the recommendations from the past reviews;
- Continue to implement relevant suggestions made from MS sector experts during the peer review of the EU NIR in 2017
- 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 2016/2017

PART 2: SUPPLEMENTARY INFORMATION REQUIRED UNDER ARTICLE 7, PARAGRAPH 1

11 KP-LULUCF

For each Article 3(3), and Article 3(4) activities, estimates reported in the EU GHG inventory result from summing up all GHG emissions and CO_2 removals reported by individual Member States (MS) and Iceland. For the voluntary activities under the Article 3(4), information is included only for those that elected to account for these activities during the second commitment period (CP2) of the KP.

It is important to note that each MS and Iceland will account for net emissions and removals for each activity under Article 3(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(3) and (4).

This chapter provides an overview of EU relevant supplementary information for KP-LULUCF activities, as reported by EU MS and Iceland. In the absence of an official annotated outline for the provision of supplementary information under the CP2 of the KP, the JRC[73] provided MS with a proposal on the outline for reporting KP-LULUCF supplementary information within the national inventory reports (NIR). Nevertheless, the type and amount of information reported by MS and Iceland slightly differs among inventories. Therefore, note that this chapter does not aim to provide an exhaustive compilation of all supplementary information reported by MS and Iceland, but only an overview of the most important elements on KP-LULUCF. For more detailed information, we suggest the readers to refer to MS and Iceland NIRs.

In particular, this chapter includes:

- General information concerning KP-LULUCF activities, (i.e. elected activities under Article 3(4), completeness of reporting of carbon pools and other sources of GHG emissions, areas reported under each activity, accounting quantities, key category analysis, definition of forest used by MS and Iceland).
- Information related to the land representation approach for KP-LULUCF activities.
- Activity-specific information, (i.e. methodologies for estimating carbon stock changes and other sources of GHG emissions, justification for omitting carbon pools, information on whether indirect and natural CO_2 removals have been factored out, information on the year of the onset of the activity, and information on other methodological issues).
- A synthesis of supplementary information required for Article 3(3) and 3(4) activities (i.e. information on natural disturbances, information on HWP, methods for constructing the FMRLs, whether MS and Iceland have implemented technical corrections, and information about conversion from natural to planted forests).

The main assumption when reporting under the KP is that the consistency of the information reported in the EU GHG inventory with the IPCC good practices is ensured when individual GHG inventories are consistent with those good practices. To achieve and ensure such assumption, the consistency of the MS and Iceland national GHG inventories with good practices is checked twice every year before national GHG inventories are officially submitted to UNFCCC. A first check is carried out in the context of MS' own QA/QC procedures, and a second one in the context of the EU's QA/QC procedures as implemented by the EU JRC experts pursuant the Regulation 525/2013.

[73] Joint Research Centre of the European Commission

11.1 General information

11.1.1 Elected activities under Article 3(4) of the Kyoto Protocol

As shown in Table 11.1, with regard to voluntary activities under the Article 3(4) during the CP2; 7 MS have elected to account for Cropland Management, 6 MS for Grazing Land Management, 1 MS and Iceland for Revegetation, and 1 MS for Wetland Drainage and Rewetting. Concerning the accounting frequency, with the exception of 2 MS, all other MS have elected to account at the end of the commitment period.

Table 11.1 Activities elected under Art. 3(4), and accounting frequency. FM: forest management, CM: cropland management, GM: grazing land management, RV: revegetation, WDR: wetlands drainage and rewetting.

Member State	Art 3.4 elected activities [1]	Accounting frequency
Austria	---	end of CP
Belgium	---	end of CP
Bulgaria	---	end of CP
Croatia	---	end of CP
Cyprus	---	end of CP
Czech Republic	---	end of CP
Denmark	CM, GM	annual
Estonia	---	end of CP
Finland	---	end of CP
France	---	end of CP
Germany	CM, GM	end of CP
Greece	---	end of CP
Hungary	---	annual
Ireland	CM,GM	end of CP
Italy	CM, GM	end of CP
Latvia	---	end of CP
Lithuania	---	end of CP
Luxemburg	---	end of CP
Malta	---	end of CP
Netherlands	---	end of CP
Poland	---	end of CP
Portugal	CM, GM	end of CP
Romania	RV	end of CP
Slovakia	---	end of CP
Slovenia	---	end of CP
Spain	CM	end of CP
Sweden	---	end of CP
United Kingdom	CM, GM, WDR	end of CP
Iceland	RV	end of CP

[1]*FM activity has become mandatory to all MS and Iceland for CP2*

11.1.2 Activity coverage under Article 3(3) and Article 3(4) (CRF table NIR-1)

Table 11.2 presents an assessment of completeness of carbon pools and GHG emissions reported by EU MS and Iceland for each mandatory and elected activity.

Carbon stock changes are estimated in most cases for biomass pools, but for dead organic matter and soil organic matter pools notation keys are also used. “NE” is mainly used when the “not a source” provision is applied, while “IE” is mainly used for belowground biomass (being included under aboveground biomass) or for “gain” or “losses” in living biomass when the stock-difference method is applied, and therefore, a net gain, or net loss, is then reported. In addition, “IE” is also used when carbon stock changes in litter and dead wood are reported together, or when dead organic matter and soil organic matter pools are estimated by using models not capable to apportion net carbon stock changes among those pools.

Despite the continuous improvements implemented by MS and Iceland in their GHG inventories, when implementing the “not a source” provision, both the EU QA/QC procedures and the UNFCCC expert review teams highlighted the need of providing more transparent information to demonstrate that omitted carbon pools are not a net source of emissions. After such recommendations more detailed information has been provided in individual inventories during the recent years, and a synthesis of such information is presented in Table 11.17.

Concerning to other sources of emissions, at European level, a full set of quantitative estimates is not yet provided, especially with regard to N_2O emissions from management of soils. Notation keys are also used when a specific source of GHG emissions does not occur within the national territories (e.g. fertilization of natural forest) or when such emissions are already reported under the agriculture sector. For instance, following IPCC methods, when the source of information does not allow to separate among LULUCF and Agriculture the final destination of the nitrogen fertilizers.

Table 11.2 Synthesis of carbon pools and other sources of GHG emissions reported for KP-LULUCF activities in EU MS and Iceland, based on table NIR-1 and sectorial tables (for the year 2016)

Member State	CHANGE IN CARBON POOL REPORTED							GREENHOUSE GAS SOURCES REPORTED							
	AGB	BGB	Litter	Dead wood	Soil		HWP	Fertilization	Drained, rewetted and other soils		Nitrogen mineralization in mineral soils	Indirect N_2O emissions from managed soil	Biomass burning		
					Min	Org		N_2O	CH_4	N_2O	N_2O	N_2O	CO_2	CH_4	N_2O
Afforestation/Reforestation															
Austria	R	R	R	R	R	NO	R	NO	NO	NO	R	NO	NO	NO	NO
Belgium	R	R	R	R	R	NO	R	NO	NO	NO	R	NO	NO	NO	NO
Bulgaria	R	IE	R	NO	R	NO	R	NO	NO	NO	NO	NO	R	R	R
Croatia	R	R	R	NO	R	NO	NO	NO	NO	NO	NO	NO	R	R	R
Cyprus															
Czech Republic	R	R	R	R	R	R	R	NO	NO	NO	NO	NO	NO	NO	NO
Denmark	R	R	R	R	R	R	R	IE	R	R	NO	R	NO	NO	NO
Estonia	R	R	R	R	R	R	R	NO	NE	NE	NO	NO	IE	R	R
Finland	R	R	IE	IE	R	R	R	R	R	R	R	R	R	R	R
France	R	R	R	R	R	IE		NO	NO	NO	R		R	R	R
Germany	R	R	R	R	R	R	IE	NO	NO, R	NO, R	R	R	IE,NO	IE,NO	IE,NO
Greece	R	R	NR	NR	NR	NO	NO	NO	NO	NO	NO	NO	R	R	R
Hungary	R	R	NR	NR	NR	NO	IE	IE	NO	NO	NO	NO	IE	R	R
Ireland	R	R	R	R	NO	R	R	IE	R	R	NO	IE	R	R	R
Italy	R	R	R	R	R	NO	R	NO	NO	NO	R	R	R	R	R
Latvia	R	R	R	R	NO	R	NO	NO	R	R	NO	NO	NO	NO	NO
Lithuania	R	R	R	NO	R	R	IE	NO	R	R	NO	NO	R	R	R
Luxemburg	R	R	R	R	R	NO	IO	NO	NO	NO	NO	NO	NO	NO	NO
Malta	NR	NR	NR	NR	NR	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO

Member State	CHANGE IN CARBON POOL REPORTED							GREENHOUSE GAS SOURCES REPORTED							
	AGB	BGB	Litter	Dead wood	Soil		HWP	Fertilization	Drained, rewetted and other soils		Nitrogen mineralization in mineral soils	Indirect N_2O emissions from managed soil	Biomass burning		
					Min	Org		N_2O	CH_4	N_2O	N_2O	N_2O	CO_2	CH_4	N_2O
Netherlands	R	R	NR	R	R	R	IE	NO	NE	NE	R	NO	R	R	R
Poland	R	R	R	R	R	R	NO	NO	NO	NO	NO	NO	R	R	R
Portugal	R	R	R	IE	R	NO	R	IE	NO	NO	R	IE	R	R	R
Romania	R	R	R	NO	R	NR	R	IE	NO	NO	R	R	R	R	R
Slovakia	R	R	R	NO,NR	R	NO,NR	NR	NO	NO	NO	NO	NO	R	R	R
Slovenia	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Spain	R	IE	NR,R	NR,R	NR,R	NO	NR	NO	NO	NO	NE,R	IE,NE	IE,NO,R	NO,R	NO,R
Sweden	R	R	R	R	R	R	R	NO	R	R	R	R	NO	NO	NO
United Kingdom	R	IE	R	IE	R	R	R	R	NE	R	R	R	R	R	R
Iceland	R	R	R	NO	R	R	NO	R	R	R	NO	NO	NO	NO	NO
Deforestation															
Austria	R	R	R	R	R	NO	IO	NO	NO	NO	R	NO	NO	NO	NO
Belgium	R	R	R	R	R	NO	R	IE	NO	NO	R	NO	NO	NO	NO
Bulgaria	R	IE	R	R	R	NO	R	NO	NO	NO	NO	NO	NO	NO	NO
Croatia	R	R	R	IE	R	NO	R	NO	NO	NO	R	NO	NO	NO	NO
Cyprus															
Czech Republic	R	R	R	R	R	R	R	NO	NO	NO	R	NO	NO	NO	NO
Denmark	R	R	R	R	R	R	R	IE	R	R	R	IE	NO	NO	NO
Estonia	R	R	R	R	R	R	R	NO	NE	NE	NO	NO	NO	NO	NO
Finland	R	R	IE	IE,R	R	R	IO	IE	R	R	R	IE	R	R	R
France	R	R	R	R	R	IE		NO	NO	NO	R		R	R	R
Germany	R	R	R	R	R	R	NO	NO	NO,R	NO,R	R	R	NO	NO	NO
Greece	R	R	R	R	R	NO	NO	NO	NO	NO	R	NO	NO	NO	NO
Hungary	R	R	R	R	R	NO	IO	IE	NO	NO	R	R	IE	R	R
Ireland	R	R	R	R	R	R	IO	IE	R	R	R	IE	NO	NO	NO
Italy	R	R	R	R	R	NO	R	NO	NO	NO	NO	NO	NO	NO	NO
Latvia	R	R	R	R	R	R	R	IE	R	R	IE	IE	NO	NO	NO
Lithuania	R	R	R	R	R	R	IO	NO	NO	NO	R	NO	NO	NO	NO
Luxemburg	R	R	R	R	R	NO	IO	NO	NO	NO	R	NO	NO	NO	NO
Malta	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Netherlands	R	R	R	R	R	R	IO	IE	NE	NE	R	IE	R	R	R
Poland	R	R	R	R	R	R	R	NO	NO	NO	NO	NO	NO	NO	NO
Portugal	R	R	R	IE	R	NO	R	IE	NO	NO	R	IE	R	R	R
Romania	R	R	R	NO	R	NR	R	IE	NO	NO	R	R	R	R	R
Slovakia	R	R	R	R	R	NO,NR	NR	NO	NO	NO	NO	NO	NO	NO	NO
Slovenia	R	R	R	R	R	NO	IO	NO	NO	NO	R	NO	NO	NO	NO
Spain	NR,R	IE,NR	NR,R	NR,R	NR,R	NO	NR	NO	NO	NO	NE,R	IE,NE	NO,R	IE,NO,R	IE,NO,R
Sweden	R	R	R	R	R	R	IO	NO	R	R	R	R	NO	NO	NO
United Kingdom	R	IE	R	IE	R	IE	IO	NO	NO	NO	R	R	R	R	R
Iceland	R	NO	NO	NO	R	R	NO	NO	R	R	NE	NO	NO	NO	NO
Forest Management															
Austria	R	R	IE	R	R	NO	R	NO	NO	NO	NO	NO	IE	R	R

Member State	CHANGE IN CARBON POOL REPORTED							GREENHOUSE GAS SOURCES REPORTED							
	AGB	BGB	Litter	Dead wood	Soil		HWP	Fertilization	Drained, rewetted and other soils		Nitrogen mineralization in mineral soils	Indirect N_2O emissions from managed soil	Biomass burning		
					Min	Org		N_2O	CH_4	N_2O	N_2O	N_2O	CO_2	CH_4	N_2O
Belgium	R	R	NO	NO	R	NO	R	NO	NO	NO	R	NO	NO	NO	NO
Bulgaria	R	IE	R	R	R	NO	R	NO	NO	NO	NO	NO	R	R	R
Croatia	R	R	NO	NO	NO	NO	R	NO	NO	NO	NO	NO	R	R	R
Cyprus															
Czech Republic	R	R	IE	R	R	R	R	NO	NO	NO	NO	NO	R	R	R
Denmark	R	R	R	R	R	R	R	IE	R	R	NO	IE	NO	NO	NO
Estonia	R	R	R	R	R	R	R	NO	NA	NA	NO	NO	IE	R	R
Finland	R	R	IE	IE	R	R	R	R	R	R	R	R	R	R	R
France	R	R	R	R	R	IE		NO	NO	NO	R		R	R	R
Germany	R	R	R	R	R	R	R	NO	NO,R	NO,R	R	R	IE,NO	NO,R	NO,R
Greece	R	R	NR	NR	NR	NO	R	NO	NO	NO	NO	NO	R	R	R
Hungary	R	R	NR	NR	NR	R	R	IE	NO	NO	NO	NO	IE	R	R
Ireland	R	R	R	R	NA	R	R	IE	R	R	NO	IE	R	R	R
Italy	R	R	R	R	NR	NR	R	NO	NO	NO	NO	NO	R	R	R
Latvia	R	R	R	R	NO	R	R	NO	R	R	R	R	R	R	R
Lithuania	R	R	R	R	NO	R	R	NO	R	R	NO	NO	R	R	R
Luxemburg	R	R	R	R	R	NO	IO	NO	NO	NO	NO	NO	NO	NO	NO
Malta	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Netherlands	R	R	NO	R	NO	NO	R	NO	NE	NE	R	NO	R	R	R
Poland	R	R	R	R	R	R	R	NO	R	NO	NO	NO	R	R	R
Portugal	R	R	R	IE	R	NO	R	IE	NO	NO	R	IE	R	R	R
Romania	R	R	R	NO	R	NR	R	IE	NO	NO	R	R	R	R	R
Slovakia	R	R	NO,NR	NO,NR	NO,NR	NO,NR	R	NO	NO	NO	NO	NO	R	R	R
Slovenia	R	R	NR	R	NR	NO	R	NO	NO	NO	NO	NO	R	R	R
Spain	R	IE	NR	NR	NR	NO	R	NO	NO	NO	NE	NE	IE,R	R	R
Sweden	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
United Kingdom	R	IE	R	IE	R	R	R	NO	NE	R	R	NO	R	R	R
Iceland	R	R	R	NR	R	R	R	NO	R	R	NE	NE	NO	NO	NO
Cropland Management															
Denmark	R	R	NO	NO	R	R			R		IE		NO	NO	NO
Germany	R	R	IE	IE,NO	R	R			NO,R		R		NO	NO	NO
Ireland	R	IE	NO	NO	R	NO			NO		IE		NO	R	R
Italy	R	R	NO	NO	R	R			NO		NO		R	R	R
Portugal	R	R	R	NO	R	NO			NO		R		R	R	R
Spain	R	IE	NR,R	NR	R	NO			NO		NE,R		NO,R	IE,NO,R	IE,NO,R
United Kingdom	R	IE	NR	NR	R	R			NE		R		NE	R	R
Grassland Management															
Denmark	R	R	NO	NO	R	R			R		IE		NO	NO	NO
Germany	R	R	IE	IE,NO	R	R			NO,R		R		NO	NO	NO
Ireland	R	IE	NO	NO	R	NO			NO		IE		NO	R	R
Italy	R	R	NO	NO	R	R			NO		NO		R	R	R
Portugal	R	R	R	NO	R	NO			NO		R		R	R	R

Member State	CHANGE IN CARBON POOL REPORTED							GREENHOUSE GAS SOURCES REPORTED							
	AGB	BGB	Litter	Dead wood	Soil		HWP	Fertilization	Drained, rewetted and other soils		Nitrogen mineralization in mineral soils	Indirect N_2O emissions from managed soil	Biomass burning		
					Min	Org		N_2O	CH_4	N_2O	N_2O	N_2O	CO_2	CH_4	N_2O
United Kingdom	R	IE	NR	NR	R	R			NE		R		NE	R	R
Revegetation Management															
Romania	R	R	R	R	R	NO		R	NO	NO	R	R	R	R	R
Iceland	R	IE	IE	NO	R	NO		R	NO	NO	IE	IE	NE	R	R
Wetlands Drainage and Rewetting															
United Kingdom	NR	NR	NR	NR		NR		NE	NE	NE		NE	NE	NE	NE

Notation keys: R – carbon stock changes or GHG emissions from other sources are reported; NR – the pool is not reported (mainly under assumption of "not a source"); NE – removals/emissions are not estimated; IE – included elsewhere; NO –not occurring; NA – not applicable.

11.1.3 Areas reported under the KP-LULUCF activities (KP CRF table NIR-2)

Total land area reported under KP-LULUCF activities by EU MS and Iceland is about 250,000.00 kha, which is approximately 54% of the total area reported under the Convention (Table 11.3).

The activity that covers the largest area at EU level is Forest Management (62%), followed by Cropland Management (22%), Grazing land Management (11%), Afforestation/Reforestation (4%) and Deforestation (1%), while Wetland Drainage and Rewetting, and Revegetation cover less than 1%.

With the exception of Finland, Netherlands and Romania all GHG inventories reports larger areas under afforestation/reforestation than under deforestation. Consequently, forest area reported under KP increases over time at EU level.

Regardless of specific activities, most of the area under the KP accounting is reported by Spain, Germany, Sweden, France, UK and Finland. The largest area under AR is reported by Italy, the largest under D is reported by France, and the largest under FM is reported by Sweden.

Table 11.3 Synthesis of total area (kha) reported under KP-LULUCF activities by EU MS and Iceland in GHG inventories 2016, based on NIR-2 tables. Grey cells indicate that the activity has not been elected.

Member State	Art. 3.3 activities		Art. 3.4 activities					TOTAL
	AR	D	FM	CM	GM	RV	WDR	
Austria	225.31	75.67	3809.69					4110.67
Belgium	44.16	39.13	671.61					754.90
Bulgaria	275.85	4.71	3622.56					3903.13
Croatia	59.31	4.70	2311.03					2375.04
Cyprus	9.63	1.13	144.57					155.34
Czech Republic	60.07	17.87	2609.78					2687.72
Denmark	104.81	11.87	532.67	2822.97	219.15			3691.48
Estonia	56.11	20.10	2363.06					2439.28
Finland	182.66	407.43	21667.61					22257.69
France	1525.16	1164.88	21483.02					24173.05
Germany	548.21	294.23	10619.31	14676.37	6277.55			32415.67
Greece	34.25	5.42	1247.69					1287.35
Hungary	172.90	14.77	1766.44					1954.11
Ireland	317.48	17.63	449.08	675.00	4344.90			5804.09
Italy	1903.34	55.17	7456.68	9019.59	426.20			18860.98

Member State	Art. 3.3 activities		Art. 3.4 activities					TOTAL
	AR	D	FM	CM	GM	RV	WDR	
Latvia	77.99	53.95	3130.56					3262.50
Lithuania	46.01	2.27	2156.69					2204.98
Luxemburg	8.89	5.86	87.27					102.02
Malta	NO,NA	NO,NA	0.07					0.07
Netherlands	62.72	66.10	308.00					436.82
Poland	735.10	31.62	8646.88					9413.60
Portugal	616.57	366.99	3749.51	2340.06	594.26			7667.38
Romania	33.80	394.28	6958.36			105.21		7491.65
Slovakia	45.05	8.56	1977.47					2031.08
Slovenia	NO,NA	27.98	1098.33					1126.31
Spain	1246.87	117.98	14431.75	20170.93				35967.53
Sweden	363.14	311.04	27869.75					28543.93
United Kingdom	565.87	64.05	2964.00	5190.79	15009.44		NE,NA	23794.15
EU	**9321.27**	**3585.40**	**154133.42**	**54895.71**	**26871.51**	**105.21**	**0.00**	**248912.52**
Iceland	45.77	0.06	93.58			289.65		429.07
EU+Iceland	**9367.05**	**3585.47**	**154227.00**	**54895.71**	**26871.51**	**394.86**	**0.00**	**249341.59**

11.1.4 Summary overview of key categories for KP-LULUCF activities (KP CRF table NIR-3)

Information included in Table 11.4 relies on the information reported by MS and Iceland in CRF table NIR-3. It can be noted that information on KC is missing for few MS because, as explained by these MS during the EU QA/QC procedures, remaining open issues in the CRF Reporter used to generate the CRF tables prevented the provision of this information in 2018, in the same way as already happened in previous years.

Table 11.4 Synthesis of KP-LULUCF activities being key category as reported by EU MS and Iceland (from table NIR-3) in 2018 submissions. “KC” indicates a key category.

Member State	Art. 3.3 activities		Art. 3.4 activities				
	AR	D	FM	CM	GM	RV	WDR
Austria	KC	KC	KC				
Belgium	KC	KC	KC				
Bulgaria	KC	KC	KC				
Croatia	KC	KC	KC				
Cyprus	KC		KC				
Czech Republic			KC				
Denmark	KC		KC	KC	KC		
Estonia	KC	KC	KC				
Finland	KC	KC	KC				
France	KC	KC	KC				
Germany	KC	KC	KC	KC	KC		
Greece			KC				
Hungary	KC	KC	KC				
Ireland	KC		KC		KC		
Italy	KC	KC	KC	KC	KC		

Member State	Art. 3.3 activities		Art. 3.4 activities				
	AR	D	FM	CM	GM	RV	WDR
Latvia	KC	KC	KC				
Lithuania	KC	KC	KC				
Luxemburg	KC	KC	KC				
Malta	KC		KC				
Netherlands	KC	KC	KC				
Poland			KC				
Portugal	KC	KC	KC	KC	KC		
Romania	KC		KC			KC	
Slovakia	KC		KC				
Slovenia		KC	KC				
Spain	KC	KC	KC	KC			
Sweden	KC	KC	KC				
UK	KC	KC	KC	KC	KC		
Iceland	KC					KC	

11.1.5 Summary of net emissions and removals (kt CO_2 eq.), and accounting quantities for KP-LULUCF activities (KP CRF table “Accounting”)

Tables 11.5 and Table 11.6 show respectively: (i) net emissions and removals, and (ii) accounted quantities, for individual MS and Iceland for each of the KP activities; and the sum for total EU and total EU plus Iceland, when relevant.

The total net accounted amount at EU level, as reported so far for CP2 by EU MS in the accounting tables is: -584,308.22 kt CO_2eq. With the addition of Iceland the total net accounting results in a net sink of -586,073.29kt CO_2eq. These values should be considered with caution, because a number of technical corrections to FMRLs still need to be implemented.

Emissions from deforestation offset about 70% of the removals accounted in afforestation/reforestation. By far, the largest contributors to emissions from deforestation are France and Romania that are responsible of about 47% of total GHG emissions from this activity in EU and Iceland.

Tables 11.5 Net emissions and removals (kt CO_2eq.) from KP-LULUCF activities for the period 2013-2016, as reported by EU MS and Iceland. Based on MS CRF accounting tables

Member State	Net emissions (+) and removals (-), kt CO_2eq											
	Art 3.3 activities								Art. 3.4 activities			
	A.1 AR				A.2 D				B.1 FM			
	2013	2014	2015	2016	2013	2014	2015	2016	2013	2014	2015	2016
Austria	-2017.59	-2031.51	-2065.31	-2096.98	536.48	524.77	518.33	511.89	-3480.36	-3672.14	-3517.85	-3270.26
Belgium	-333.64	-370.94	-408.37	-445.92	1113.33	1137.63	1162.24	1186.64	-2426.95	-2460.09	-2464.30	-2456.66
Bulgaria	-1125.41	-1262.00	-1382.47	-1514.67	125.93	59.56	162.76	82.34	-5985.43	-6011.73	-5836.85	-5797.34
Croatia	-85.87	-94.25	-132.74	-231.71	122.52	106.85	136.60	123.93	-7077.00	-6970.12	-6366.78	-6329.27
Cyprus	-34.34	-39.81	-38.73	-33.88	1.72	1.63	1.53	1.43	-119.77	-126.16	-125.71	-4.77
Czech Republic	-498.47	-553.76	-593.74	-635.53	234.18	231.18	179.87	218.92	-5890.85	-5787.90	-5918.15	-4435.69
Denmark	22.98	-326.75	-607.62	40.84	35.83	116.44	252.76	210.42	-2546.19	-3774.13	667.73	677.95
Estonia	-155.06	-171.75	-187.43	-184.26	333.15	298.60	259.63	231.15	-3274.36	-3405.45	-3906.68	-4117.23
Finland	-247.26	-407.84	273.82	-308.15	3908.78	3629.40	3291.48	3267.49	-55914.70	-55531.50	-51314.83	-47230.62
France	-9491.81	-9853.06	-10173.21	-10492.97	11356.55	11317.57	11360.41	11404.92	-55685.68	-56405.96	-54975.16	-50200.24
Germany	-6230.29	-6451.30	-6688.59	-6918.32	2035.72	2064.05	2094.69	2124.11	-54367.62	-54913.99	-54648.83	-55023.95
Greece	-135.85	-146.89	-124.41	-137.96	47.33	47.28	44.90	56.17	-1960.13	-1960.25	-1949.27	-1918.21
Hungary	-1254.28	-1094.07	-1248.07	-1196.10	465.79	477.51	504.75	564.86	-2260.91	-3384.99	-4347.19	-3070.24
Ireland	-3711.44	-3702.66	-3802.49	-3860.98	190.94	223.20	266.20	205.89	-435.55	-256.60	-529.69	-600.06
Italy	-7841.80	-8383.66	-8853.29	-8372.17	2011.72	2022.73	2033.48	2043.58	-30214.07	-31199.40	-32464.61	-29110.27
Latvia	-138.70	-147.68	-155.23	-165.83	190.29	194.99	199.38	203.95	-6377.11	-633.17	-2452.25	-3553.15
Lithuania	-333.98	-364.22	-406.90	-464.32	205.99	263.37	25.55	50.46	-8930.97	-7946.02	-7517.06	-9465.95
Luxemburg	-179.37	-176.28	-173.19	-170.10	46.90	44.68	42.46	40.24	-436.29	-359.70	-306.47	-390.23
Malta	NO	NO	NO	NO	NO	NO	NO	NO	NE,NO	NE,NO	NE,NO	NO,NE

Member State	Net emissions (+) and removals (-), kt CO_2eq											
	Art 3.3 activities								Art. 3.4 activities			
	A.1 AR				A.2 D				B.1 FM			
	2013	2014	2015	2016	2013	2014	2015	2016	2013	2014	2015	2016
Netherlands	-632.77	-681.92	-732.11	-783.40	1237.66	1261.72	1286.64	1311.24	-1364.39	-1355.75	-1332.66	-1319.63
Poland	-2841.79	-2815.71	-2849.21	-2832.82	203.48	316.55	301.23	5522.39	-42741.15	-35692.06	-31734.20	-37830.88
Portugal	-3414.76	-3600.81	-3392.46	-2441.65	2124.72	2100.53	2075.63	2066.64	-7364.70	-8964.12	-7898.57	-2104.25
Romania	-352.31	-346.17	-346.07	-346.00	8076.26	8076.26	8076.26	8076.26	-27459.97	-27479.10	-27854.57	-27867.18
Slovakia	-443.06	-462.61	-496.72	-522.78	42.89	62.39	60.49	28.35	-6646.35	-4721.41	-5256.68	-5092.83
Slovenia	NA	NA	NO,NA	NO,NA	431.94	436.40	441.47	447.03	-4702.20	-4876.50	-4970.87	-5013.14
Spain	-12645.95	-12145.37	-11239.24	-10302.03	568.85	563.32	561.20	559.26	-26832.30	-27956.50	-28944.32	-28556.60
Sweden	-1269.35	-1356.01	-1409.73	-1486.23	3152.66	2854.26	2353.26	2684.85	-44439.05	-46006.60	-45934.35	-46396.08
United Kingdom	-1275.03	-1597.30	-1987.20	-2361.78	1231.62	1347.38	1274.21	1654.79	-22831.82	-22921.48	-23005.62	-22100.80
EU	**-56667.22**	**-58584.33**	**-59220.70**	**-58265.68**	**40033.24**	**39780.23**	**38967.39**	**44879.18**	**-431765.88**	**-424772.81**	**-414905.78**	**-402577.58**
Iceland	-185.45	-206.28	-227.43	-232.85	0.16	0.11	0.65	0.27	-79.82	-83.01	-86.82	-91.62
EU + Iceland	**-56852.66**	**-58790.61**	**-59448.13**	**-58498.53**	**40033.39**	**39780.35**	**38968.03**	**44879.44**	**-431845.70**	**-424855.81**	**-414992.60**	**-402669.20**

Member State	Net emissions (+) and removals (-), kt CO_2eq				
	Art. 3.4 activities				
	B.2 CM				
	1990	2013	2014	2015	2016
Denmark	4305.53	2431.79	3137.57	2614.00	3306.35
Germany	12668.64	14657.92	14452.56	14656.53	14875.24
Ireland	-18.82	-32.65	-75.42	-93.60	-133.54
Italy	-119.52	396.99	336.54	349.69	-656.32
Portugal	3352.41	347.02	358.35	356.34	356.27
Spain	-869.55	665.96	-1787.05	-2278.76	-2445.94
United Kingdom	15135.82	13430.78	13169.71	13140.20	13050.25
EU	34454.50	31897.81	29592.27	28744.40	28352.31

Member State	Net emissions (+) and removals (-), kt CO_2eq				
	Art. 3.4 activities				
	B.3 GM				
	1990	2013	2014	2015	2016
Denmark	929.41	1179.22	1088.85	1281.27	1123.02
Germany	25771.82	22365.06	22316.58	22159.22	22043.31
Ireland	7295.00	6742.52	6707.76	6738.09	6732.09
Italy	-5.13	-641.62	-672.23	-705.99	-705.99
Portugal	1442.74	43.32	22.55	-39.59	-100.62
United Kingdom	-7494.01	-6368.87	-6421.08	-6484.12	-6533.79
EU	27939.84	23319.63	23042.42	22948.88	22558.02

Member State	Net emissions (+) and removals (-), kt CO_2eq				
	Art. 3.4 activities				
	B.4 RV				
	1990	2013	2014	2015	2016
Romania	-1698.59	-1211.36	-1222.00	-1258.62	-1309.34
EU	**-1698.59**	**-1211.36**	**-1222.00**	**-1258.62**	**-1309.34**
Iceland	-347.70	-548.93	-557.56	-569.54	-595.96
EU + Iceland	**-2046.30**	**-1760.29**	**-1779.57**	**-1828.16**	**-1905.30**

Member State	Net emissions (+) and removals (-), kt CO_2eq				
	Art. 3.4 activities				
	B.5 WDR				
	1990	2013	2014	2015	2016
United Kingdom	NE	NE	NE	NE	NE
EU	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

NE – removals/emissions are not estimated; IE – removals/emissions are included elsewhere; NO – removals/emissions are not occurring; NA – MS does not account for the activity.

Table 11.6 Cumulated accounting quantities for 2013-2016 of KP-LULUCF activities as reported by EU MS and Iceland (Kt CO_2eq), based on 2018 MS and Iceland CRF accounting tables*

Member State	Accounting quantity							
	Article 3.3		Article 3.4					MS accounting amount on LULUCF activities (RMUs)
	AR	D	FM	CM	GM	RV	WDR	
Austria	-8211.39	2091.47	-11168.61					-17288.53
Belgium	-1558.87	4599.84	188.00					3228.96
Bulgaria	-5284.56	430.59	8076.65					3222.68
Croatia	-544.56	489.90	-5206.49					-5261.15
Cyprus	-146.76	6.31	251.60					111.15
Czech Republic	-2281.50	864.15	-3288.58					-4705.93
Denmark	-870.55	615.45	-6280.16	-5732.43	954.71			-11312.99
Estonia	-698.49	1122.53	-3739.72					-3315.68
Finland	-689.43	14097.15	-69947.66					-56539.94
France	-40011.05	45439.45	-34807.05					-29378.65
Germany	-26288.49	8318.57	-129282.39	7967.67	-14203.10			-153487.74
Greece	-545.11	195.67	-1494.55					-1843.99
Hungary	-4792.52	2012.90	-8900.44					-11680.06
Ireland	-15077.57	886.23	1031.78	-259.91	-2259.56			-15679.03
Italy	-33450.92	8111.51	-27604.11	904.99	-2705.32			-54743.85
Latvia	-607.44	788.62	5378.75					5559.93
Lithuania	-1569.41	545.38	-11963.99					-12988.03
Luxemburg	-698.95	174.28	-547.42					-1072.09
Malta	NO	NO	0.00					0.00
Netherlands	-2830.19	5097.26	327.58					2594.65
Poland	-11339.53	6343.65	-39466.29					-44462.16
Portugal	-12849.69	8367.52	-12157.61	-11991.64	-5845.32			-34476.74
Romania	-1390.54	32305.03	-34223.80			1793.05		-1516.26
Slovakia	-1925.17	194.11	-12525.27					-14256.32
Slovenia	NO,NA	1756.84	-6878.71					-5121.87
Spain	-46332.59	2252.62	-19889.72	-2367.57				-66337.26
Sweden	-5521.32	11045.02	-54055.83					-48532.12
United Kingdom	-7221.32	5507.99	272.28	-7752.34	4168.19		NE	-5025.21
EU	**-232737.92**	**163660.03**	**-477901.76**	**-19231.23**	**-19890.40**	**1793.05**	**0.00**	**-584308.22**
Iceland	-852.01	1.18	-33.06	NA	NO,NA	-881.17		-1765.07
EU + Iceland	**-233589.93**	**163661.22**	**-477934.83**	**-19231.23**	**-19890.40**	**911.88**	**0.00**	**-586073.29**

**any information on EU KP-LULUCF activities presented here is shown for information purpose only*

11.1.6 Definition of forest and any other criteria

The threshold values applied to define “forest” under the KP by EU MS and Iceland are summarized in Table 11.7.

With few exceptions, threshold values and definitions applied for reporting forest areas under the KP are identical to those used to report forest area under the Convention. An exception is Finland that applies 0.5 ha. as minimum forest area under KP, whereas two different values are used for reporting forest land under the Convention i.e. 0.25 ha in Southern and 0.5 ha in Northern Finland.

Table 11.7 Threshold values applied 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	--
Bulgaria	10	5	0.1	--
Croatia	10	2	0.1	20
Cyprus	10	5	0.3	--
Czech Republic	30	2	0.05	20
Denmark	10	5	0.5	20
Estonia	30	2	0.5	--
Finland	10	5	0.5	20
France	10	5	0.5	20
Germany	10	5	0.1	--
Greece	25	2	0.3	--
Hungary	30	5	0.5	10
Ireland	20	5	0.1	20
Italy	10	5	0.5	--
Latvia	20	5	0.1	--
Lithuania	30	5	0.1	--
Luxemburg	10	5	0.5	--
Malta	30	5	1.0	--
Netherlands	20	5	0.5	30
Poland	10	2	0.1	10
Portugal	10	5	1.0	20
Romania	10	5	0.25	20
Slovakia	20	5	0.3	20
Slovenia	30	2	0.25	--
Spain	20	3	1.0	25
Sweden	10	5	0.5	--
United Kingdom	20	2	0.1	20
Iceland	10	2	0.5	20

Only few MS provided explicit definitions on what is considered as natural forests. The vast majority of MS reported that conversions of natural to planted forests do not take place in their territories, based on the fact that (i) all natural forests are under strict protection (e.g. Czech Republic), or mainly, because (ii) there are no natural forests within the MS.

When definitions are provided, natural forests are considered as those matching the definition of primary forests used by FAO (e.g. Finland), or forest lands with specific silvicultural features related to age of trees, stand structure, species compositions, etc., (e.g. Estonia). In some case, natural forests are defined by exclusion from what is defined as planted forest (e.g. Hungary).

11.1.7 Information on how definitions of each activity under Article 3(3), and each mandatory and elected activity under Article 3(4) have been implemented and applied consistently over time

Lands subject to KP-LULUCF activities have been generally identified considering that since the entire national territory is subject to direct anthropogenic influence, all lands under a specific land use category have to be reported in the corresponding direct human-induced activities. For instance, some countries considered "human-induced" AR any expansion of forest areas since 1990 (see following chapters for more details). Most of the MS considered all national pre-1990 forest area to be subject to management and, therefore, associated to FM activity. Only in few cases, MS do not include the entire forest area under KP LULUCF activities; e.g. Greece reports under FM and AR only one third of its forest land area.

Consistency of the land representation systems (i.e., identification and tracking of lands) is ensured with the use of the same activity definitions along the time series and data sources. Some MS have also performed comparison and internal verification exercises of activity data with other national datasets, to ensure the consistency (e.g. Finland compared AR and D data generated from NFI with statistics from the forest authority).

In addition, identification and tracking of lands also contributed to the consistency of the KP reporting with the reporting of the land use categories under the Convention and with the KP reporting under the first commitment period (CP1). Both, MS that elected to account for voluntary activities under the CP1, and those that did not elect to account for any voluntary activity under the CP1 and or CP2, started the reporting of the current CP looking into the activity data and the land use matrix underlying the already stablished reporting of lands under the Convention and under the CP1. In terms of reporting, the CP2 did not lead to a start from scratch, MS faced the new reporting requirements of the CP2, but they continued looking backward to the areas reported during the CP1 and implementing the same approaches to assign the unit of lands and their changes so that ensuring the consistency and that a unit of land that was accounted for during the CP1 continues to be accounted for during the CP2.

The implementation of checks during the first years of the CP2 to detect discontinuities, along with the checks implemented currently to ensure the consistency of the time series, also contributed to address the requirement of ensuring that a unit of land that is accounted for during the CP1 is also accounted during the CP2. Emphasis was given to ensure that a land "once Kyoto, always Kyoto".

11.1.8 Description of precedence conditions and/or hierarchy among elected Article 3(4) activities, and how they have been consistently applied in determining how each land has been classified

According with the good practices, all EU MS and Iceland that have elected voluntary activities under Article 3(4) (see Table 11.1) have established a hierarchy among activities, in some cases driven by intensity of the human intervention, which ensures that there is not double accounting of lands. In general, the highest hierarchy is assigned to CM followed by GM and RV. The activity WDR is by definition at the lowest level.

All national systems of MS and Iceland ensure that once a unit of land has been accounted for under any KP activity, it has consistently tracked and accounted for in subsequent years. To this purpose, MS and Iceland implement methods to avoid double counting (or omission) of lands under different activities (i.e. based on repeated field assessments and remote sensing products). In addition, also the implementation of a hierarchy among mandatory and elected activities ensures a consistent classification of lands.

The CRF table NIR-2 implicitly fulfills the obligation to demonstrate that emissions by sources and removals by sinks resulting from activities elected under Article 3(4) are not accounted for under Article 3(3) activities. To this regard, the consistency in the time series is checked every year during the QA/QC procedures, to ensure that: (i) the total area reported in NIR-2 table is constant over time and matches the official country area; and (ii) the total area for each activity "at the end of the current inventory year", as reported for the year X-1, is the same to "total area at the end of the previous inventory year" reported for the year X.

11.2 Land-related information

11.2.1 Spatial assessment unit used for the determining the area of the units of land under Article 3(3)

For each MS, the spatial assessment unit applied for identifying and tracking lands under Afforestation/Reforestation and Deforestation, as well as for Forest management, is the threshold value of minimum area, and minimum width (if applicable), used to define forest. This ensures that none land, defined as forest, and subject to direct human-induced activities, is left aside from the accounting.

11.2.2 Methodology used to develop the land transition matrix

Areas of KP-LULUCF activities have to be consistent with areas of correspondent land categories reported under the Convention. This is an issue subject to annual QA/QC checks implemented by the EC JRC before the final version of the EU inventory is compiled.

The land transition matrix reported under the Convention (CRF table 4.1) and the one reported under KP (CRF table NIR-2) allow to check the consistency of the reported areas for land categories and KP activities across the time series.

Annual areas for KP activities are estimated by MS and Iceland either based on extrapolation or interpolation of available datasets at different times (e.g. remote sensing products), or based on annual estimates provided by specific land surveys (i.e. sampling grids, subsidies records, land registries/cadaster). Sometimes, inventory compilers combine also several data sources involving expert judgment (e.g. Italy's assumption that conversions to forest can only occur from grasslands).

A synthesis of the methodologies for land identification and tracking of lands is provided in Table 11.8. For more detailed information on data sources and methods applied MS and Iceland, their individual national GHG inventories should be consulted.

Table 11.8 Methodologies for land identification and tracking of lands subject to KP- LULUCF activities by the EU MS and Iceland

Member State	Methods			Land identification and tracking features for the "lands" or "units of lands"
	NFI	Mapping by Earth Observations methods	Land registry systems, including surveys	
Austria	X			Statistical methods
Belgium	X	X		Statistical methods
Bulgaria	X			maps and forest management plans
Croatia	X	X		Statistical methods

Member State	Methods			Land identification and tracking features for the "lands" or "units of lands"
	NFI	Mapping by Earth Observations methods	Land registry systems, including surveys	
Cyprus		X		CORINE Land Cover Maps
Czech Republic			X	Wall-to-wall mapping approach
Denmark	X	X		Statistical methods
Estonia	X			Statistical methods
Finland	X	X		Statistical methods
France			X	Statistical methods
Germany	X	X		Wall-to-wall mapping approach
Greece			X	Afforestation registry and Land Use Change Database
Hungary			X	Statistical methods
Ireland	X			Statistical methods, Land Parcel Information System and Central Statistics Office analysis of Utilized Agricultural Area (CL and GLM)
Italy	X		X	Statistical methods
Latvia	X			Statistical methods
Lithuania	X	X		Wall-to-wall mapping approach (ARD) and statistical methods (FM)
Luxemburg		X		Geoprocessing based on successive land use maps
Malta		X		Malta use mainly CLC product to assess areas subject to KP
Netherlands	X			Wall-to-wall approach
Poland	X		X	Statistical methods
Portugal	X	X		Wall-to-wall maps
Romania	X		X	Statistical methods
Slovakia			X	Statistical methods
Slovenia	X			Statistical methods
Spain		X	X	Wall-to-wall approach
Sweden	X			Statistical methods
United Kingdom			X	National planting statistics (AR) multiple sources (D), agricultural census data and countryside survey data (CM,GM), and research program (WDR)
Iceland	X	X		Statistical methods

11.2.3 Maps and/or databases to identify the geographical locations, and the system of identification codes for the geographical locations

The majority of inventories reported a single geographical boundary at country level (Table 11.9), although in some cases, underlying data might provide information at higher spatial disaggregation. On the other hand, some inventories report two (e.g. Finland) or more geographical boundaries (e.g. Italy, and UK) that often correspond to administrative regions and that are summed up in CRF tables to provide a total national value.

According to the availability of data and resources (Table 11.8), the individual inventories rely on various methods and approaches to identify and track lands under Article 3(3) and Article 3(4) of the KP. Generally, the data sources used for the identification of KP-LULUCF activities are the same, or in line with those, used under the Convention; nevertheless, because of specific requirements existing under the KP, in some instances, countries have implemented dedicated projects aimed to collect additional information that allow to comply with KP reporting requirements.

Reporting method 1 is based on the use of grid-based assessments, usually with Approach 3 or sometimes Approach 2 with supplementary information. Most of the national systems rely on the grid of their National Forest Inventories to identify and track lands under AR, D and FM, very often complemented by remote sensing datasets (especially to derive 1990), so most MS apply reporting Method 1 and Approach 3 (being this approach the only one that allow tracking lands across time) or approach 2 plus additional information to allow tracking lands.

National systems using Approach 3 may rely also on land parcel identification system (e.g. as used for subsidy payments or licensing), which allow recording and tracking individual parcels in time and space since the onset of the subsidized activity and for which the information is, in some cases, in digital format (e.g. in Ireland). Such systems are supported by adequate verification procedures at the country level as they are under public funding. Additional information when Approach 2 is used is taken from license database, payment scheme database, forest management planning related databases, or expert judgment.

Reporting Method 2 is used in only few cases, when, each single area subject to a KP activity is identified and tracked, usually, based on a geographical information system with wall-to-wall datasets derived from remotely sensed data.

Table 11.9 Information on reporting methods and approaches used for reporting KP activities (based on the information available in NIRs)

Member State	Reporting Method used for identifying geographical locations of lands
Austria	1
Belgium	1
Bulgaria	1
Croatia	1
Cyprus	1
Czech Republic	1
Denmark	1
Estonia	1
Finland	1
France	1
Germany	2
Greece	1
Hungary	1
Ireland	2
Italy	1
Latvia	1
Lithuania	2
Luxemburg	1
Malta	1
Netherlands	2
Poland	1
Portugal	1
Romania	1 (FM,D) / 2 (AR)
Slovakia	1
Slovenia	1
Spain	1
Sweden	1
United Kingdom	1
Iceland	1

11.3 Activity-specific information

11.3.1 Methods for carbon stock change and GHG emissions and CO_2 removal estimates

Methods used for estimating emissions and removals related to Article 3(3) and Article 3(4) activities are consistent with those used for reporting carbon stock changes and nob-CO_2 emissions in the corresponding land use categories under the Convention. In Chapter 6, methods and datasets used are described for each of the relevant land use categories and MS. In addition, more detailed information on such methodologies can be found as an annex to this report (Annex III) and in individual GHG inventories.

11.3.2 Description of the methodologies and the underlying assumptions used

Information used to estimate carbon stock changes under ARD & FM

The main data source used for reporting carbon stock changes in ARD and FM activities are the national forest inventories carried out by individual MS. In few cases, annual net CO_2 emissions and removals are modeled based on non-NFI data (i.e. modeling based on yield tables and age-classes distribution from plantation plans and other available national statistics). Carbon stock changes from mineral soils associated with any conversion to and from forest lands are estimated by modeling or by using the IPCC default methodology together with country-specific reference carbon stocks values. When these activities occur in organic soils, the resulting GHG emissions are estimated using country-specific factors or in very few cases with IPCC default factors.

The reporting of carbon stock changes in litter, dead wood, and mineral soils carbon pools was improved considerably in the last years, as proven by the reduced number of MS using notation keys for these carbon pools in the current inventory.

In 2018, as explained by few MS during the QA/QC checks, some internal constrains prevented the full provision of information in the KP tables. Therefore, only quantitative information was provided. Empty cells mainly relate with notation keys that should have been introduced but that they do not resulted directly in an incompleteness reporting of emissions and removals.

The range of the implied carbon stock change factors reported for AR (Table 11.10) is similar to the one reported in the Convention tables for land converted to forest land. Among inventories, there are notable differences on the net biomass increment that are due to the type of species, climatic conditions and other specific silvicultural characteristics (e.g. non-uniform rate of harvesting, different management practices). One additional reason for large differences is the use of either time averaged or actual annual growth data, depending on the methodology applied by the inventory compilers.

Slovenia reports that there is not AR in its territory, and Malta neither AR nor D. Some other MS reported the notation key (NE, NO or NA) for carbon pools for which it was demonstrated the absence of net emissions under the "not a source" provision (***Table 11.17***), or when AR (or any other activity) does not occur under organic soils.

The EU has devoted, and is still devoting, efforts to enhance the harmonization of the use of notation keys among MS, however some differences on which notation key have to be used when the "not a source" provision is implemented, still remain across MS .

Table 11.10 Implied carbon stock change factors (tC $ha^{-1}yr^{-1}$) by pool reported under AR activity by EU MS and Iceland (for the year 2016), based on KP CRF tables.

AR						
Member State	**Above ground Biomass**	**Below ground Biomass**	**Litter**	**Dead wood**	**Min Soils**	**Org Soils**
Austria	0.97	0.26	0.82	0.02	0.47	NO,NA
Belgium	1.51	0.28	NO,NA	NO,NA	1.13	NO,NA
Bulgaria	2.24	NO,IE	0.22	NO,NE	-0.96	NO
Croatia	0.82	0.33	0.22	NO,NA	-0.24	NO,NA
Cyprus	0.60	0.17	0.23	0.00	0.01	NO
Czech Republic	1.91	0.38	0.48	0.02	0.10	NO
Denmark	-0.31	0.03	0.25	-0.01	0.08	-1.30
Estonia	0.86	0.36	0.30	0.00	-0.72	-0.30
Finland	0.68	0.22	IE,NA	IE,NA	0.11	-1.30
France	1.15	0.47	0.14	0.03	0.10	NO,IE

AR						
Member State	**Above ground Biomass**	**Below ground Biomass**	**Litter**	**Dead wood**	**Min Soils**	**Org Soils**
Germany	2.87	0.53	0.47	0.03	-0.22	-2.24
Greece	0.94	0.17	NE,NA	NE,NA	NE,NA	NA
Hungary	1.47	0.37	NE,NA	0.05	NE,NA	NO,NA
Ireland	1.92	0.88	0.60	0.18	NO,NA	-0.73
Italy	0.89	0.18	0.01	0.01	0.13	NO,NA
Latvia	0.36	0.09	0.08	0.09	NA	-0.52
Lithuania	1.36	0.21	0.09	NO,NA	0.41	4.84
Luxemburg	3.27	0.66	0.43	0.13	0.73	NO
Malta	NO	NO	NO	NO	NO	NO
Netherlands	2.98	0.37	NO,NE	0.14	-0.04	-0.16
Poland	0.80	0.21	NO	NO	0.05	-0.68
Portugal	1.06	0.09	0.05	NO,IE	0.23	NO
Romania	1.70	NO,IE	0.05	NO,IE	1.03	NO,IE
Slovakia	1.25	0.28	0.41	NO,NA	1.23	NO,NA
Slovenia	NA	NA	NA	NA	NA	NA
Spain	1.80	IE,NA	0.06	0.03	0.40	NO,NA
Sweden	0.85	0.28	0.23	0.02	-0.07	-2.22
United Kingdom	1.73	IE,NA	0.20	IE,NA	-0.71	-1.03
Iceland	0.72	0.18	0.14	NO,NA	0.41	-0.37

Notation keys for all tables below: IE – included elsewhere i.e. included in other pools. NO – not occurring e. NA- not applicable, NE-not estimated (the MS using NE, NA, NO justify these pools as being "not a net source" or negligible; or that nor activity takes place in organic soils).

The use of several notation keys under a single carbon pool is due to the aggregation system of the CRF tables. See CRF table of the concerned MS for more clarification.

Under Deforestation, there is a rather full reporting of carbon pools (Table 11.11). A particular case is given by Germany that reports a sink in mineral soils associated with conversions of cropland to grassland, in previously deforested lands. Estimations are based on country-specific data. Or Malta that did not report areas of Deforestation.

Moreover, some MS used also notation keys under Deforestation. For instance, when carbon stock changes for a certain pool have been already included in the estimation of other carbon pool due to the methodology used to derive carbon stock changes (e.g. below-ground biomass include as part of above-ground biomass, or litter estimated along with SOC), as it is the case for the use of "IE" by Finland, Spain, UK, Romania and Croatia.

Furthermore, also the notation key "NO" is used when Deforestation does not take place in organic soils.

Finally, the notation key NA, as a second notation key, as occurred in all the similar tables, is a matter of the aggregation implemented by the CRF Reporter that adds to the summed up value also the notation key "NA" when this refers to "*Deforested land previously reported under afforestation/reforestation and forest management and subject to natural disturbances"*

Table 11.11 Implied carbon stock change factors (tC ha-1yr-1) by pool reported under D activity in EU MS and Iceland (for the year 2016), based on KP CRF tables.

D						
Member State	**Above ground Biomass**	**Below ground Biomass**	**Litter**	**Dead wood**	**Min Soils**	**Org Soils**
Austria	-0.66	-0.16	-0.51	0.00	-0.46	NO,NA
Belgium	-5.13	-1.16	-0.47	-0.12	-1.81	NO,NA
Bulgaria	-1.81	NO,IE	-0.25	-0.13	-2.57	NO
Croatia	-0.20	-0.07	-4.51	IE,NA	-2.12	NO,NA
Cyprus	-0.27	-0.07	-0.15	0.00	-0.35	NO
Czech Republic	-2.42	-0.48	-0.33	-0.07	-0.04	NO,NA
Denmark	-2.17	-0.35	-1.71	-0.15	-0.09	-5.00
Estonia	-0.97	-0.23	-1.06	-0.05	-0.68	-1.61
Finland	-0.53	-0.16	IE,NA	-0.01	-0.38	-5.08
France	-1.41	-0.38	-0.15	-0.05	-0.61	NO,IE
Germany	-0.96	-0.11	-0.50	-0.05	0.11	-5.86
Greece	-0.36	-0.15	-0.24	-0.04	-1.87	NO,NA
Hungary	-2.24	-0.56	-1.26	-0.40	-0.78	NO
Ireland	-0.28	-0.03	-0.03	-0.16	-0.36	-1.11
Italy	-3.14	-0.66	-0.20	-0.10	-5.54	NO,NA
Latvia	-0.10	-0.02	-0.09	-0.11	-0.14	-1.38
Lithuania	-2.09	-0.46	-0.79	-0.35	-2.15	-2.51
Luxemburg	-0.64	-0.15	-0.13	-0.04	-0.81	NO,NA
Malta	NO	NO	NO	NO	NO	NO
Netherlands	-3.10	-0.45	-1.54	-0.10	0.02	-2.22
Poland	-23.67	-4.73	0.00	-0.03	-19.19	NO
Portugal	-0.28	-0.04	-0.05	IE	-1.05	NO
Romania	-3.57	IE,NA	-0.30	IE,NA	-1.49	NO,NA
Slovakia	-0.65	-0.15	-0.06	-0.03	-0.01	NO,NA
Slovenia	-2.74	-0.27	-0.29	-0.13	-0.83	NA
Spain	-0.89	IE,NA	-0.06	-0.03	-0.29	NO,NA
Sweden	-0.83	-0.28	-0.45	0.00	-0.71	-1.35
United Kingdom	-2.75	NO,IE,NA	-0.10	NO,IE,NA	-2.14	NO,IE,NA
Iceland	0.66	0.17	-0.02	NO,IE,NA	-0.62	-7.87

With regard to FM (Table 11.12), notation keys are more widely used for reporting carbon pools, than under AR and D. Mineral soils, litter and dead wood carbon pools when reported are mainly estimated to be a net sink of carbon under FM. Organic soils are always reported as a net source whenever drainage took place in such areas.

In addition, as reported in Malta's NIR in this submission, removals and emissions were not calculated from this category, following a recommendation of the LULUCF Expert Review Team during their in-country review. In view of this, since Malta is limited to two forest reserves, where the forest cover is almost at maturity and where therefore carbon stock losses are offset by carbon stock gains, so that, without considering the indirect impacts as the fertilization effect due to nitrogen deposition and the increasing CO_2 concentration in the atmosphere, their long-term carbon stock balance can be assumed at equilibrium

Concerning the reporting of carbon pools for agricultural activities (Table 11.13, Table 11.14), biomass is reported mainly as a net source of emissions under GM and as a net sink under CM. By contrary, mineral soils are mainly reported as a net sink under GM and as a net source under CM.

With regards to WDR, the UK informed to be implementing a program to develop the corresponding quantitative estimates based on then 2013 IPCC KP Wetland supplement that will be submitted in the next years.

Table 11.12. Implied carbon stock change factors (tC ha-1yr-1) by pool reported under FM activity in EU MS and Iceland (for the year 2016), based on MS CRF tables.

FM						
Member State	**Above ground Biomass**	**Below ground Biomass**	**Litter**	**Dead wood**	**Min Soils**	**Org Soils**
Austria	0.26	0.03	NO,NE,IE,NA	0.06	-0.18	NO,NA
Belgium	0.50	0.09	NO,NA	NO,NA	0.53	NO,NA
Bulgaria	0.40	NO,IE	0.04	0.03	-0.06	NO
Croatia	0.13	0.13	NO,NA	NO,NA	NO,NA	NO,NA
Cyprus	0.04	0.01	0.00	0.00	0.00	
Czech Republic	0.35	0.07	NO,IE	NO	NO,NE	NO
Denmark	-0.06	0.17	-0.38	-0.09	NO,NA	-1.30
Estonia	0.25	IE,NA	NE,NA	0.01	0.16	-0.18
Finland	0.29	0.05	IE,NA	IE,NA	0.24	-0.25
France	0.45	0.17	0.00	-0.03	IE,NA	IE
Germany	0.90	0.13	-0.01	-0.05	0.41	-2.24
Greece	0.33	0.12	NO,NE,NA	NO,NE,NA	NO,NE,NA	NO,NA
Hungary	0.37	0.09	NE,NA	NE,NA	NE,NA	-2.60
Ireland	-0.57	0.37	0.48	0.11	NO,NA	-0.45
Italy	0.90	0.18	0.00	0.00	NO,NE,NA	NO,NA
Latvia	0.18	0.05	NO,NA	0.08	NO,NA	-0.52
Lithuania	1.06	0.24	0.01	0.02	NO,NA	-1.46
Luxemburg	1.00	0.22	0.00	0.00	0.00	NO
Malta	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE	NO
Netherlands	0.87	0.16	NO	0.22	NO	NO
Poland	0.77	0.21	NO,NA	NO,NA	0.11	-0.68
Portugal	0.42	0.16	0.00	NO,IE	-0.01	NO
Romania	1.01	NO,IE,NA	0.00	NO,NA	0.09	-0.68
Slovakia	0.47	0.09	NO,NA	NO,NA	NO,NA	NO,NA
Slovenia	0.97	0.25	NO,NA	0.00	NO,NA	NO,NA
Spain	0.51	NO,IE,NA	NO,NE,NA	NO,NE,NA	NO,NE,NA	NO,NA
Sweden	0.25	0.08	-0.14	0.07	0.20	-0.32
United Kingdom	1.07	NO,IE,NA	0.46	NO,IE,NA	0.42	1.02
Iceland	0.20	0.05	0.01	NO,IE,NA	0.01	-0.37

Table 11.13 Implied carbon stock change factors (tC ha-1yr-1) by pool reported under CM activity in EU MS (for the year 2016), based on MS CRF tables.

CM						
Member State	**Above ground Biomass**	**Below ground Biomass**	**Litter**	**Dead wood**	**Min Soils**	**Org Soils**
Denmark	-0.04	-0.02	NO	NO	0.00	-6.25
Germany	0.00	-0.01	IE,NA	NO,IE,NA	-0.05	-7.43
Ireland	0.02	IE	NO	NO	0.03	NO
Italy	-0.01	NO,IE	NE	NE	NE	10.00
Portugal	0.01	0.00	0.00	IE	-0.04	NO
Spain	0.02	IE	0.00	NO	0.01	NO
United Kingdom	-0.01	NE,IE	NE	NE	-0.56	-5.00

Table 11.14 Implied carbon stock change factors (tC ha-1yr-1) by pool reported under GM activity in EU MS (for the year 2016), based on MS CRF tables.

GM						
Member State	**Above ground Biomass**	**Below ground Biomass**	**Litter**	**Dead wood**	**Min Soils**	**Org Soils**
Denmark	-0.54	0.00	NO	NO	-0.02	-6.67
Germany	-0.01	0.00	IE,NA	NO,IE,NA	0.08	-6.36
Ireland	0.00	NO,IE	NO	NO	0.13	-5.18
Italy	NO	NO	NE	NE	0.45	NO
Portugal	-0.01	-0.01	0.00	IE	0.09	NO
United Kingdom	0.00	NE,IE	NE	NE	0.14	-0.04

Table 11.15 Implied carbon stock change factors (tC ha-1yr-1) by pool reported under RV activity in EU MS and Iceland (for the year 2016), based on MS CRF tables.

RV						
Member State	**Above ground Biomass**	**Below ground Biomass**	**Litter**	**Dead wood**	**Min Soils**	**Org Soils**
Romania	3.14	IE	0.01	NO	0.24	NO
Iceland	0.06	IE	IE	NO	0.53	NA

Table 11.16 Implied carbon stock change factors (tC ha-1yr-1) by pool reported under WDR activity in EU MS and Iceland (for the year 2016), based on MS CRF tables.

WDR						
Member State	**Above ground Biomass**	**Below ground Biomass**	**Litter**	**Dead wood**	**Min Soils**	**Org Soils**
United Kingdom	NE	NE	NE	NE	NE	NE

Information used to estimate direct and indirect N_2O emissions from N fertilization (4(KP-II)1)

Only few MS report fertilization of mature forests (e.g. Sweden) or young plantations (e.g. UK). For the majority of MS and Iceland, fertilization of forests is not a common practice, or if any, N_2O emissions are expected to be extremely low, and are in any case captured and reported under the Agriculture sector. For instance, the last occurs in cases when a MS is not able to separate fertilizers applied to forest lands from those applied in agriculture (e.g. a unique total national value is available from national statistics).

Information used to estimate CH_4 and N_2O emissions from drained and rewetted organic soils (4(KP-II)2)

Total EU area of drained organic soils on forest related activities for which emissions are reported is about 8,000 kha, which occurs mainly in Finland and Germany. Emissions are estimated based on IPCC default factors or country-specific factors, but in any case, estimation methods are consistent with those used to report under Convention.

In general, most of the drainage area is associated with agricultural activities. Therefore, in the CRF table 4(KP-II)2, most of the reported values refer to MS that elected to account for CM or GM and that report estimates of CH_4 emissions. Moreover, their associated CO_2 emissions are reported in the background activity table together with carbon stock changes in other carbon pools, and N_2O emissions are reported under agriculture.

N_2O emissions from N mineralization/immobilization due to carbon loss/gain associated with land-use conversions and management change in mineral soils (4(KP-II)3)

N_2O emissions, from N mineralization, are expected to be reported for those MS for which a loss of soil carbon stock is reported under the KP activities. These emissions are mainly reported for Deforestation.

In some instances, acknowledging the need to report this source of emissions, some individual inventories have used the notation key NE in the CRF table 4(KP-II)3, along with an explanation provided in the NIR on the efforts that are ongoing to report this source of emissions in the coming years.

Information used to estimate GHG emissions from biomass burning (4(KP-II)4)

Estimation methods are consistent with those used to report emissions from biomass burning under the Convention. In general, monitoring systems on burned areas are not able to discriminate whether the fire occurred on AR lands or on lands subject to FM so that burnt areas are apportioned on the basis of their share on total forest areas.

In Europe, usually burned areas are protected by law, so that there is not the possibility of a land use change after a fire event. Accordingly, just in few cases GHG emissions from biomass burning are reported under Deforestation. Besides that, there are some emissions from biomass burning reported under this activity that relate to “controlled burning” as a management practice of forest residues.

A small share of total emissions from biomass burning under non forest-related activities is also reported in the CRF table 4(KP-II)4.

11.3.3 Justification when omitting any carbon pool or GHG emissions/removals from activities under Article (3.3) and elected and mandatory activities under Article (3.4)

A decision tree guiding the use of the “not a source” provision was elaborated by JRC, and MS and Iceland were encouraged to follow it whenever such provision is applied, in order to ensure that no underestimation of emissions occur. (http://forest.jrc.ec.europa.eu/activities/lulucf/workshops/).

Accordingly, during the EU QA/QC process, MS have been encouraged to use the notation key “NR” in CRF table NIR-1 for pools reported under the “not a source”. Further, it was requested to provide information, on the reasons for omitting carbon pools, in the CRF documentation box and in the NIR of the MS and Iceland concerned. Table 11.17 summarized the demonstrations provided by the individual inventories when a carbon pool was omitted.

Table 11.17 Overview of information provided by MS and Iceland to demonstrate that omitted carbon pools are not a net source of emissions.

Member State	Activity	Carbon pool	Reasoning
Belgium	AR, FM	DW, LT	Regarding deadwood and litter, Belgium opted for a conservative approach, considering no change in carbon stock is considered in these pools in the case of afforestation/reforestation and Forest management.
Bulgaria	AR	DW	Deadwood is assumed not to occur on AR areas. Due to the young age of the forests at AR areas (since 1990) and the assumed lack of dead wood at areas of all other land uses it is assumed that a stock change of dead wood does not occur at AR areas. If there was any in the young forests of AR areas it would represent a C stock increase due to the lack of dead wood in the previous land uses. So, the assumption is conservative.
Croatia	AR, FM	DW	It is assume that the carbon stock on DW can only increases after AR and in remaining FL.
Czech Republic	FM	DW, LT, SOC	The assumption that the deadwood carbon pool does not represent a source of emissions is based on both reasoning, sound knowledge of probable system responses and empirical data. By other hand, it is also assumed that, under the conditions of current forestry practices at the country level, forest soils do not represent a net source of CO_2
Denmark	FM, CM, GM	DW, LT, SOC	No litter and dead organic matter are reported under CM and GM as this is seen as not occurring or as very insignificant as it is only related to the small area with fruit plantations and hedges.
Estonia	FM	LT	For FM Estonia does not have sufficient data regarding litter stocks, thus the Tier 1 method was implemented, assuming that carbon stocks are in equilibrium, therefore the changes in the litter pool are assumed to be zero. In ARR 2016 ERT recommended to obtain necessary data for litter pool. Estonia has an ongoing project to obtain litter stock data and more thorough explanation is added in Chapter 6.2.2.
Germany	CM, GM	DW, LT	Dead wood and litter do not occur in connection with cropland management and grassland management
Greece	AR, FM	SOC, DW, LT	Based on several studies SOC and DOM increase in AR. For FM, silvicultural practices promotes the carbon accumulation in both those carbon pools, which is even more justified by the fact that the living biomass pool in forest under management acts as a net sink. Consequently, the dead organic matter pool and mineral soils in soil organic matter pools in Greece cannot be a net source of carbon. Quantitative demonstration is also provided in the NIR
Hungary	AR, FM	SOC, DW, LT	To demonstrate that soils are not a source, a conservative approach is taken based on the IPCC 2006GL methodology using country-specific and other data. The demonstration for DW and LT is based on expert judgment which is a practicable method in our situation.
Ireland	FM, CM, GM	SOC, DW, LT	Information supporting this assumption are based on the new SOC database from the For CRep project and also from published literature. Based on the decision tree in Section 2.9.4.1 of the 2013 KP Supplement to the 2006 IPCC Guidelines, and Section 5.2.2.4, Vol 4 of the 2006 Guidelines, changes in Litter and Dead Matter carbon pools are assumed to be stable in agricultural activities.
Italy	FM, CM, GM	SOC, DW, LT	Italy has decided not to account for the soil carbon stock changes from activities under Article 3.4, providing transparent and verifiable information to demonstrate that soils pool is not a source in Italy.
Latvia	AR, FM	SOC, LT	The soil monitoring study initiated in 2012 by the Joint stock company “Latvia state forests” and Ministry of Agriculture demonstrates no statistically significant difference in carbon stock in mineral soil in grassland, forest land remaining forest in fertile stand types and in afforested lands, i.e. no changes appear in soil organic matter (SOM) due to afforestation. The results are based on 95 plots in forest, 34 plots in afforested lands and 40 plots in grassland; for each plot 4 repetitions have been taken.
Lithuania	AR, FM	DW, SOC	Based on NFI 1998-2011 data changes of dead wood are not significant in the afforested and reforested lands. For estimation of carbon stock change of dead wood it was assumed to be zero and reported as ‘NO’.
Netherlands	AR, FM	LT, SOC	Justification based on NFI data that shows that the conversion of non-forest to forest always involves a build-up of carbon.
Poland	FM	DW, LT	When an area is afforested, first it is cleared of all above-ground biomass in case there was any, however, no DW and LI are usually present on these lands prior to afforestation. After afforestation, dead woody debris, litter as well as dead trees start to accumulate.
Romania	RV, FM	DW, LT, SOC	DW reported as not occurring or it is considered as a very small sink in AR and RV since initial mass is null, then it could only increase in time, or in any case it cannot decrease. Under FM, Quantitative and qualitative arguments are involved to demonstrate that SOC, DW and LT are not sources of emissions over CP

Member State	Activity	Carbon pool	Reasoning
Slovenia	FM	LT, SOC	Results of our preliminary expertise for period 1996 – 2006 (Kobal M., Simoncic P., 2011), show relative stable carbon stocks in litter in forest land remaining forest land. Estimates under FM for carbon stock changes in litter and soils were therefore not reported.
Spain	FM, CM	LT,DW, SOC.	It is assumed that the pool are not a net source in line with the IPCC Tier 1 assumption. The carbon stock in this pool increased since the base year therefore it would result in a sink, however the quantity of this sink is not yet estimated.
United Kingdom	CM, GM, WDR	LB, DOM, SOC	The UK has elected three additional Article 3.4 activities: Cropland Management, Grazing Land Management and Wetland Drainage and Rewetting. We are not yet in a position to report emissions and removals from all of these activities and the relevant tables are filled in with the notation key NE. The UK is putting in place a research and methodological development programme for these activities to enable full reporting by the end of the commitment period.
Iceland	AR,	DW	Harvest Wood Products are not estimated in this year submission. Data on domestic wood utilization and production of wood products from domestic wood are not official data and the official statistical agency in Iceland (Statistics Iceland (http://www.statice.is/)) has fragmented, unverified and incomplete reporting of these data

For a consistent demonstration of 'not a source', MS and Iceland have been encouraged to avoid simple assumption of "equilibrium" following IPCC Tier 1 methods, but to demonstrate, based on qualitative information, reasoning and, to the extent possible, quantitative estimates from any available documentation (i.e. scientific papers, reports, etc.) that the omitted pool does not result in a net source of emissions. Since 2010, EU has performed annual assessments of the implementation of the 'not a source' provision and has provided support for improving and harmonizing the information provided by MS to justify any omission of carbon stock changes from carbon pools.

11.3.4 Information on whether or not indirect and natural CO_2 removals have been factored out

Because of the use of the "managed land" approach, which so far is the stipulated approach used for estimating emissions and removals from anthropogenic activities, individual inventories have not factored out from the reported estimates indirect and natural CO_2 removals. In most cases, they argued the lack of methods to do so, or that, due to the length of the reporting period, the magnitude of these removals is insignificant.

For FM, it is recognized that the issue of factoring out indirect removals from elevated carbon dioxide concentrations above pre-industrial levels, indirect nitrogen deposition, and the dynamic effects of age structure resulting from KP activities prior to 1 January 1990 is addressed in the accounting through the FMRL. Indeed, it is expected that the effects of such processes on the emissions and removals occurring during the commitment period approximately cancel out in the accounting when the projected FMRL is compared to the reported FM estimates.

11.3.5 Changes in data and methods since the previous submission (recalculations)

An overview of the reasons for recalculation of inventory estimates is provided in table 11.18

Table 11.18 Summary of information on changes and methods since the previous submissions (recalculations)

Member State	Overview of reasons for recalculations
Austria	A calculation error in the HWP estimates related to veneer sheets was corrected and led to minor changes in the removals from HWPs. The HWP production figures for 2015 were updated in the most recent FAO statistics. Consequently, the removal figures for this year had to be updated accordingly. The estimate of paper production from domestic wood was expanded by the wood pulp production/ import/export according to equations 2.8.2 and 2.8.4 of the IPCC (2014) KP Supplement and the HWP time series was recalculated accordingly. All these recalculations led also to minor changes in the annual removals of ARD for the years 2013 to 2015.
Belgium	Until 2016 the HWP category reported values were based on a generic model (German Wood Carbon Monitor) developed by S. Rüter. Belgium has developed its own model in 2017. For further information. Table NIR-2 was revised in 2018, ensuring consistency with the total land area. Average carbon stocks in

Member State	Overview of reasons for recalculations
	forest were revised in Wallonia and Flanders according to the last regional forest inventory cycles and land use matrix was slightly revised. Theses recalculations bring a significant decrease of the sink in forest management and a limited decrease of emissions from deforestation.
Bulgaria	Comparing the Submission 2017 there are no recalculations.
Croatia	ARD and FM areas are reported according to results of conducted survey through LULUCF 1 project. According to the conducted analyses increase of forests area that happened before 1990 were identified under the specific years and shifted and reported as FM area in 1990. In period 1990-2015 it was determined increase of forest area that amounts of 262,383.93 ha in this case.
Cyprus	This is the first submission hence no recalculations are reported.
Czech Republic	This inventory includes changes in biomass estimates due to the revised root/shoot ratio, which affect estimates in all KP LULUCF activities (AR, D, FM). Next, emission estimates form burning and forest have been revised and deadwood carbon stock estimates have been newly introduced for FM. These changes required recalculation of emission estimates for all reporting years and the currently reported estimates are herewith revised compared to those in the previous submission. This submission also rectified a minor error of area-based attribution (for the period 2010-2015) of biomass carbon stock change to Forest Management, which was identified in connection with the latest review.
Denmark	Minor recalculations have been made due to updates in NFI. Also minor changes in the Land Use Matrix have occurred.
Estonia	Areas subject to Afforestation/Reforestation, Deforestation and Forest management are updated annually by NFI, new data is integrated to overall activity data. Methodological consistency between the reference level and reporting for forest management during the 2nd commitment period, including the area accounted for the treatment of harvested wood products is secured by implementation of the same methodological approaches for the whole accounting period and recalculation of the whole time series according to a new methodology.
Finland	The areas of Article 3.3 activities and Forest Management were recalculated. The areas were recalculated because new NFI data were available, also new remote sensing data for updating. For litter estimation the species of energy wood was estimated in more detail: before and average of tree species allocation was used, and now a complete time series based on statistics is applied.
France	Consideration of the latest available results from the National Forest Inventory, which updates biomass growth and mortality; Modification of the extrapolation of forest growth and mortality parameters for recent years; Modification of N_2O emissions related to soil mineralization when conversions result in soil carbon loss.
Germany	No recalculations were implemented in the current submission.
Greece	In the current submission no specific changes have been made with regard to methodologies applied in comparison to the previous submission. The only recalculations performed in comparison to the previous submission refers to the 3.4 Forest Management activity as a result to the update of the forest management plans database.
Hungary	This year, as mentioned before, we completed the methodology by adding the estimation of carbon stock changes in the deadwood pool on AR land, and by also adding estimates of indirect N_2O emissions from mineral soils due to leaching/runoff. We also corrected an error for 2015 for carbon stock changes in the HWP pool.
Ireland	Deforestation to settlements: - There was an error in the calculation of emissions of CO_2 from organic soils for forest land converted to settlements for the inventory year 2006 to 2014. The error was corrected, but had a very small effect on the net emission from this subcategory. Cropland Management: - Refinement of the analysis of the LPIS spatial dataset; Revision of the activity for biomass burning. Further information on these recalculations is presented in section 6.4.11. Grazing land Management: - Revised assessment of land area statistics and management practices. Revision of the activity for biomass burning. Further information on these recalculations
Italy	A comprehensive comparison of 2018 and 2017 submissions has been carried out. Concerning the ARD activities under art. 3.3 of the Kyoto Protocol, the main driver for the deviations from the previous sectoral estimates is the update of activity data and from the detection and correction of computation errors. With reference to the ARD activities, the 2017 submission results in a slight deviation for the Afforestation/Reforestation activities (average decrease of 0.1%) and no deviations for Deforestation activities, respect the previous estimates. In Table 9.8 deviations, related to the ARD activities, resulting from the comparison of the 2018 submission against the previous estimates are reported.
Latvia	Implementation of changes due to use of the 2006 IPCC Guidelines and the IPCC Wetlands Supplement for certain categories and implementation of the 2nd cycle and floating cycle of the NFI continued this year. The sector reporting was considerably updated since the previous submission by development of national GHG accounting and projection tool and implementation of results of several scientific studies. Methodological consistency between the reference level and reporting for forest management during the 2nd commitment period, including the area accounted for the treatment of harvested wood products is secured by implementation of the same methodological approaches for the whole reporting period and recalculation of the whole time series according to a new methodology.
Lithuania	No recalculations were implemented in the current submission.
Luxemburg	Since the previous submission the calculation of direct and indirect N_2O emissions associated with the loss of soil carbon stock due to land use changes (deforestation) have been refined.
Malta	No recalculations were implemented in the current submission.
Netherlands	As a result of the explicit identification of Trees outside Forest under Grassland, the activity data and resulting emissions and removals for accounting of afforestation and reforestation, deforestation and Forest Management have changed.

Member State	Overview of reasons for recalculations
Poland	All changes are caused by the change in activity data, for forest and forest management activity. In this submission, we have implemented a number of recalculations. The main reason for the recalculations is that we identified some minor calculation updates in the area of some categories. A few other recalculations were made due to some minor category-specific issues
Portugal	No recalculations were implemented in the current submission.
Romania	No recalculations were implemented in the current submission.
Slovakia	No recalculations were implemented in the current submission.
Slovenia	Considering ERT revision report and recommendations, data and methodologies were internally revised and recalculations were made.
Spain	Incorporation of the provisional estimate of land use areas and changes in land use for the period 1970-1989, based on the available statistics. Elimination of transition from forest land to non-herbaceous grassland.
Sweden	The forest management reference level was recalculated to -32.2 Mt CO_2-eq. and the technical correction applied to the original value was estimated to 9.2 Mt CO_2-eq.
UK	Recalculation area the result of some modification in the CARBINE model.
Iceland	No recalculations were implemented in the current submission.

11.3.6 Improvement status and plan

During this submission, the following improvements have been performed in order to correct errors and inconsistencies flagged during the internal QA/QC checks, or in order to address recommendations provided by the 2016 and 2015 ERT:

- The layout of the vast majority of the tables was changed for a better readability.
- Inclusion of information on KC for all the MS, despite of remaining bugs in the CRF Reporter Software, which prevent the inclusion of that information in the CRF table NIR-3 for some MS.
- Significant increase of the TACCC in some individual GHG inventories (e.g. MLT, FRA) and hence in the EU inventory.
- Inclusion of better explanations across the chapter to justify the use of the notation keys for reporting carbon pools in the KP activities by MS.
- Disaggregated information on the background level and the margins used for the accounting of FM was included under the natural disturbance provision section.
- Information on HWP originating from Deforestation events is now provided in the CRF tables (i.e. information item) of the MS for which this source of HWP is relevant. Moreover some paragraphs have been added also on this regards in this chapter.
- Information was added on the FMRL for the EU that is inscribed in the appendix of the submission 2/cmp.7. Moreover, information on the particular circumstance that is facing the EU on this regard is also included in the relevant section.
- Information was added to explain how a unit of land that was accounted for during the CP1, continues to be accounted for during this CP2.
- Information on how emissions from natural disturbances were included in the FMRL.
- Correction of identified errors from previous submission, e.g. in Romania, Cyprus, Italy

Furthermore, the EU plans to continue devoting efforts to enhance the overall TACCC of the KP chapter with some further improvements and the correction of some identified issues for which their correction was not possible in this submission. In particular, the focus will be on:

- To continue enhancing the internal QA/QC checks to ensure the avoidance of inconsistencies between information provided in individuals MS submissions and the EU submission; and internally, between NIR and CRF tables.
- To continue working with MS to ensure the completeness of the inventory, in particular with Cyprus and Malta for the mandatory KP activities, Belgium for HWP, and with UK in order to provide quantitative estimates for the KP activity WDR.

- To continue supporting MS in the estimation and provision of information on Technical Corrections, and to ensure the consistency between the FMRL and the reporting of the activity FM.
- To continue working with MS towards the harmonization on the use of the notation keys.

11.3.7 Uncertainty estimates

For information on uncertainties please refer to chapter 1.6

11.3.8 Information on other methodological issues

During the EU QA/QC process an important number of checks are implemented every year to ensure the accuracy, transparency, completeness, and consistency of the KP information included in the individual inventories. Focus is also placed on increase the comparability, and on improving the overall quality of the EU GHG inventory.

For instance, among many others, the consistency among the information submitted under the KP and the Convention is assessed every year in terms of methods, emission factors and activity data to ensure its consistency and discard potential issues. Also many other checks are implemented to ensure that estimates are prepared by applying methodologies that are consistent with IPCC methods, and adequate to the significance of the category or carbon pool that is being estimated.

11.3.9 The year of the onset of an activity, if after 2013

This information is implicitly achieved by each individual inventory, and consequently by the EU GHG inventory, through the provision of the estimates in the NIR-2 table. The onset of any activity on any land is reported according to the year when the land is reported as subject to the activity for the first time. Checks are also devoted to ensure that once a unit of land is reported in such table, it continues to be reported in subsequent submissions.

11.4 Article 3(3)

11.4.1 Information that demonstrates that activities under Article 3(3) began on or after 1 January 1990 and before 31 December of the last year of the commitment period, and are direct human-induced

Land representation systems implemented at national level are able to determine the onset for any KP activity along time series, and starting from 1990 onwards.

For example, planting year is mentioned as the information used to assess the onset of AR activity (e.g. DNK, UK, GRC, IRL), or, the year when the encroaching woody vegetation meets the definition of forest, for instance in the case of natural-assisted afforestation, as detected by national forest inventories or remotely sensed products, that because are not often annually available are supported by interpolation/extrapolation techniques.

For D, information comes from annual direct assessments, for instance, when national statistics based on license for clear-felling are available; or datasets on land cover and land use compiled by sampling or wall-to-wall techniques with ground data and, or remotely sensed data. In the latter cases, as mentioned above, because data are not often annually available, interpolation/extrapolation techniques have to be involved. According to the IPCC, it is good practice to provide documentation to prove that all land reported under afforestation and reforestation are subject to direct human-induced activities. In this sense, relevant documentation provided in the individual inventories often 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 11.19 shows a synthesis of current information reported by EU MS and Iceland on the direct-human induced origin of reported AR lands.

Table 11.19 Summary of current information reported by EU MS and Iceland aimed at demonstrating that Afforestation/Reforestation activities are direct human-induced.

Member State	**Type of information/justification provided**				
	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**	
Bulgaria		**X**		**X**	
Croatia	**X**	**X**			
Cyprus				**X**	
Czech Republic	**X**	**X**			
Denmark				**X**	
Estonia				**X**	**X**
Finland	**X**			**X**	**X**
France			**X**		
Germany		**X**			
Greece	**X**				
Hungary	**X**				
Ireland	**X**	**X**		**X**	
Italy			**X**		
Latvia	**X**				
Lithuania		**X**			
Luxemburg			**X**	**X**	
Malta	--	--	--	--	--
Netherlands					**X**
Poland	**X**				
Portugal				**X**	
Romania	**X**				
Slovakia	**X**				
Slovenia		**X**		**X**	
Spain	**X**				
Sweden			**X**	**X**	
United Kingdom	**X**			**X**	
Iceland			**X**		

In general, a rather "broad" interpretation of "direct human-induced" AR is applied by most MS, so that around 90% of the total area reported under conversion to forest land is assumed as directly human-induced AR. However, some MS adopt some more stringent criteria. For instance, UK does not report under AR the areas of planting that are not state-owned or grant-aided. If not included under AR, natural forest expansion has been reported by individual inventories under FM.

11.4.2 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 by the land monitoring systems, the classification of an area as deforested once the tree coverage has been removed, is more challenging. Individual inventories 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, see Table 11.20.

The simple combination of NFI data with remotely sensed 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. For instance, information on license that is typically required when a land use change occurs. Or in the absence of detailed information on the future use of the land, some MS defined an expected time period in years within which the removal of tree cover has to be followed by natural regeneration or planting, once such time period is passed and trees are not yet growing again on the land, the land is considered deforested.

On the other hand, most of the MS reported that there are legal obligations to restore the forest on harvested areas, or following wildfires, so that such kind of forest cover loss are never identified as deforestation.

Table 11.20 Information on differentiation between temporary forest cover loss and deforestation provided by MS and Iceland in their GHG inventories.

Member State	Short description
Austria	In Austria temporarily unstocked areas (e.g. harvested area, disturbances) remain forests and are not accounted as deforestation. NFI teams are trained to distinguish between the results of forest management operations and Land Use Changes.
Belgium	It is assumed that forest has been planted and can be recognized on all areas that have been harvested or have been subject to other human disturbance but for which it was expected that a forest would be replanted. In this view no plantation is expected on areas identified as deforested. About one third of the deforested areas were replaced by settlements, for which no re-establishment of forest will occur. Each point identified by the geoprocessing tool as being subject to LUC is verified through photo-interpretation to confirm the interpretation.
Bulgaria	Deforestation areas that followed all administrative steps needed to get the permission for deforestation. Only such areas are accounted as D areas in Bulgaria.
Croatia	The main criteria for distinguishing the harvesting or forest disturbance followed by the re-establishment of forest from deforestation is whether or not the land use has changed, which is strictly regulated by the legal framework.
Cyprus	This information is not yet available. The Forest Department is conducting a full inventory of forested areas which should be complete by 2020. This should give us the additional information needed to distinguish between forest disturbance and deforestation. Harvesting is not taking place extensively in Cyprus and no areas are clear-cut of forest as the common practice is the thinning of trees.
Czech Republic	The main criteria for distinguishing the harvesting or forest disturbance followed by the re-establishment of forest from deforestation is whether or not the land use has changed, which is strictly regulated by the legal framework.
Denmark	Deforestation is detected by analysis of satellite images. Furthermore deforestation of larger areas is confirmed by e.g. projects on nature restoration. Temporarily unstocked areas are typically located within larger forest areas and will in most cases be reforested within a period of 10 years as according to the Forest Act of Denmark, which applies to all Legal Forest Reserves (Fredsskov) and equals approximately 70 % of the total forest area. Clear-cuts outside forests - e.g. small plantations of conifers on former cropland - is considered deforestation.
Estonia	According to Estonian legislation, the land category change by humans is allowed only with orders from local authorities and/or the Minister of the Environment. This must be preceded by the reassignment of the land (e.g. commercial, residential or transport land), which is reflected both in the Land Cadaster and Land Registry. When a NFI sample plot is located in a clear-cut area, the surveyor assesses whether the cutting has been done for regeneration purpose or for land-use change. Clear signs of a land-use change can be seen in the surrounding and location of the area; also the data from Land Cadaster and Land Registry is checked. According to the Forest Act, the forest owner is obliged to implement reforestation techniques to the extent that within five years after logging or forest death a renewed forest is ensured. Re-establishment of a forest usually starts within 2 years after harvesting.
Finland	When a clear-cut area is located in a NFI sample plot, the surveyor assesses whether the cutting has been done for regeneration purpose or for land-use change. The distinction between these two cases can generally be made on a reliable basis. The distinction between these two cases can generally be made on a reliable basis. Clear signs of a land-use change can be seen in the surroundings and location of the area: construction projects, stacked cutting residuals or if the area is under a regional or town plan. The re-establishment of a forest usually starts within two years after the harvesting. The Forest Act lays down provisions that a new forest must be established within three years after the

Member State	Short description
	regeneration cutting. In the case the land-use change occurs after a clear-cut, this can be taken into account by classifying the sample plot as non-forest.
France	The method used to monitoring lands, works over two features, land use and land cover, therefore it is able to differentiate forest cover loss from deforestation.
Germany	Länder laws are to be enacted that set forth obligations for all forest owners whereby clear-cut or degraded forest areas are to be reforested, or replenished, in cases in which natural regrowth remains incomplete, within a reasonable period of time, unless conversion to another type of use has been approved or is otherwise permitted. In general, reforestation is called for on all forest areas that are to remain in use as forest land. That is a legal requirement, and it is the customary practice in the German forestry sector. Forest land that is temporarily unstocked thus continues to fall within the scope of required reporting on forest management pursuant to Art. 3.4 KP. The situation is different in cases in which forest land becomes unstocked and planning calls for subsequent use of the land to fall within the category "non-forest land". Such land is to be considered deforested land, with the relevant deforestation directly human-induced, regardless of whether the deforestation was caused by harvesting or by natural disturbances.
Greece	According to the national legislative framework the forest land use after any disturbance cannot be changed. More specifically in the cases of wildfire events, the areas affected, are instantly declared to be reforested by the responsible authority which is the Forest Service, with this decision being published in the Official Government Gazette. Harvesting, either in public or private forests, is regulated through national laws (Presidential Degree No 126/1986) and regulations, according to which, specific, and discrete procedures have to be followed only after the authorization of the Forest Service.
Hungary	In Hungary, all forests must be regenerated after clearing mature stands by law. All AR and D areas, as well as those under regeneration are identified by categorizing forest compartments. These compartments have been surveyed since 1 Jan 2008 for all information that is relevant for assigning them to the respective Kyoto forest categories (AR or D and, in case of regenerations, FM), as well as their location within each geographical area. It is also possible to identify each compartment in both the underlying database of this report (which is part of the documentation) and on the forest management maps since 2008.
Ireland	NFI identifies if the lands are unstocked or deforested (5 years periodicity)
Italy	Extensive forest disturbances have been rare in Italy, except for wildfires. Land-use changes after damage do not occur; concerning wildfires, national legislation doesn't allow any land use change after a fire event for 15 years. Harvesting is regulated through regional rules, which establish procedures to follow in case of harvesting. Although different rules exist at regional level, a common denominator is the requirement of an explicit written communication with the localization and the extent of area to be harvested, existing forest typologies and forestry treatment. Deforestation is allowed only in very limited circumstances (i.e. in construction of railways the last years) and has to follow several administrative steps before being legally permitted. In addition, clear-cutting is a not allowed practice.
Latvia	In Latvia temporarily unstocked areas (e.g. harvested area) remain forests and are not accounted as deforestation if no other activities prohibiting forest regeneration are implemented. The NFI teams are trained to distinguish between forest management and land use changes.
Lithuania	According to Lithuanian Forest Law the clear cut areas should be reforested during 3 years and are under strict control of forest management and State inspection. Temporarily unstocked areas after harvesting remain forests and are not accounted as deforestation. Every deforestation case must be reported to LSFC and is very rare. Any deforested area must follow the afforestation of three time larger area than the one was deforested.
Luxemburg	Art 13 of the National Nature Conservation Act states that 3 years after a clear cut on forestland, the owner is pledged to reconstruct the forestland. This means that areas of forestland, where a clear-cut has occurred, has to be considered as forestland, as no other use of forestland after a clear-cut is permitted. In addition, after a period of three years, the owner is forced to take measures to restore forestland, if it hasn't occurred already. So no deforestation can occur by law, except if permitted by a ministerial act. If this is the case, this is documented by the Ministry.
Malta	No Deforestation is reported.
Netherlands	Following the Forest definition and the mapping practice applied in the Netherlands, areas subject to harvesting or forest disturbance are still classified as Forest and as such will not result in a change in land use in the overlay of the land-use maps (Kramer et al., 2009; Arets et al., 2016).
Poland	Since no remote sensing technology is directly involved in the KP LULUCF emission inventory, there is no issue related to distinguishing harvesting or forest disturbance from deforestation. Harvesting and forest disturbance always occur on forest land, while deforestation is a cadastral change of land use from forest land to other land use categories
Portugal	Some losses of forest cover are obvious deforestation events and are classified as deforestation as soon as they are detected (e.g. conversions to settlements, flooding by a recently constructed water reservoir, conversion to irrigated farmland). In other situations the land use following forest cover loss is less obvious. In those situations, and consistent with the KP forest definition, land is considered as "temporarily unstocked" for a period of up to 5 years. After such period the land should be confirmed as forest land (i.e., no deforestation has occurred) or non-forest land. In the latter case the land is considered deforested and the time series for area of FM is recalculated since the year when the event was first detected.
Romania	The forest disturbance alone cannot trigger land conversions from forestland. Thus distinction between harvested and disturbance affected areas, on the one hand, and deforestation, on the other, is made as follows: for the former, there is legal obligation for the forest owner/administrator to maintain the land under forests category and forestry regime (including tree harvest based on permit), to apply the forest management plans specifications and regenerate it within a given timeframe (maximum 2 years); for the latter, following legal procedure with the issuance of the approval, a new land use category is assigned

Member State	Short description
	to that land, and the forestry regime is no longer applicable.
Slovakia	The temporarily (no more than 2 years) unstocked areas (e.g. harvested area, disturbances) are still considered as forest area and are not accounted as deforestation. According to the cadastral law deforestation means that the category of forest land was definitely and permanently changed to another land use category.
Slovenia	Extensive forest disturbances have been rare in Slovenia. If a large forest area is mainly or totally damaged, the legislation on prevention of insect and fungus disturbances binds owners to remove the rest of the damaged trees. After that, the reestablishment work should be started immediately if possible. That areas remain registry as forest land in forestry spatial information system database.
Spain	After a disturbance, the land does not change its use. By other hand all deforested land are assessed on the basis of cartography where unless a change of the land use is detected, the land would continue to be considered as forest land.
Sweden	Final felling is a natural step in the rotation cycle of forestry. Also storms may result in large areas of felled trees (wind-throws). If final felling or disturbances as storms have been identified between two consecutive inventories this is not enough to classify the plot as D. However, if for instance a new road, a power line or other land use preceding the definition of forest is located on the former Forest land, then the plot is considered D. The emission from “loss of biomass” is matched to the conversion year. If final felling has occurred on a plot between two consecutive inventories with no sign of D, but D is confirmed at the next re-inventory, then the year of D is “re-calculated” to match the “loss of biomass” to the conversion year.
UK	The data sources used for estimating Deforestation do not confuse between harvesting or forest disturbance and deforestation. This is because the unconditional felling licenses used for the estimation of rural deforestation are only given when no restocking will occur, and the survey of land converted to developed use describes the conversion of forest land to the settlement category, which precludes re-establishment. The Countryside Survey data (used for gap filling) are adjusted in order that deforestation is not over-estimated. New data sources (post-2000) have been used that clearly identify the post-deforestation land use.
Iceland	Deforestation is estimated by special inventory where the change in the area of forest where deforestation has been reported is estimated by GPS delineation of a new border between forest and the new land use which is dominantly settlements (new power lines, roads or buildings). Major forest disturbances will be detected in the NFI but local forest disturbances (wildfires etc.) will be handled with special inventory as done for deforestation

11.4.3 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 individual inventories ensure consistent reporting in time and space of KP lands declared as temporary un-stocked areas. Such post-disturbed areas correspond to all lands reported as harvested under clear-felling and all those areas where natural disturbances caused a complete loss of forest cover, e.g. windfall, destructive fires, and that are thus kept under AR or FM reporting.

In general, the distinction between deforested areas and temporarily un-stocked areas is achieved by national methodologies, through the implementation of multiple assessment criteria and hierarchical phases, field checks or plot data processing. Supplementary arguments for a correct classification of the lands are given by enforcement of law requirements.

11.4.4 Information related to the natural disturbances provision under Article 3(3)

In accordance with decision 2/CMP.7; 14 MS and Iceland have stated in their “initial Reports” the intention of excluding emissions resulting from natural disturbances that affect AR lands during the CP2. However, Malta has stated in its 2018 submission that no emissions from natural disturbance will be excluded. (Table 11.21).

In general, MS argued that the effects of natural disturbances are always understood as “beyond the control” since those areas are considered direct human-induced and subject to management plans that implement prevention measurements to avoid such damages. In addition, it is also argued that according to current laws it is not allowed to change the use of a disturbed land, but just to implement measures to rehabilitate such forest areas.

The types of disturbance for which MS and Iceland intends to exclude emissions from the accounting of AR activities vary among individual submissions. This also explains why a value on background level and margin for the EU was not provided. Among other factors, the heterogeneity on the type of disturbances considered by MS makes the information on background level and margin meaningless at EU level, either under AR or FM.

In general, wildfires seem to be the most important disturbance affecting AR areas. However, several MS intend to exclude emissions only from areas affected by windstorms, while some others considered all disturbances types as a safeguard measured in case some of these events occur in the future.

Overall, MS have developed a consistent time series of emissions from natural disturbances that cover different time spans depending on data availability. Annual emissions included in the time series were based on country-specific activity data, collected by national authorities, and emissions that are calculated in line with the methods used for reporting the forest land category reported to Convention.

Regarding the estimation of the background level and the margin, the vast majority of MS have used the default method as described in the 2013 KP Supplement. In the case of Luxembourg and Sweden, the background levels have been set as zero due to the low incidence of natural disturbances that emerged from the analysis of past disturbances.

MS have also provided information to demonstrate the no expectation of net credits by implementing the default method (i.e. ensuring that annual emissions in the background group used to calculate the background level are always lower or equal to the background level plus the margin). In some instance, MS have also stated that:

- No trend was observed in natural disturbance emissions during the calibration period, or is expected during the commitment period.
- The background level of emissions for FM included in the FMRL after technical correction is equal to the average of annual emissions from natural disturbances during the calibration period which are in the background group.

Besides that, in line with requirements for the exclusion of emissions from natural disturbances, in some cases, it has been also argued that salvage logging does not occur in lands subjected to forest fires, as all biomass and dead organic matter is immediately oxidized when affected by wildfires. In contrast, some other MS that intend to exclude emissions from windstorms applied a percentage value of the wood stock that is not subject to salvage logging (e.g. Netherlands and Romania) and for which emissions can be excluded.

Table 11.21 Synthesis of Information from MS and Iceland that intend to apply the natural disturbance provision under AR activity during CP2, as reported in individual NIR

Member States	Approach used for developing the BL and the Margin	BL	Margin	Type of disturbance
		Kt CO_2 eq		
Bulgaria	Default method	4.000	2.190	wildfires, extreme weather events – windstorms, wet snowfall, ice, others
Croatia	Default method	1.120	3.980	Wildfires
France	Default method	5790.000	1581.000	Wildfires, storms, droughts
Greece	Default method	1.351	2.385	Wildfires
Ireland	Default method	23.950	46.666	Wildfires
Italy	Default method	0.451	0.708	Wildfires
Luxembourg	Minimum level of historical time series	0.000	0.000	Extreme weather events (storms)
Netherlands	Default method	0.007	0.006	Wildfires

Member States	Approach used for developing the BL and the Margin	BL	Margin	Type of disturbance
		Kt CO_2 eq		
Portugal	Default method	29.870	9.540	---
Romania	Default method	0.200	0.220	Wildfires
Spain	Default method	[0.287 tCO_2eq/ha.]	[0.209 tCO_2eq/ha.]	All considered in the 2013 KP supplement
Sweden	Default method	0.000	300.000	Wildfires, insect attacks and disease infestations, extreme weather events and geological disturbances
United Kingdom	Default method	34.900	18.800	Wildfires, insect attacks and disease infestations, extreme weather events and geological disturbances
Iceland	---	---	---	---

So far, emissions from natural disturbances have not been excluded from the accounting of AR activities. Some MS have stated that although emissions from natural disturbances, in some of the reporting years, have exceeded the calculated background level plus the margin, the method used to track the disturbance events does not allow to know the georeferenced location of the affected areas as it is required under the decision 2/CMP.8., (e.g. Ireland). Some other MS informed that irrespective to their intention to implement the natural disturbances provision, it seems unlike that emissions will be excluded pursuant this provision due to the low incidence of disturbances or because most emissions are associated to salvage logging that follows disturbance (e.g. Luxembourg).

11.4.5 Information on Harvested Wood Products under Article 3(3)

All MS used the "Production approach" to estimate net emissions and removals from this carbon pool. The methodology corresponds to the IPCC Tier 2 method, where first-order decay functions with default half-life values are used, along with activity data that are often collected from international data sources (i.e. FAO, UNECE, etc.). More details can be found in section 6.2.6 of this document and in the individual MS GHG inventories.

Some MS have stated that it is not possible to separate HWP originated from AR lands from those originated from FM lands. Therefore, when this is the case, following a conservative approach, all the emissions and removals from this carbon pool have been assigned to FM lands (in line with IPCC guidance). Additionally, some other MS have also stated that HWP are never originated from AR lands as the age of the trees does not allow harvesting practices (e.g. Croatia, Latvia). Finally, when carbon stock changes from HWP are separately reported between AR and FM, the default IPCC method (equation 2.8.3 of the 2013 KP Supplement) has been used for this purpose.

Concerning HWP originated from deforestation events, following reporting rules, these have been reported on the basis of instantaneous oxidation. Following an issue discussed during the 2016 annual review process, MS are currently providing information, when it is relevant, on *"harvest originating from deforestation events*" in table 4(KP-I)C for information purposes, which allow checking transparently the quantities considered as instantaneous oxidation.

Moreover, MS have also progressively enhanced the transparency of the information included in the NIR by providing more detailed descriptions on the origin of HWP reported under deforested lands. In some instances, the share of HWP originating from D within the total budget of the country is estimated on an area-basis share of lands under D and FM for individual reporting years (e.g. Czech Republic).

Beside this, some MS report, and account, for emissions and removals from HWP originated from trees growing in lands subject to deforestation (e.g. Finland). While, some MS justified that by law HWP cannot be linked to Deforestation (e.g. Greece).

Instantaneous oxidation approach has been also used to estimate carbon stock changes from wood products in solid waste disposal sites and harvested wood used for energy purposes as stated in individual GHG inventories.

11.5 Article 3(4)

11.5.1 Information that demonstrates that activities under Article 3(4) have occurred since 1 January 1990 and are human-induced

Land representation systems that are used at national level to track the lands are able to determine the onset of the activities along the time series. Table NIR-2 allows to check when a unit of land enter in the accounting, and to track that such unit of land continues to be accounted for during the subsequent years of the time series.

Since FM, CM, GM, WDR, and RV (as understood by Romania and Iceland), are management activities, they always qualify as direct human-induced. In most of the cases, MS implemented the broad approach, described in the 2013 IPCC KP Supplement, to define what management refers to.

11.5.2 Information relating to Forest Management

Forest management is understood as the set of forest practices and operations, which occur at the stand-level as harvesting, natural and human-induced regeneration, site and soil preparation (including drainage, burning of slash), seeding, thinning, pruning, fertilization and liming, conservation of habitats, and fire prevention.

Sustainable forestry has a long tradition in Europe, indeed, there are management plans dating from hundreds years ago. Currently, each MS has in force its own legislation on forest lands, as well as other laws supporting a sustainable management and protection of forest areas. At the EU level, forestry is not regulated directly by specific laws, but there are strong requirements for sustainable management of forests via European regulations on environmental obligations (on nature protection, biodiversity protection etc.), sustainable rural development, and renewable energy policies. Some MS report forest certification as an additional tool to highlight the sustainability of the whole chain of forestry and associated products.

Data reported under different international processes (e.g. FAO, MCFPE, CBD) may be different due to different reference time and definitions underlying each of the reporting obligations. Thus, any comparisons among data sources has to be done cautiously.

A particular case that was subject to a question from the EU ERT is the case of France. In the past, new forest areas that are considered managed but that are not considered direct human-induced, and therefore not qualify as AR, were not included in the accounting under FM. France has now clarify that this issue is now solved and that all the managed areas of forest are entered in the KP accounting.

11.5.2.1 Conversion of natural forest to planted forest

The vast majority of inventory compilers has reported that these conversions do not take place in their territories. The main reasons are, either that these forests do not exist (i.e. as all the forests are under more or less intensive management plans), or because all natural forests are under strict conservation and protection regimes (e.g. Czech Republic) that prevent such conversions.

For the year 2016, only Latvia (194.39 Kha) and Romania (1,654.99 Kha) have provided estimates of such areas in the CRF table NIR 2.1, and, their corresponding estimates of emissions/removals were included under the FM activity. However, numbers provided by Romania seem unrealistic, and they could be associated with a misinterpretation of the information that should be provided in that table. This issue will be followed up in next submission.

11.5.2.2 Forest Management Reference Level (FMRL)

For the construction of the FMRL, EU MS and Iceland implemented different approaches, although all of them were based on projections under a “business-as-usual” scenario (Table 11.22). This section provides a synthesis of information on those values and approaches, but for more detailed information, it is suggested to refer to individual submissions of information on FMRL, as submitted by the EU, EU MS, and Iceland before the beginning of the CP2; or to the individual GHG inventories.

As regards with approaches used in the construction of the FMRL; 11 MS and Iceland prepared model-based projections using country-specific methodologies. In these cases, national forest inventory data, remotely sensed information, and other available national statistics were the main data sources used. 14 MS prepared model-based projections using a common approach coordinated by the JRC in collaboration with the International Institute for Applied System Analysis (IIASA) and the European Forest Institute (EFI). To this purpose, the G4M and EFISCEN models were implemented on the basis of information on forest features (from country sources) and on wood production and prices of land and timber, derived from the GLOBIOM model. Finally, three MS used historical data projections based on the elaboration of historical data, assumed as proxy for a “business-as-usual” scenario. Specifically, Greece used the historical average of net removals from forests for the period 1990-2009, while Cyprus and Malta based their FMRL on the linear extrapolation of historical net emissions from forest for the period 1990-2008.

Table 11.22 Synthesis of information related to the construction of the FMRL values as reported by EU MS and Iceland in 2018 submissions.

Member State	Value inscribed in the Appendix to the annex to decision 2/CMP.7 (kt CO_2 eq/yr.)	Technical correction	FMRL based on projections under a "Business-as-usual" scenario		
			Model-based projections using country-specific methodology	Model-based projections using JRC approach	Projections based on historical data assumed as proxy for a "business-as-usual"
Austria	-6516	5823	X		
Belgium	-2499	NA		X	
Bulgaria	-7950	23		X	
Croatia	-6289	905	X		
Cyprus	-157	NA			X
Czech Republic	-4686	NA		X	
Denmark	409	-83	X		
Estonia	-2741	NE		X	
Finland	-20466	-14545	X		
France	-67410	21795		X	
Germany	-22418	NE	X		
Greece	-1830	257			X
Hungary	-1000	-40		X	
Ireland	-142	-571	X		
Italy	-22166	-1680		X	
Latvia	-16302	11703		X	
Lithuania	-4552	-922		X	
Luxemburg	-418	182		X	
Malta	-49	49			X
Netherlands	-1425	NE		X	
Poland	-27133	NA	X		
Portugal	-6830	3286	X		
Romania	-15793	-3665		X	
Slovakia	-1084	-1214		X	
Slovenia	-3171	NE	X		
Spain	-23100	NO		X	
Sweden	-41336	9156	X		
UK	-8268	-14515	X		
EU*	-315323	15943			
Iceland	-154	77	X		
EU + Iceland *	-315476.5	16020			

**The FMRL value for EU and EU + Iceland is: The value inscribed in the Appendix to the annex to decision 2/CMP.7 for EU27 applying FOD function for HWP for those MS for which this value is available in the decision, plus the values applying instantaneous oxidation inscribed for: Croatia, Iceland (when relevant), plus values applying instantaneous oxidation for those MS for which a FMRL value applying FOD function for HWP was not available.*

It should be noted that the FMRL value inscribed in the decision 2/CMP.7 for the EU corresponds to 27 MS that were part of the Union at that moment. Such values as inscribed in the appendix of the decision are:

I. -253336 kt CO_2 eq/yr, applying instantaneous oxidation,

II. -306736 kt CO_2 eq/yr, applying first-order decay function for HWP.

Nevertheless, these values are included here only for information purposes. It should be noted that the accounting quantities for the KP activity FM as reported by MS depend on the FMRL values and their technical corrections (TC). Thus, in order to ensure the consistency among the EU GHG inventory (i.e. as a sum of MS's GHG inventories) and the individual inventories, the EU GHG inventory must use in the CRF table, not the value inscribed in the appendix of the Decision, but the sum of values for FMRL and TC are reported by current MS involved in the Union plus Iceland:

I. -315476.5 kt CO_2 eq/yr
II. 16020.4 kt CO_2 eq/yr

Doing it in this way, as already discussed with the ERT during the ARR 2016 and 2015, the sum of accounting quantities for FM submitted by individual inventories matches the accounting quantity that is reflected in the EU CRF table 'Accounting" and in the Table 11.6 of this chapter.

However, for this year, despite significant efforts implemented by the EU, Romania still included in its submission a FMRL that do not correspond with the values applying FOD functions for HWP but instantaneous oxidation, consequently, for this year a small discrepancy among the accounting quantity for FM as reported for the EU and the sum of accounting quantities for FM as reported by the MS is expected.

In addition, with respect to the background level of emissions associated with natural disturbances that have been included in the FMRL of the EU, it should be noted that no emissions from natural disturbance were explicitly excluded, in fact, emissions were automatically captured as part of the historical records used. For MS that used the JRC approach, the calibration procedure automatically incorporated into the projections the average rate (for the period 2000-2008) of the GHG impact of past natural disturbances, which are not explicitly estimated by the models. At that moment, it was assumed, and it is still valid, that forest fires represent the major natural disturbance type for most of the countries and their averaged emissions for the years 2000-2008 reached 0.3% of the total 1990 GHG emissions for the same countries.

11.5.2.3 Technical Corrections of FMRL

In line with requirements of the Decision 2/CMP.7, MS have already assessed the consistency between the FMRL and the reporting of FM activity in terms of methodological elements (e.g. pools and gases included, area considered, natural disturbances, etc.). As a result, 18 MS and Iceland implemented technical corrections to the FMRL (Table 11.22) in order to ensure such consistency.

Reasons for these inconsistencies and the associated technical corrections vary among inventories (Table 11.23). Overall, they mostly relate to the inclusion of emissions and removals from previously unaccounted carbon pools, the use of the new methodological guidance, especially on HWP and BL of natural disturbances, and the availability of updated data for FM reporting as compared with the data used for the construction of the FMRL.

However, noting the selection of accounting frequency for KP activities at the end of CP2, some MS have informed that, regardless of some inconsistencies that were found among the methodological elements, this year it was not possible to implement a technical correction, due to constrains on time and/or resources. In some case, it is explicitly indicated that a technical correction is expected to be implemented in the coming years (e.g. the Netherlands, Spain).

To this regard, the JRC has always encouraged MS to provide information on methodological consistency of FMRL in the annual GHG inventories, and, to the extent possible, to provide preliminarily quantitative information on the expected magnitude of any possible technical correction, as already did for some MS. The JRC is in contact with MS, and in particular those that used the JRC approach in the construction of their FMRL, providing them support on this matter. It is expected that all MS will implement a TC correction, as a minimum, at the time of the accounting which will ensure the consistency between the FMRL and the reporting of FM.

Table 11.23 Information on inconsistencies among the FMRL and the reporting of FM activity that have triggered the need of TC

Member State	Information on the need for TC
Austria	Improvements and updates in the forest land remaining forest land category have impacts on accounting for Forest Management in the second commitment period which require the following adjustments: 1) Inclusion of the litter and soil pools. 2) Updated expansion ratios: 3) Updated data on 'drain': 4) Updated dead wood pool: 5) Corrections in the calculations of the 'increment' 6) Update of harvested wood products:
Bulgaria	Bulgaria in cooperation with JRC plan to have two technical corrections up to the end of the commitment period. In period 2017-2018 it is planned to make TC in order to update the FMRL according to the new NFI data (2016) and to update the HWPs estimates according to the 2013 KP Supplement. Meanwhile in order to ensure the consistency of the reported information, as an interim solution, Bulgaria has carried out a re-calibration of the model results used in construction of the FMRL in 2011. The result of the re-calibration is -8.145 Mt CO_2 eq.
Croatia	Since the submission of FMRL Croatia implemented several methodological improvement steps in estimating its emissions/removals of FM. Due to these methodological improvements, changes in the FM input data, FM estimates and FM figures of historic years occur. As a consequence of all these methodological changes the FMRL changes from -6,289 kt CO_2 net removals to FMRLcorr. – 4,906.20178 kt CO_2 net removals without HWP instantaneous oxidation) and to FMRLcorr. – 5,384.16933 kt CO_2 net removals with the HWP
Denmark	For the accounting of emissions a FMRL is constructed specifying the expected average annual net emissions from the HWP pool for the second commitment period. Due to the data corrections it was decided to correct the original FMRL reported in 2011 (Johansen et al. 2011). This correction also entailed a change in the reference period used to project the inflow to the HWP pool – from 2005-2009 to 2008-2012 – in order to provide a more accurate reference level using the most recently collected data. Had the reference period not been changed, the FMRL would have significantly underestimated the inflow for 2013 and thus caused a significant gap between the reported net emissions and the projected net emissions by the FMRL. This means that the HWP pool would actually have been projected to decrease as op-posed to the expected increase in the pool during the second commitment period.
Finland	In the technical assessment report over Finland's FMRL submission, two issues were brought out expressing possible inconsistency between the projected FMRL and historical emissions and removals from FM, namely, the predicted increment of growing stock and amount of natural losses. Both remarks apply to the estimates produced by models. These issues were not yet processed for this submission. After the adoption of FMRL, further research to develop these models was started and it is expected that the results will resolve the possible problems. The results are planned to be implemented in the 2019 GHG inventory.
Greece	The changes that have occurred in relation to methodological elements, which are triggering a technical correction are: 1 The update of the Forest Management Plans database. The new data incorporated in the database have resulted in the recalculation of the whole time series for the 4.A.1 "Forest land remaining Forest land/managed" category which is equivalent to the Forest Management activity. 2 The area of forest land remaining forest land/managed that equals to Forest Management area has changed. 3 In the current submission, CO_2 and non-CO_2 emissions from dead wood and litter subject to wildfires in lands under 3.4 have been reported for the first time. 4 There has been a recalculation of the whole time series of emissions from wildfires. 5 The period 1990-2014 has been considered for the technical correction of the FMRL, while the FMRL value inscribed in the appendix of 2/CMP.7 is based on the average of emissions/removals of the period 1990-2009. 6 In the estimation of emissions/removals from Forest land remaining forest land, the updated emission and conversion factors from 2006 GL AFOLU and KP Supplement have been used. In addition, the new global warming potential values for CH_4 and N_2O from the 4th AR IPCC have been used. 7 In the current submission, both a FMRL assuming instantaneous oxidation and applying the FOD function for HWP is submitted. It should be noted that a forest management reference level applying first-order decay function for HWP was not included in the appendix of 2/CMP.7,
Hungary	A technical correction was necessary for the FMRL because there are several methodological changes that have been implemented in the estimation of emissions and removals from FM, including the HWP pool.
Ireland	Ireland has performed recalculations for the historic time series and 2013 and will apply a technical correction when accounting for the second commitment period. The requirement to apply a recalculation is based on conditions as outlined in the IPCC 2013 Revised Supplementary Methods and Good Practice Guidance Arising from the Kyoto Protocol (IPCC 2013 GPG KP-LULUCF): 1 Use of new models to derive the reported carbon stock (CSC) changes in the inventory 2013. 2 There have been a range of methodological changes for estimation CO_2, N_2O and CH_4 emissions from organic and mineral soils. 3 Ireland has obtained new historical data for several elements included in the construction of the FMRL
Latvia	The need for Technical Correction is determined by following reasons: 1.- The method used for GHG reporting changed after the adoption of FMRL as part of improving inventory quality and due to conversion of calculations from the IPCC GPG LULUCF 2003 to 2006 IPCC Guidelines and IPCC Wetlands Supplement. 2.- New non-CO_2 GHG sources are included in reporting for FM in the second commitment period. 3.- Recalculated historical data was done for the most important parameters. 4.- The accounting of HWP has been also improved since estimation of the FMRL which was submitted before Decision 2/CMP.7. Technical Correction was calculated based on a model re-calibration. A full re-run of the model will be carried in the future to allow Latvia to implement a complete Technical Correction.

Member State	Information on the need for TC
Luxembourg	The IPCC KP Supplements require a technical correction of the FMRL if methodological changes result in calculation of the time series, if new historical data become available or if pools are included in current reporting that have not been taken into account in the FMRL. Those conditions are fulfilled as the current FMRL does not use the methodological approach employed in Luxembourg and hence a technical correction of the FMRL was carried out.
Malta	Since the national greenhouse gas inventory submission of 2011, Malta has changed the methodology for estimating emissions and removals for the sector LULUCF. During those previous submissions the category 'Forestland remaining forestland' was taken to include coniferous forest, mixed forest and shrubland (maquis). Malta has now a national definition which states that a forest is defined as an area of minimum 1 hectare with a tree crown cover of more than 30% and minimum tree height of 5 meters. This has resulted in shrubland no longer being considered as part of the category 'Forestland', now being classified as part of the category 'Grassland'. In view of this, Malta is seeking a correction of the FMRL currently inscribed under the Kyoto Protocol. This methodological change leads to the sink value of -49Gg CO_2 equivalent as reported when using the previous methodology being reduced to a net removal for the category 'Forestland remaining forestland' of 0Gg CO_2 equivalent.
Portugal	All spreadsheets for estimating emissions and removals from KP LULUCF have been adapted so that they recalculate automatically the FMRL if and when the base information changes. Following the specifications of Decision 2/CMP.7, the assumptions used in FMRL construction are kept constant. All changes to the FMRL value are therefore due to changes in the base information (historical time series) or changes in methodologies in use, which then apply both to the historic time series and to reporting in the commitment period. Since the communication of the FMRL by Portugal in 2011, several changes have been introduced in the reporting by Portugal.
Sweden	Sweden has performed a technical correction for the forest management reference level due to the following reasons: - The historical dataset for Living biomass representing the period 2005-2009 has been updated using new inventory data from the NFI. - The historical dataset for Litter representing the period 2000-2009 has been updated using new inventory data from the soil inventory. - The historical dataset for Soil organic carbon representing the period 2000-2009 has been updated using new inventory data from the soil inventory. The method to calculate emissions/removals from the harvested products pool was slightly revised in Submission 2015. - New sources of greenhouse gases was amended in the reporting in Submission 2015. - The emission factor for drained organic forest soils and nitrogen fertilization was changed in Submission 2015. - Biomass burning now includes only emissions of N_2O and CH_4. - The GWPs for CH_4 and N_2O have been changed according to decision 4/CMP.7 and affects all estimates of emissions of CH_4 and N_2O.
UK	The UK has calculated a technical correction (TC) to the FMRL for the 2016 inventory. The FMRL submitted by the UK in 2011 was based on the 1990-2008 UK greenhouse gas inventory, since which, the following data and assumptions have changed that necessitate a technical correction: 1.- A switch in the model used from CFlow to CARBINE; 2.- Inclusion of pre-1921 forest area; 3.- Change in tree growth assumptions; 4.- Change in the assumptions about harvesting rates; 5.- Updated information on the rate of deforestation; 6.- Updated approach to estimating the incidence of emissions from wildfires;

11.5.2.4 Carbon equivalent Forest Conversion

This provision is not relevant for EU MS, nor for its MS, nor for Iceland.

11.5.3 Information related to the natural disturbances provision under article 3(4)

In accordance with decision 2/CMP.7; 19 MS and Iceland have stated their intention of excluding emissions resulting from natural disturbances that affect areas subject to FM during CP2, (Table 11.24). However, Malta has stated in its 2018 submission that no emissions from natural disturbance will be excluded. So far, emissions from natural disturbances have not been excluded from the accounting of FM activity.

Most detailed information on the approach used for the calculation of the background level and the margin, as well as, on other requirements for Parties that intend to apply this provision can be found in section 11.4.4 of this report. In addition, further and specifically related information to MS and Iceland can be found in individual GHG inventories.

Table 11.24 Synthesis of Information from MS and Iceland that intends to apply the natural disturbance provision under FM activities during CP2.

Member States	Approach used for developing the BL and the Margin	BL	Margin	Type of disturbance
		Kt CO_2 eq		
Austria	Default method	[0.147t CO_2eq/ha.]	[0.171 t CO_2eq/ha.]	All considered in the 2013 KP supplement
Belgium	Default method	3.540	7.800	Wildfires
Bulgaria	Default method	848.012	531.646	Wildfires, extreme weather events – windstorms, wet snowfall, ice, others
Cyprus	Default method	---	---	Wildfires, extreme weather events – windbreaks, snow breaks and ice breaks
Croatia	Default method	59.478	114.073	Wildfires
Estonia	Default method	181.731	112.544	Biotic or abiotic damages being the most critical Extreme weather events (storms)
Finland	Default method	532.000	314.000	Windstorms, insect attacks and wildfires
France	Default method	13588.000	1744.000	Wildfires, storm, droughts
Greece	Default method	82.078	144.937	Wildfires
Ireland	Default method	69.363	66.782	Wildfires
Italy	Default method	1689.239	1374.197	Wildfires
Luxembourg	Minimum level of historical time series	0.000	0.000	Extreme weather events
Netherlands	Default method	2.380	2.000	Wildfires and wind storms
Portugal	Default method	1080.880	1197.120	Wildfires
Romania	Default method	66.000	61.000	Wildfires and windfalls
Spain	Default method	4166.460	3033.170	All considered in the 2013 KP supplement
Sweden	Default method	14.120	3000.000	Wildfires, insect attacks and disease infestations, windstorms and geological disturbances
United Kingdom	Default method	270.000	112.000	Wildfires, insect attacks and disease infestations, windstorms and geological disturbances
Iceland	---	---	---	---

11.5.4 Information on Harvested Wood Products under Article 3(4)

All MS used the “Production approach” to estimate net emissions and removals from this carbon pool, in line with the 2013 KP Supplement. The default IPCC method (equation 2.8.3 of the 2013 KP Supplement) was mainly used to allocate the carbon stock changes to specific forest related activities under Article 3(3), and Article 3(4).

As regards with harvest from lands not included under forest management or under Article 3(3) activities, only 5 MS have reported quantitative information on CRF table 4(KP-I) C. All the other MS have explained that HWP are not originating from lands subject to any other activity than ARD, or FM.

11.5.5 Information relating to Cropland Management, Grazing Land Management and Revegetation, Wetland Drainage and Rewetting if elected, for the base year

For CP2, emissions and removals from CM are reported and accounted for by Denmark, Germany, Ireland, Italy, Portugal, Spain and UK. With the exception of Spain, these MS also elected to account for emissions and removals from the activity GM. Moreover, RV activity has been elected only by Romania and Iceland; whereas only United Kingdom will account for emissions and removals from the activity WDR. Nevertheless, United Kingdom has informed that they are not yet in the position of reporting emissions/removals from this activity, but a full reporting is expected, at the latest, by the end of the commitment period as a result of an ongoing research programme and efforts on methodological development.

Definitions implemented by the MS and Iceland are consistent with those contained in decision 16/CMP.1. Cropland and Grazing land management activities consist in the implementation of specific practices and operations, which differ substantially from country to country. CM is dedicated to agricultural crops, perennial and annual, woody and non-woody crops, including lands temporary under reserve or out of the productive cycle (fallow lands). GM is the system of practices consisting in manipulating site features and the amount of vegetation on lands for livestock production (include e.g. drainage of organic soils, vegetation improvement).

As regard of the activity RV, as stated in individual GHG inventories, Iceland includes the activity of increasing carbon stocks on eroding or eroded/desertified sites through the establishment of vegetation or the restoration of existing vegetation that covers a minimum area of 0.5 hectares and does not meet the definitions of afforestation or reforestation. It includes also, activities related to emissions of GHG and/or decreases in carbon stocks on sites which have been categorized as revegetation areas and do not meet the definition of deforestation. For Romania this activity corresponds with plantation of trees on non-forest lands and can be associated with forest belts.

The area under CM corresponds, in overall, to the area reported under Cropland minus the cropland area originated from forest conversion since 1990, while GM areas may likely not corresponding to Grassland since usually not the entire area of grassland within a country is managed for grazing.

Activity data for CM and GM in the base year, and all the years of the CP, are compiled from remotely sensed products, or NFIs grids, coupled with any available ancillary data. Agriculture census, national statistics, cadaster data, result-based payments information, and some European initiatives (e.g. LPIS) have also a significant role on data acquisition.

Concerning RV, Iceland use national registry to collect the area subject to this activity, while in Romania activity data is available either as number of planted trees or km of tree lines or ha as recorded in statistical reports.

11.6 Other information

11.6.1 Key category analysis for Article 3(3) activities and any elected Article 3(4) activity

MS apply mainly quantitative criteria for the assessment of key categories among KP-LULUCF activities (see Table 11.4), based on the correspondence between KP activities and land categories in the Convention. When elected, FM, CM and GM, as well as, ARD are key categories in most of the cases. Further information regarding KC analysis can be found in section 11.1.4.

11.6.2 Information related to Article 6

With the exception of Romania, all other MS do not report information on JI projects.

In the case of Romania, a JI AR project is being carried out, which lasted from 2012-2017. Estimates of GHG emissions and removals are calculated for the commitment period and reported as a separate division in CRF Table 4(KP-I) A1.1

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 2016 for the EU[74] registry is submitted together with this report (Annex 1.13). The data in the EU registry reflect only the transactions to and from the EU 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 EU registry

The standard electronic format tables for the EU 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 Union registry at 31.12.2017 as well as information on transfers of the units in 2017 to and from other Parties of the Kyoto Protocol.

The joint assigned amount of the EU, its Member States and Iceland for the second commitment period of the Kyoto Protocol is equal to the percentage inscribed for the Union, its Member States and Iceland in the third column of Annex B to the Kyoto Protocol as replaced by the Doha Amendment (80 %) of its base year emissions multiplied by eight. Council Decision (EU) 2015/1339 sets out the terms of the joint fulfilment agreement as well as the respective emission levels of each Party to that agreement. The Agreement between the EU, its Member States and Iceland, concerning Iceland's participation in the joint fulfilment of commitments by the EU, its Member States and Iceland for the second commitment period of the Kyoto Protocol sets out the terms governing Iceland's participation.[75] The emission levels define the Member States' and Iceland's assigned amounts for the second commitment period. These emission levels have been determined on the basis of the existing Union legislation for the period 2013-2020 under the 'Climate and Energy package'[76]. This assigned amount of the EU is determined in line with the terms of the joint fulfilment agreement, as described in the EU's initial report and was established upon the completion of the initial review. The joint assigned amount as established upon completion of the initial review is 37 604 433 280 t CO_2 eq; the EU assigned amount is 15 813 089 338 t CO_2 eq.

12.3 Summary of information reported in the CP2 SEF tables of the EU registry.

SEF tables for the EU registry are provided in Annex 1.13. Table 12.1 provides an overview of transactions included in Table 2(b) in the EU registry.

[74] The Community registry was replaced by the Union registry in 2012

[75] OJ L 207, 4.8.2015, p. 17

[76] Directive 2009/29/EC of the European Parliament and of the Council amending Directive 2003/87/EC so as to improve and extend the greenhouse gas emission allowance trading scheme of the Community and Decision No 406/2009/EC of the European Parliament and of the Council of 23 April 2009 on the effort of Member States to reduce their greenhouse gas emissions to meet the Community's greenhouse gas emission reduction commitments up to 2020, OJ L 140, 5.6. 2009.

Table 12.1 Transactions included in Table 2(b) in the EU registry.

		Additions						Subtractions					
	Total transfers and acquisitions	**AAUs**	**ERUs**	**RMUs**	**CERs**	**tCERs**	**lCERs**	**AAUs**	**ERUs**	**RMUs**	**CERs**	**tCERs**	**lCERs**
1	**AT**	NO	NO	NO	458,832	NO	NO	NO	NO	NO	11,139	NO	NO
2	**SE**	NO	NO	NO	1,638,914	NO	NO	NO	NO	NO	113,284	NO	NO
3	**DK**	NO	NO	NO	16,155	NO	NO	NO	NO	NO	1,092	NO	NO
4	**LI**	NO	NO	NO	NO	NO	NO	NO	NO	NO	14,775	NO	NO
5	**DE**	NO	NO	NO	953,892	NO	NO	NO	NO	NO	554,336	NO	NO
6	**GB**	NO	NO	NO	4,014,277	NO	NO	NO	NO	NO	683,071	NO	NO
7	**NO**	NO	NO	NO	12,166	NO	NO	NO	NO	NO	94,570	NO	NO
8	**ES**	NO	NO	NO	241,452	NO	NO	NO	NO	NO	104,878	NO	NO
9	**AU**	NO	NO	NO	943,312	NO	NO	NO	NO	NO	5,070,826	NO	NO
10	**HU**	NO	NO	NO	9,647	NO	NO	NO	NO	NO	9,647	NO	NO
11	**PT**	NO	NO	NO	167	NO	NO	NO	NO	NO	NO	NO	NO
12	**CH**	NO	NO	NO	10,435,307	NO	NO	NO	NO	NO	7,382,252	NO	NO
13	**BE**	NO	NO	NO	217,165	NO	NO	NO	NO	NO	NO	NO	NO
14	**IE**	NO	NO	NO	115,965	NO	NO	NO	NO	NO	115,965	NO	NO
15	**LU**	NO	NO	NO	314,417	NO	NO	NO	NO	NO	314,417	NO	NO
16	**NL**	NO	NO	NO	17,607,672	NO	NO	NO	NO	NO	408,076	NO	NO
17	**CDM**	NO	NO	NO	4,991	NO	NO	NO	NO	NO	NO	NO	NO
18	**FR**	NO	NO	NO	NO	NO	NO	NO	NO	NO	127,000	NO	NO
19	**IT**	NO	NO	NO	323,106	NO	NO	NO	NO	NO	NO	NO	NO
20	**FI**	NO	NO	NO	346,506	NO	NO	NO	NO	NO	81,549	NO	NO
21	**Subtotal**	NO	NO	NO	37,653,943	NO	NO	NO	NO	NO	15,086,877	NO	NO

12.4 Discrepancies and notifications

With respect to the respective paragraphs of decision 15/CMP.1 the following information is provided for the EU registry:

- **Paragraph 12:** No discrepancies identified by the transaction log.
- **Paragraph 13**: No notifications directed to the Party to replace lCERs 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: https://ets-registry.webgate.ec.europa.eu/euregistry/EU/public/reports/publicReports.xhtml

Article 6 project information

No ERUs have been issued in the EU Registry in 2013

No ERUs have been issued in the EU Registry in 2014

No ERUs have been issued in the EU Registry in 2015

No ERUs have been issued in the EU Registry in 2016

No ERUs have been issued in the EU Registry in 2017

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 AAUs have been issued in the EU Registry in 2013

No AAUs have been issued in the EU Registry in 2014

No AAUs have been issued in the EU Registry in 2015

No AAUs have been issued in the EU Registry in 2016

No AAUs have been issued in the EU Registry in 2017

The total quantity of ERUs issued on the basis of Article 6 projects

No ERUs have been issued in the EU Registry in 2013

No ERUs have been issued in the EU Registry in 2014

No ERUs have been issued in the EU Registry in 2015

No ERUs have been issued in the EU Registry in 2016

No ERUs have been issued in the EU Registry in 2017

The total quantity of ERUs, CERs, AAUs and RMUs acquired from other registries.

YEAR	Registry	AAU	ERU	RMU	CER
2013	GB	0	0	0	29.448
2013	CH	0	0	0	172.337
2014	AT	0	0	0	1
2014	FR	0	0	0	165.465
2014	DK	0	0	0	3.142

2014	DE	0	0	0	39.320
2014	SE	0	0	0	122.180
2014	GB	0	0	0	2.256.786
2014	AU	0	0	0	120.870
2014	NO	0	0	0	167.074
2014	CH	0	0	0	1.790.323
2014	NL	0	0	0	575.673
2014	IT	0	0	0	168.671
2014	ES	0	0	0	60.966
2014	CDM	0	0	0	14.921
2015	CDM	0	0	0	136.554
2015	FR	0	0	0	1.071.564
2015	SE	0	0	0	2.091.044
2015	DK	0	0	0	45.156
2015	NO	0	0	0	753.110
2015	DE	0	0	0	5.336.978
2015	GB	0	0	0	12.377.526
2015	NL	0	0	0	9.557.045
2015	AU	0	0	0	1.799.631
2015	ES	0	0	0	997.749
2015	BE	0	0	0	130.368
2015	CH	0	0	0	9.203.722
2015	PT	0	0	0	935.000
2015	IT	0	0	0	1.836.849
2015	FI	0	0	0	52.378
2016	AT	0	0	0	75.396
2016	AU	0	0	0	386.987
2016	BE	0	0	0	239.290
2016	CDM	0	0	0	6.620
2016	CH	0	0	0	6.066.604
2016	DE	0	0	0	1.402.960
2016	DK	0	0	0	634.856
2016	ES	0	0	0	229.375
2016	FI	0	0	0	294.692
2016	FR	0	0	0	1.314.645
2016	GB	0	0	0	13.163.692
2016	IT	0	0	0	154.464
2016	NL	0	0	0	9.551.267
2016	NO	0	0	0	11.392
2016	PT	0	0	0	3.403.623
2016	SE	0	0	0	5.101.906
2017	AT	0	0	0	458.832
2017	SE	0	0	0	1.638.914
2017	DK	0	0	0	16.155

2017	DE	0	0	0	953.892
2017	GB	0	0	0	4.014.277
2017	NO	0	0	0	12.166
2017	ES	0	0	0	241.452
2017	AU	0	0	0	943.312
2017	HU	0	0	0	9.647
2017	PT	0	0	0	167
2017	CH	0	0	0	10.435.307
2017	BE	0	0	0	217.165
2017	IE	0	0	0	115.965
2017	LU	0	0	0	314.417
2017	NL	0	0	0	17.607.672
2017	CDM	0	0	0	4.991
2017	IT	0	0	0	323.106
2017	FI	0	0	0	346.506

The total quantity of RMUs issued on the basis of each activity under Article 3, paragraphs 3 and 4

No RMUs have been issued in the Union registry in 2013

No RMUs have been issued in the Union registry in 2014

No RMUs have been issued in the Union registry in 2015

No RMUs have been issued in the Union registry in 2016

No RMUs have been issued in the Union registry in 2017

The total quantity of ERUs, CERs, AAUs and RMUs transferred to other registries.

YEAR	Registry	AAU	ERU	RMU	CER
2014	GB	0	0	0	135.000
2014	CH	0	0	0	1.397.541
2015	FR	0	0	0	106.092
2015	SE	0	0	0	12.246
2015	DK	0	0	0	548.202
2015	NO	0	0	0	40.385
2015	DE	0	0	0	514.092
2015	GB	0	0	0	675.749
2015	NL	0	0	0	261.062
2015	AU	0	0	0	1.394.059
2015	ES	0	0	0	1.350
2015	BE	0	0	0	5.465
2015	CH	0	0	0	5.696.488

2015	IT	0	0	0	1
2015	FI	0	0	0	31.924
2016	AT	0	0	0	37.698
2016	AU	0	0	0	3.573.312
2016	BE	0	0	0	7.554
2016	CH	0	0	0	9.703.077
2016	DE	0	0	0	218.209
2016	ES	0	0	0	20.000
2016	FR	0	0	0	300
2016	GB	0	0	0	2.061.256
2016	NL	0	0	0	648.580
2016	NO	0	0	0	49.879
2016	PT	0	0	0	510
2016	SE	0	0	0	3.992
2017	AT	0	0	0	11.139
2017	SE	0	0	0	113.284
2017	DK	0	0	0	1.092
2017	LI	0	0	0	14.775
2017	DE	0	0	0	554.336
2017	GB	0	0	0	683.071
2017	NO	0	0	0	94.570
2017	ES	0	0	0	104.878
2017	AU	0	0	0	5.070.826
2017	HU	0	0	0	9.647
2017	CH	0	0	0	7.382.252
2017	IE	0	0	0	115.965
2017	LU	0	0	0	314.417
2017	NL	0	0	0	408.076
2017	FR	0	0	0	127.000
2017	FI	0	0	0	81.549

No ERUs, CERS, AAUs or RMUs were transferred to other registries in 2013.

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
2015	0	0	0	0
2016	0	0	0	0
2017	0	0	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
2013	0	0	0	0
2014	0	0	0	0
2015	0	0	0	0
2016	0	0	0	0
2017	0	0	0	0

The total quantity of other ERUs, CERs, AAUs and RMUs cancelled

YEAR	AAU	ERU	RMU	CER
2013	0	0	0	0
2014	0	0	0	1.892
2015	0	0	0	487.961
2016	0	0	0	877.355
2017	0	0	0	3.433.767

The total quantity of ERUs, CERs, AAUs and RMUs retired

YEAR	AAU	ERU	RMU	CER
2013	0	0	0	0
2014	0	0	0	0
2015	0	0	0	0
2016	0	0	0	0
2017	0	0	0	0

12.6 Calculation of commitment period reserve (CPR)

For the purposes of the joint fulfilment, the commitment period reserve applies to the EU, its Member States and Iceland individually. The EU commitment period reserve, established upon the completion of the initial review, is 14 231 780 406 t CO_2 eq.

12.7 KP-LULUCF accounting

Each EU Member State and Iceland apply Article 3(3) and (4) of the Kyoto Protocol and decisions agreed thereunder individually. Member States account individually for emissions by sources and removals by sinks from Kyoto LULUCF activities and individually decide on accounting modalities and elections where foreseen under the Kyoto Protocol. Any issuance of removal units (RMUs) or cancellation of units resulting from the accounting under Articles 3(3) and (4) would be made to the Member States’ and Iceland’s Kyoto registries. 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

The European Union already had a quantified emission limitation and reduction target in the first commitment period and provided a description of its national system in the report to calculate the assigned amount of the first commitment period. Subsequently, any changes that occurred to the EU national system were reported as part of the annual supplementary information under Article 7 of the Kyoto Protocol and included in the national inventory report.

There are no changes compared to the 2017 inventory submission related to the national system.

As mentioned inthe 2017 inventory submission of the EU under the Kyoto Protocol, that the Kyoto greenhouse inventory for the second commitment period follows the terms of the joint fulfilment agreement for the second commitment period which includes 28 Member States[77] and Iceland.

The institutions which were part of the EU inventory system and responsible for the EU inventory preparation during the first commitment period remain the same at the start of the second commitment period. The Directorate General Climate Action of the European Commission has overall responsibility for 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 Directorates General of the European Commission: Eurostat, and the Joint Research Centre (JRC) .

[77] Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, United Kingdom

14 INFORMATION ON CHANGES IN NATIONAL REGISTRY

The following changes to the national registry of EU have therefore occurred in 2017. Note that the 2017 SIAR confirms that previous recommendations have been implemented and included in the annual report.

Reporting Item	Description
15/CMP.1 annex II.E paragraph 32.(a) Change of name or contact	None
15/CMP.1 annex II.E paragraph 32.(b) Change regarding cooperation arrangement	No change of cooperation arrangement occurred during the reported period.
15/CMP.1 annex II.E paragraph 32.(c) Change to database structure or the capacity of national registry	The version of the EUCR released after 8.0.7 (the production version at the time of the last Chapter 14 submission) introduced minor changes in the structure of the database. These changes were limited and only affected EU ETS functionality. No change was required to the database and application backup plan or to the disaster recovery plan. The database model is provided in Annex A. No change to the capacity of the national registry occurred during the reported period.
15/CMP.1 annex II.E paragraph 32.(d) Change regarding conformance to technical standards	Changes introduced since version 8.0.7 of the national registry are listed in Annex B. Each release of the registry is subject to both regression testing and tests related to new functionality. These tests also include thorough testing against the DES and were successfully carried out prior to the relevant major release of the version to Production (see Annex B). No other change in the registry's conformance to the technical standards occurred for the reported period.
15/CMP.1 annex II.E paragraph 32.(e) Change to discrepancies procedures	No change of discrepancies procedures occurred during the reported period.
15/CMP.1 annex II.E paragraph 32.(f) Change regarding security	No changes regarding security occurred during the reported period.
15/CMP.1 annex II.E paragraph 32.(g) Change to list of publicly available information	No change to the list of publicly available information occurred during the reported period.
15/CMP.1 annex II.E paragraph 32.(h) Change of Internet address	No change of the registry internet address occurred during the reported period.
15/CMP.1 annex II.E paragraph 32.(i) Change regarding data integrity measures	No change of data integrity measures occurred during the reported period.
15/CMP.1 annex II.E paragraph 32.(j) Change regarding test results	Changes introduced since version 8.0.7 of the national registry are listed in Annex B. Both regression testing and tests on the new functionality were successfully carried out prior to release of the version to Production. The site acceptance test was carried out by quality assurance consultants on behalf of and assisted by the European Commission.

15 INFORMATION ON MINIMIZING 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, text from the last year's inventory report was included and additional and new information is 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.

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 in 2009, called "Impact Assessment Guidelines"(European Commission 2009a). The Impact Assessment guidelines were revised in May 2015, since then called "Better Regulation Guidelines" (European Commission 2015a).

Assessing systematically the likely effects of different policy initiatives on developing countries is a requirement based on Article 208(1) TFEU (Treaty on the Functioning of the European Union), which stipulates that the EU “shall take account of the objectives of development co-operation in the policies that it implements which are likely to affect developing countries”. This constitutes the legal basis of a concept generally known as “Policy Coherence for Development” (PCD). Practically, the application of the PCD principle means recognizing that some EU policy measures can have a significant impact outside of the EU which may contribute to or undermine the Union's policy objectives concerning development. Through PCD, the EU seeks to take account of development objectives in all of its policies that are likely to affect developing countries, by minimising contradictions and building synergies between different EU policies to benefit developing countries and by increasing the effectiveness of development cooperation. Measures regarding climate change mitigation and affecting adaptation needs in developing countries have been identified as “measures known to have impacts on developing countris”. The assessment of impacts on developing countries includes economic, social and environmental impacts.

Related to economic impacts the following guiding questions have to be assessed (European Commission 2015a, Better Regulation “Toolbox”, p. 221ff):

- Who are the developing countries’ producing (and exporting to the EU) the goods/services affected? Are these least developed countries?
- What is the impact on proportion (esp. in value) of the trade between these developing countries and the EU, in particular regarding the trade balance of developing countries?
- What is the likely impact on price volatility?
- What are the impacts on proportion between the purchase of raw materials and finished products from developing countries?
- What is the impact on the competiveness of exporters in developing countries in terms of intended or unintended trade barriers?
- What are the impacts on the initiative on intellectual property rights, standards, and technology and business skills in developing countries and on their capacity to trade their goods (towards the EU or between themselves)?
- What is the impact on food security for local population (e.g. by impacting on price of commodities or food on world and regional/local markets or by limiting access to land, water or other assets)?
- What is the impact on different population groups (urban vs. rural, small vs. large scale farmers)?
- What are the impacts on international and domestic investment flows (outflows and inflows including FDI) in the developing countries?
- What are the impacts on the private sector in developing countries (including competitiveness, access to finance, access to market)?

Related to social impacts the following guiding questions have to be assessed:

- What are the impacts on labour market (e.g. creation of job or decrease in employment level, impacts on different groups of workforce – low-skilled vs. high skilled workforce, wages level, working conditions)?
- What are the impacts on main stakeholders and institutions affected by the proposal?
- What is the impact on poverty levels and inequality in developing countries?
- What are the impacts on gender equality and on the most vulnerable groups of society?
- What is the impact on human rights in the development countries?
- What is the impact on migration in developing countries (rural-urban or international)?
- What is the impact on food security for the local population (e.g. by impacting on price of commodities or food on world and regional/local markets or by limiting access to land, water or other assets)?

- What is the impact on different population groups (urban vs. rural, small vs. large scale farmers)?

Related to environmental impacts the following guiding questions have to be assessed:

- How does it impact ecosystem approach?
- What is the impact on emission targets in developing countries?
- What is the impact on chemicals authorisation as well as on use and waste management?
- What is the impact on green economy development, both globally and in partner countries?
- What is the impact on the low carbon technology transfer and its availability in developing countries?
- What is the impact on the biodiversity (mono-cropping, deforestation) and global or local food security?
- What is the impact on the management and use of natural resources, e.g. minerals, timber, water, land, etc.?
- Are these options consistent with our support (under development cooperation policy) to responsible approaches to natural resources management such as FLEGT[78], EITI[79] or Kimberley agreement[80]?

Depending on the case, a comprehensive literature review is conducted, while in some cases a detailed, substantial and quantified analysis including detailed quantitative data to establish the causal link betwee the policy option and its impacts. A range of analytical approaches can be used for this purpose, such as econometric analysis or computable general equilibrium (CGE) models

Consulting interested parties is an obligation for every impact assessment and all affected stakeholders should be engaged. Each consultation includes a 12-week internet-based public consultation and can be complemented by other approachs and tools. 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 **Third** Biennial Report 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/transparency/regdoc/?fuseaction=ia&year=2018&serviceId=10269&s=Suche&error=noresult&CFID=16972558&CFTOKEN=7ce03bad2962e268-DBC06E67-04FA-143C-58603848AD05CA33 **since 2017 and** http://ec.europa.eu/smart-regulation/impact/ia_carried_out/cia_2016_en.htm#clima **for years before)**). 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 in the UNFCCC reporting guidelines for GHG inventories does not include an obligation to report on each specific mitigation policy, the EU chooses the approach to provide some specific examples for a more complete overview on the ways how the EU is striving to minimize adverse impacts.

[78] The Action Plan on Forest Law Enforcement, Governance and Trade (FLEGT) is the European Union response to illegal logging that was adopted in 2003. http://ec.europa.eu/environment/forests/illegal_logging.htm

[79] The Extractive Industries Transparency Initiative is a global coalition of governments, companies and civil society working together to improve openness and accountable management of revenues from natural resources. https://eiti.org/eiti.

[80] The Kimberley Process (KP) is a joint government, industry and civil society initiative to stem the flow of conflict diamonds – rough diamonds used by rebel movements to finance wars against legitimate governments. http://www.kimberleyprocess.com/

Major EU policies such as the Directive on the promotion of the use of renewable energy (Directive 2009/28/EC, in particular its relation to biomass and biofuels, are presented in more detail as examples in this chapter, because the related impact assessments identified potential impacts on third countries.

Directive on the promotion of the use of renewable energy - Promotion of biomass and biofuels

The Directive on renewable energy (Directive 2009/28/EC) set 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 liquid biofuels, biogas, hydrogen and electricity from renewables. 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. To address the risk of potentially negative 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 include:

- 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.

On 30 November 2016, the Commission published a proposal for a revised Renewable Energy Directive to ensure that the target of at least 27% renewables in the final energy consumption in the EU by 2030 is met (European Commission 2017b). The revised Renewable Energy Directive strengthens the existing EU criteria for bioenergy sustainability and extends them to cover also biomass and biogas for heat and power. More specifically, the Directive includes the following new requirements (European Commission 2016):

- The sustainability criteria for biofuels are improved, including by requiring that (new) advanced biofuels emit at least 70% fewer GHG emissions than fossil fuels.
- A new sustainability criterion on forest biomass in introduced, in order to ensure that the production of woodfuel continues to be sustainable and that any LULUCF emissions are accounted for (in the country of biomass production).
- The EU sustainability criteria are extended to cover solid biomass and biogas used in large heat and power plants (above 20 MW fuel capacity).This means, for instance, that electricity and heat from biomass have to produce at least 80% fewer GHG emission compared to fossil fuels by 2021and 85% less by 2026.

A Directive amending the current legislation on biofuels through the Renewable Energy and the Fuel Quality Directives was adopted in 2015 (Directive (Eu) 2015/1513) with the objectives:

- To increase the minimum greenhouse gas saving threshold for new installations to 60% in order to improve the efficiency of biofuel production processes as well as discouraging further investments in installations with low greenhouse gas performance.
- To include indirect land use change (ILUC) factors in the reporting by fuel suppliers and Member States of greenhouse gas savings of biofuels and bioliquids;

- To limit the amount of food crop-based biofuels and bioliquids that can be counted towards the EU's 10% target for renewable energy in the transport sector by 2020, to the current consumption level, 5% up to 2020, while keeping the overall renewable energy and carbon intensity reduction targets;
- To provide additional market incentives to the eixsing ones for biofuels with no or low indirect land use change emissions, and in particular the 2nd and 3rd generation biofuels produced from feedstock that do not create an additional demand for land, including algae, straw, and various types of waste, as they will contribute more towards the 10% renewable energy in transport target of the Renewable Energy Directive.

With these measures, the Commission wants to promote stronger biofuels that help achieving substantial emission cuts, do not directly compete with food and are more sustainable at the same time. While the directive does not affect the possibility for Member States to provide financial incentives for biofuels, the Commission considers that in the period after 2020 biofuels should only receive financial support if they lead to substantial greenhouse gas savings and are not produced from crops used for food and feed. The Impact Assessment of the Directive analysed social, economic and environmental impacts on third countries in detail[81]. The Directive also ensures that the Commission reports 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.

On 1 February 2017, the European Commission published its regular Renewable Energy Progress Report (European Commission 2017a) under the framework of the 2009 Renewable Energy Directive. The report includes information on the assessment of sustainability of EU biofuels. The 2017 report and its accompanying staff working document (European Commission 2017b) report that the net savings in greenhouse gas emissions resulting from the use of renewable energy in transport of around 35 Mt CO_2-equivalent in 2014. Indirect Land Use Change (ILUC) emissions associated to biofuels consumed in the EU are estimated to be 23 Mt CO_2-equivalent, leaving a net saving of 12 Mt CO_2-equivalent. Recent modelling work of the ILUC impacts of individual biofuel feedstock confirms that ILUC emissions can be much higher for biofuels produced from vegetable oils compared to biofuels produced from starch or sugar. Advanced biofuels from non-food crops have generally very low or no ILUC emissions. In 2014, around 10% of bioethanol and around 26% of biodiesel consumed in the EU was imported.

The main exporting countries for biodiesel were Malaysia (palm oil), Brazil and the US (Soybean) and for bioethanol Guatemala, Bolivia, Pakistan, Russia, Peru, Ukraine, Canada and Moldova.

Projections for 2020 foresee that the EU biofuel policy could lead to an expansion of 1.8 Mha of cropland in the EU and to 0.6 Mha in the rest of the world, with 0.1 Mha at the expense of forest. Expansion of cropland at global level would occu at the expense of grassland (-1.1 Mha), abandoned land (-0.9 Mha) and other natural vegetation (-0.4 Mha). No significant negative effects from the production of biofuels and bioliquids on biodiversity, water resources, water quality and soil quality were found in the EU. However, indirect land use change can cause biodiversity losses if additional land expansion takes place in sensitive areas, such as forests and highly biodiverse grassland. The EU ethanol consumption had negligible impact on cereal prices given that the EU share in the global ethanol market did not exceed 7%, and the global cereal market is driven mainly by demand for feed. In the future, the strongest biofuel consumption growth is expected in developing countries, while the increased demand for food and feed for a growing and more affluent population is projected to be mostly met through productivity gains, with yield improvements expected to account for about 80% of the increase in crop output. Regarding land use right, the most recent reports on large-scale land deals confirm the finding of the 2015 Commission progress report on renewable energy that only very small share of biofuel projects outside the EU have been developed with the EU market in mind.

The Communication from the Commission on voluntary schemes and default values in the EU biofuels and bioliquids sustainability scheme (2010/C 160/01)[82] sets up a system for certifying sustainable

[81] http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52014SC0296&from=EN

[82] OJ C160, 19.6.2010, p.1

biofuels, including those imported into the EU. It lays down rules that such schemes must adhere 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 are implemented.

The European Commission has so far (April 201**8**) recognised 1**6** voluntary schemes: International Sustainability and Carbon Certification (ISCC), Bonsucro EU, Round Table on Responsible Soy (RTRS EU RED), Roundtable of Sustainable Biofuels (RSB EU RED), Biomass Biofuels voluntary scheme (2BSvs), Red Tractor Farm Assurance Combinable Crops & Sugar Beet Scheme, SQC (Scottish Quality Farm Assured Combinable Crops (SQC) scheme), Red Cert, NTA 8080, RSPO RED (Roundtable on Sustainable Palm Oil RED), NTA 8080, Roundtable on Sustainable Palm Oil RED (RSPO RED), Biograce GHG calculation tool, HVO Renewable Diesel Scheme for Verification of Compliance with the RED sustainability criteria for biofuels, Gafta Trade Assurance Scheme, KZR INIG System, Trade Assurance Scheme for Combinable Crops **and Universal Feed Assurance Scheme**[83].

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.

In April 2013 the EU temporarily suspended enforcement of the EU ETS requirements for flights operated from or to non-European countries, while continuing to apply the legislation to flights within and between countries in Europe. The EU took this initiative to allow time for the International Civil Aviation Organization (ICAO) Assembly in autumn 2013 to reach a global agreement to tackle aviation emissions – something Europe has been seeking for more than 15 years. In October 2013 the EU's hard work paid off when the ICAO Assembly agreed to develop by 2016 a global market-based mechanism (MBM) addressing international aviation emissions and apply it by 2020. Until then countries or groups of countries, such as the EU, can implement interim measures.

In response to the ICAO outcome and to give further momentum to the global discussions, the European Commission has proposed amending the EU ETS[84] so that only the part of a flight that takes place in European regional airspace is covered by the EU ETS. In April 2014 the "Regulation (EU) No 421/2014 of the European Parliament and the Council of 16 April 2014 amending the Directive 2003/87/EC establishing a scheme for greenhouse gas emission allowance trading within the Community, in view of the implementation by 2020 of an international agreement applying a single global market-based measure to international aviation emissions" entered into force.

The regulation limit**s** the aviation coverage of EU ETS to emissions from flights within the European Economic Area (EEA) for the period from 2013 to 2016. This applies to all (also third country) aircraft operators. All options are left open for the EU to react to the developments of the ICAO Assembly in 2016 and to re-adjust the scope of the EU ETS from 2017 onwards. The regulation also includes exemptions for small emitters.

In October 2016, the ICAO agreed on a Resolution for a global market-based measure to address CO_2 emissions from international aviation as of 2021. The agreed Resolution sets out the objective and key design elements of the global scheme, as well as a roadmap for the completion of the work on implementing modalities. The Carbon Offsetting and Reduction Scheme for International Aviation, or CORSIA, aims to stabilise CO_2 emissions at 2020 levels by requiring airlines to offset the growth of

[83] https://ec.europa.eu/energy/en/topics/renewable-energy/biofuels/voluntary-schemes

[84] See Proposal for a Directive of the European Parliament and of the Council amending Directive 2003/87/EC establishing a scheme for greenhouse gas emission allowance trading within the Community, in view of the implementation by 2020 of an international agreement applying a single global market-based measure to international aviation emissions, http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52013PC0722

their emissions after 2020. In light of the progress on the global measure under ICAO, the European Commission has proposed to continue the current approach beyond 2016. This proposal will now be considered by the European Parliament and the Council of the European Union.

A roadmap for moving to a competitive low carbon economy in 2050

In 2011 the Commission released the Communication "A Roadmap for moving to a competitive low carbon economy in 2050" (COM(2011) 112 final) outlining a strategy to meet the long-term target of reducing domestic emissions by 80 to 95% by 2050 as agreed by European Heads of State and governments. The Roadmap shows how the sectors responsible for Europe's emissions - power generation, industry, transport, buildings and construction, as well as agriculture - can make the transition to a low-carbon economy over the coming decades. The transition towards a competitive low-carbon economy means that the EU should prepare for reductions in its domestic emissions by 80% by 2050 compared to 1990, with cost effective reduction milestones of 40% by 2030 and 60% in 2040.

The shift to a resource-efficient and low-carbon economy should be supported by using all resources, decoupling economic growth from resource and energy use, reducing CO_2 emissions, enhancing competitiveness and promoting greater energy security. A low-carbon economy will mean a much greater use of renewable sources of energy, energy-efficient building materials, hybrid and electric cars, 'smart grid' equipment, low-carbon power generation and carbon capture and storage technologies.

Because more locally produced energy would be used in a low-carbon economy, mostly from renewable sources, the EU would be less dependent on imports of oil and gas from outside the EU. On average, the EU could save € 175 - 320 billion annually on fuel costs over the next forty years.

With the shift from fuel expenses (operating costs) to investment expenditure (capital expenditure) in clean technology and clean energy, investment costs will occur in the domestic economy, requiring increased added value and output from a wide range of manufacturing industries (automotive, power generation, industrial and grid equipment, energy–efficient building materials, construction sector etc.), while fuel expenses for fossil fuel imports which are to a large extent flowing to third countries would be reduced.

Communication on a policy framework for climate and energy in the period from 2020 to 2030

In 2016, the European Commission published the legislative proposals to implement the 2030 climate and energy framework which sets three key targets for the year 2030:

- At least 40% cuts in greenhouse gas emissions by 2030 (from 1990 levels)
- At least 27% share for renewable energy
- At least 27% improvement in energy efficiency

To achieve the at least 40% target the EU emissions trading system (ETS) sectors would have to cut emissions by 43% (compared to 2005) – to this end, the ETS is to be reformed and strengthened. The non-ETS sectors would need to cut emissions by 30% (compared to 2005) – this needs to be translated into individual binding targets for Member States. IWhile binding at the EU level, there would not be binding renewable targets for Member States individually but the objective would be fulfilled through clear commitments decided by the Member States themselves which should be guided by the need to deliver collectively the EU-level target and build upon what each Member State should deliver in relation to their current targets for 2020. While not foreseeing national-level energy targets, the 2030 framework proposes a new governance framework based on national plans for competitive, secure and sustainable energy.

An impact assessment (IA) was conducted for this communication (European Commission 2014b), which gives significant detail on costs and savings achieved on the basis of the proposed policy under different scenarios. All scenarios demonstrate reduced GHG emissions compared to the Reference scenario. All scenarios show reduced energy consumption (both primary and final) compared to the Reference scenario, with more pronounced energy savings and improved energy intensity in scenarios with strong energy efficiency policies, with highest improvements in those scenarios that next to ambitious energy efficiency policies also include a renewables target. Future fuel consumption in the EU will have economic impacts on fuel prices as well as trade effects for fuel exporting countries, therefore the impacts on future fuel use are summarized: With regard to fuel use, the IA analysed that solid fuel consumption declines substantially under all scenarios until 2030. Also oil consumption decreases in all scenarios, but much faster in those with policies that promote transport electrification. Natural gas absolute consumption also declines in all scenarios (in general less harply than oil) but slightly more under the scenarios that include renewable targets. By 2050 in all scenarios natural gas becomes the main fossil fuel. Net energy imports decrease significantly for all scenarios already in 2030 between 4% to 22% below 2010 levels in 2030 and by about 50% in most scenarios in 2050.[85]

The EU Emissions Trading System (ETS) will remain an important instrument to bring about the transition to a low carbon economy. A market stability reserve (MSR) will be established from 2018 onwards – the placing of allowances in the reserve shall operate from 1 January 2019 – which provides an automatic adjustment of the supply of auctioned allowances based on a pre-defined set of rules with the aim to avoid large supply/demand imbalances in the ETS.

As another step in delivering on the EU's target to reduce greenhouse gas emissions by at least 40% domestically by 2030 (with the sectors covered by the ETS having to reduce their emissions by 43% compared to 2005) in line with the 2030 climate and energy policy framework the European Commission **is the reform of the EU emissions trading system (ETS) for the period after 2020 which was approved by the Council on 27 February 2018. The emissions trading system is reformed by introducing the following elements:**

- **The cap on the total volume of emissions will be reduced annually by 2.2% (linear reduction factor).**
- **The number of allowances to be placed in the market stability reserve will be doubled temporarily until the end of 2023.**
- **A new mechanism to limit the validity of allowances in the market stability reserve above a certain level will become operational in 2023.**

Regulation for energy efficiency labelling

In July 201**7** a Regulation setting a framework for energy efficiency labelling and repealing Directive 2010/30/EU **was adopted**[86]. This review of the Energy Labelling Directive aims at further exploiting the potential of energy efficiency especially with regard to the EU target of improving energy efficiency by 27% by 2030 compared to 2005. Consequently, it will lead to a moderation of energy demand and a reduction of the energy dependency of the European Union. The proposal follows up on the Energy Union Framework Strategy and intends to replace Directive 2010/30/EU on the indication by labelling and standard product information of the consumption of energy and other resources by energy-related products. This proposal is made now following the evaluation of the Directive. Product specific

[85] For a more detailed analysis and explanation on the scenarios, see the Impact Assessment Accompanying the document Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions A policy framework for climate and energy in the period from 2020 up to 2030, available: http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52014SC0015

[86] http://ec.europa.eu/smart-regulation/impact/ia_carried_out/docs/ia_2015/com_2015_0341_en.pdf

regulations made under the Directive remain in force but will be reviewed. By common energy labelling within the EU customers can obtain accurate, relevant and comparable information on the energy efficiency and consumption of energy-related products wherever they are in the Union.

The Commission carried out an ex-post evaluation of the Energy Labelling Directive and specific aspects of the Ecodesign Directive, furthermore it carried out an impact assessment accompanying the proposal[87]. The final option chosen was to improve the existing regulatory framework on energy labelling, to require labelled products to be registered in a new database, improve the legal structure by changing the current Energy Labelling Directive to a Regulation, to align it with the market surveillance regulation, and to fund EU joint market surveillance actions.

Third countries are affected, because the A-G energy labelling scheme has been followed as a model in many different countries around the world and some countries have also implemented EU ecodesign regulations[88]. They are also affected through the Agreement on Technical Barriers to Trade which is to ensure that regulations, standards, testing and certification procedures do not create unnecessary obstacles, while also providing the right to implement measures to achieve legitimate policy objectives.

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

[87] http://ec.europa.eu/smart-regulation/impact/ia_carried_out/docs/ia_2015/swd_2015_0139_en.pdf

[88] http://www.ecofys.com/files/files/ec-2014-impacts-ecodesign-energy-labelling-on-third-jurisdictions.pdf

important instrument to advance the objectives of the Convention, e.g. the use of renewable energies. A progressive reduction of all fiscal 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. Therefore 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”[89] have been established. The Guidelines foresee in particular the possibility to authorise State aid for particular environmental purposes, such as for renewable energy sources or energy saving. The European Commission published on 9 April 2014 the “Guidelines on State aid for environmental protection and energy 2014-2020” The Guidelines set out the conditions under which state aid measures for environmental protection or energy objectives may be declared compatible with the internal market. This proposal includes a list of environmental and energy measures for which state aid under certain conditions may be compatible with the EU Treaty, covering the following areas:

- Aid to energy from renewable sources
- Energy efficiency measures, including cogeneration and district heating and district cooling
- Aid for resource efficiency and in particular aid to waste management
- Aid to Carbon Capture and Storage (CCS)
- Aid in the form of reductions in or exemptions from environmental taxes and in the form of reductions in funding support for electricity from renewable sources
- Aid to energy infrastructure
- Aid for generation adequacy
- Aid in the form of tradable permit schemes
- Aid for the relocation of undertakings

In June 2012, the Commission adopted Guidelines on certain State aid measures in the context of the EU Emissions Trading System (EU ETS). The Guidelines provide a framework under which Member States may compensate some electro-intensive industries, such as steel and aluminium producers, for part of the higher electricity costs expected to result from the application of the harmonised allocation rules to be applied in the EU ETS as from 2013. The rules, subject to state aid scrutiny, ensure that national support measures are designed in a way that preserves the EU objective of decarbonising the European economy and maintains a level playing field among competitors in the internal market. The sectors deemed eligible for compensation include producers of aluminium, copper, fertilisers, steel, paper, cotton, chemicals and some plastics. The Guidelines give a right, not an obligation, to provide subsidies to energy intensive industries.

Carbon leakage means that global greenhouse gas emissions increase when companies in the EU shift production outside the EU because they cannot pass on the cost increases induced by the ETS to their customers without a significant loss of market share to third country competitors. Based on the ETS Directive (2003/87/EC as amended by 2009/29/EC), the Commission shall compile a list of sectors and sub-sectors deemed exposed to significant risk of carbon leakage. Sectors on the list will receive a higher share of free allowances. The criteria and thresholds to determine whether a sector is deemed exposed to carbon leakage or not are defined in Article 10a(13-18) of the ETS Directive and focus on additional costs incurred by the ETS Directive and trade intensity. The calculations are based on official Eurostat data and data collected from Member States. The final carbon leakage list for 2015-19 was adopted by the Commission on October 27th, 2014[90] after the draft list had been published on 5 May 2014 and applies to free allocation for the first time in 2015. According to the ETS Directive, it will be possible to add further sectors to the list if they comply with the criteria stated in the Directive, but it will not be possible to remove sectors from the list until its expiration.

[89] Official Journal No C 82, 1.4.2008, p.1

[90] http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32014D0746&from=EN

The Proposal for a Directive of the European Parliament and of the Council amending Directive 2003/87/EC to enhance cost-effective emission reductions and low-carbon investments builds on the positive experience with the harmonised rules implemented since 2013, by further developing predictable, robust and fair rules for free allocation of allowances to industry during the fourth trading period (2021-2030) to address the potential risk of carbon leakage in an adequate manner. This includes:

- Revising the system of free allocation to focus on sectors at highest risk of relocating their production outside the EU – around 50 sectors in total.
- A considerable number of free allowances set aside for new and growing installations.
- More flexible rules to better align the amount of free allowances with production figures.
- Update of benchmarks to reflect technological advances since 2008.
-

Several support mechanisms will be established to help the industry and the power sectors meet the innovation and investment challenges of the transition to a low-carbon economy. These include two new funds:

- Innovation Fund – extending existing support for the demonstration of innovative technologies to breakthrough innovation in industry.
- Modernisation Fund – facilitating investments in modernising the power sector and wider energy systems and boosting energy efficiency in 10 lower-income Member States.

The revised ETS directive adopted in 2018 also contains a number of new provisions to protect industry against the risk of carbon leakage and the risk of application of a cross-sectoral correction factor:

- **The share of allowances to be auctioned will be 57%, with a conditional lowering of the auction share by 3% if the cross-sectoral correction factor is applied. If triggered, it will be applied consistently across the sectors.**
- **Revised free allocation rules will enable better alignment with the actual production levels of companies, and the benchmark values used to determine free allocation will be updated.**
- **The sectors at highest risk of relocating their production outside the EU will receive full free allocation. The free allocation rate for sectors less exposed to carbon leakage will amount to 30%. A gradual phase-out of that free allocation for the less exposed sectors will start after 2026, with the exception of the district heating sector.**
- **The new entrants' reserve will initially contain unused allowances from the current 2013-2020 period and 200 million allowances from the market stability reserve. Up to 200 million allowances will be returned to the market stability reserve if not used during the period 2021-2030.**

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 Kyoto Protocol 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)".[91]

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

[91] See http://eur-lex.europa.eu/LexUriServ/site/en/com/2001/com2001_0264en01.pdf

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.

In March 2015 the European Commission's Directorate-General for Economic and Financial Affairs published an article called "Measuring Fossil Fuel Subsidies"[92] in its Economic Brief which aims to shed some light on the true magnitude and allocation of fossil fuel subsidies so as to enable comparisons between countries and regions to provide background to policy discussions.

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 and the more efficient use of resources.

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. The first phase of NZEC was completed between 2006 and 2009. Four research and development projects financed by the European Commission and UK involving Chinese and European academic organizations, companies and government bodies made significant progress in identifying options and constraints for CCS in China.

Phase II of NZEC (planned between 2010 and 2012) examined the site-specific requirements for and define in detail a demonstration plant and accompanying measures. It will include the technical and

[92] http://ec.europa.eu/economy_finance/publications/economic_briefs/2015/pdf/eb40_en.pdf

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 (to be completed by 2020) should commence thereafter and will see the construction and operation of a commercial-scale demonstration plant in China.

In 2009 the European Commission published a Communication on CCS in emerging developing countries (European Commission 2009b). The Communication sets out the Commission's plans for establishing an investment scheme to co-finance the design and construction of a power plant to demonstrate carbon capture and storage (CCS) technology in China. The Commission has programmed funding of up to €50 million for the construction and operation phase of the project, out of a total of €60 million that has been earmarked for cooperation with emerging economies on cleaner coal technologies and carbon capture and storage.. At the 2009 Summit, China and EU jointly agreed to finalise the feasibility (phase II) of a demonstration plant, and a Memorandum of Understanding was signed between the European Commission and the Ministry of Science and Technology (MOST). Implementation is on-going. In 2010 Norway joined the initiative.

The EU is cooperating with other Annex I and Non-Annex I Parties (Australia, Brazil, Canada, China, France, Germany, Greece, India, Italy, Japan, Korea, Mexico, Netherlands, New Zealand, Norway, Poland, Romania, Russian Federation, Saudi Arabia, Serbia, 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 **2017 a new Technology Roadmap** was released by the Carbon Sequestration Leadership Forum. This road map indicates that **CCS has been proven to work and has been implemented in the power and industrial sectors, but that a number of important challenges remain that must be addressed to achieve widespread commercial deployment of CCS.** A number of meetings and workshops are held each year. **In 2017 the CSLF held its 7th Ministerial Meeting in Abu Dhabi. The highlight of the meeting was the Ministerial Conference on December 6, which was focused on advancing the business case for carbon capture, utilization, and storage (CCUS). Ministers and designates who attended the conference identified key actions needed to accelerate the large-scale deployment of CCUS. These included the following:**

- **Working together to ensure that CCUS is broadly accepted and supported as part of the suite of clean energy technologies, along with other low-emission energy solutions.**
- **Leveraging the success of operational CCUS projects worldwide while emphasizing the urgency of developing and executing new CCUS projects in the future.**
- **Encouraging the development of regional strategies that strengthen the business case for CCUS and accelerate its deployment.**
- **Exploring new utilization concepts beyond carbon dioxide (CO_2) enhanced oil recovery (EOR) that have the potential to add commercial value.**
- **Supporting collaborative research and development (R&D) on innovative, next-generation CCUS technologies with broad application to both the power and industrial sectors.**
- **Expanding stakeholder engagement and strengthening links with other global clean energy efforts to increase public awareness of the role of CCUS and build momentum.**

Increasing global shared learnings on CCUS by disseminating best practices and lessons learned from CCUS projects and strengthening coordination on R&D efforts globally.The portfolio of CSLF-recognized projects, as of October 2016 was 54 projects spread out over five continents, one additional project was added in 2017.

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 strengthening 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)[93], 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 analysing EU-GCC relations with respect to oil and gas issues and proposing new policy initiatives and approaches to enhance cooperation between the two regional groupings.

The Commission has started a project with the specific objective to create and facilitate the operation of an EU-GCC Clean Energy Network. 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. In January 2013, the EU-GCC Energy Cooperation Conference was held in Abu Dhabi, UAE, as a side event of the "World Future Energy Summit- WFES 2013. The presentation by the high-level team of attendees from the GCC and Europe highlighted the achievements in areas of mutual interest for the two regions including renewables, energy efficiency and demand-side management, electricity interconnections, carbon capture and storage, as well as natural gas. Some of the concrete outcomes that were summarized during the sessions include publications, research work/papers, established partnerships between the GCC and EU, co-operation project ideas, targeted working meetings and training workshops. In 2013 also a Workshop and training seminar on integration of renewables in the grid and on energy efficiency and demand side management was held in Oman and an event related to CCS took place in London. In December 2013, the EU-GCC Energy Experts Group meeting was reconvened. The dialogue focused on energy efficiency and natural gas, and included EU market regulators and the private sector, as well as representatives of the EU-GCC clean energy network. In December 2015, the European Union launched the "EU GCC Clean Energy Network II" (CENII) project aiming at further developing the activities of the Network and at supporting its sustainability over the mid-term.

In 2016 a background paper on "Areas of potential EU GCC Clean Energy Cooperation" was published (EU-GCC Clean Energy Network II, 2016). An essential element of the project are the five Working Groups that focus on areas of common interest for the stakeholders of the two re gions (EU, GCC):

[93] The Gulf Cooperation Council covers Bahrain, Kuwait, Oman, Qatar, Saudi Arabia and the United Arab Emirates.

- Renewable Energy Sources
- Energy Demand Side Management and Energy Efficiency
- Clean Natural Gas and Related Technologies
- Electricity Interconnections and Market Integration
- Carbon Capture and Storage
- Climate change policies

The areas of future cooperation were outlines as

- Networking and Partnership development
- Organisation of experts' events, thematic discussions, seminars, webinars, training sessions and high level conferences
- Operation of Working Groups
- Dissemination of information
- Promotion and facilitation of of joint demonstration and pilot projects.

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 ConocoPhillips (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 handling 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.
- 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 connection 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). The EIB has also developed other means of financing, such as equity and carbon funds, to further support renewable energy and energy-efficiency projects (see here GEEREF and the Mediterranean Solar Plan, MSP). 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/saf/search.html?type=eia

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 supports 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 the EU's 6th national communication and 1st , 2nd and 3rd Biennial Report**s** several support programmes exist in this respect. These include:

- *Africa, Caribbean and the Pacific (ACP-E) Energy Facility*

The ACP-EU Energy Facility (EF) was established in 2005 to co-finance projects on increasing access to modern and sustainable energy services for the poor in African, Caribbean and Pacific (ACP) countries, especially in rural and peri-urban areas.

Following the successful implementation of the first Energy Facility, it was decided to create a second Energy Facility, which has later been extended to include more projects than originally foreseen.

Therefore, a total of four Calls for Proposals (CfP) have been made under the EF: under the first EF (9th EDF) only one CfP was launched committing EUR 196 million to supporting projects; under the second EF (10th EDF), EUR 100 million was allocated to the first CfP, EUR 132 million to the second (targeting rural electrification) and EUR 15 million to the third call (targeting fragile states).

A total of 173 projects were selected to receive support to increase access to energy in Africa, the Caribbean and the Pacific, and a total project budget of approximately EUR 800 million has been provided by the EU and other donors. Most projects of the first EF have now ended or are about to be finalized. In addition, many of the projects from the first CfP under the second EF have ended or been extended. Subsequent projects are either about to start or are being implemented. A specific website for the monitoring of the ACP-EU Energy Facility was created under http://www.energyfacilitymonitoring.eu/. The present website emphasizes the dissemination of project results. It allows the EU to:

- **contribute to the quality in implementation through the dissemination of results, success stories and lessons learned from the Energy Facility projects;**
- **encourage a community of practice that fosters the exchange of experience between projects.**

- *Latin America Investment Facility (LAIF)*

The European Commission also established the Latin America Investment Facility (LAIF) in 2010. The primary objective of LAIF is to finance key infrastructure projects in transport, energy, social and environmental sectors as well as to support private sector development in the Latin American region, in particular small- and medium-sized enterprises (SMEs). The main purpose of the LAIF is to mobilise additional financing to support investment in Latin America, encouraging beneficiary governments and public institutions to carry out essential investment in projects and programmes that could not be otherwise financed either by the market or by development Finance Institutions alone.

As part of its efforts to achieve this objective, LAIF pursues three strategic objectives:

- Improving interconnectivity between and within Latin American countries, in particular establishing better energy and transport infrastructure, including energy efficiency, renewable energy systems and the sustainability of transport and communication networks.
- Increasing the protection of the environment and supporting climate change adaptation and mitigation actions.
- Promoting equitable and sustainable socio-economic development through the improvement of social services infrastructure and support for small- and medium-sized enterprises (SMEs).

In 2009-2016 the Facility has had at its disposal a total budget of approximately €323 million, made available under the EU's Development Cooperation Instrument (DCI). Of this amount, LAIF has approved almost €305 million in grants to projects with a combined investment cost of over €8 billion.

- ***Carribean Investment Facility***

Like LAIF, CIF is one of the EU's regional blending facilities, which combine EU grants with other public and private sector resources to leverage additional non-grant financing to support investments in infrastructure and to support the private sector. The main purpose of CIF is to support investments in strategic economic infrastructure and private sector development, with a focus on small and medium-sized enterprises (SMEs), as well as to contribute to measures that help Caribbean countries to adapt to and mitigate the impacts of climate change.

The main strategic objectives of CIF are:

• Strengthening investments in strategic economic infrastructure, such as renewable energy, transport, information and communication technologies, and interconnectivity.

• Increasing investments in water and sanitation, climate adaptation and sustainable social infrastructure.

• Supporting investments in SME-development, including SMEs which contribute to the green economy.

CIF resources are made available under the European Development Fund (EDF), the EU's multiannual funding instrument to support countries in the African-Caribbean-Pacific (ACP) group. The EDF earmarked a minimum of €40 million in direct funding for CIF for the period 2012-2015. An additional allocation of €30.2 million was made available from the National Indicative Programme of Guyana in 2013. Since it was officially launched in March 2013, CIF has provided a total contribution of around €68.6 million to finance nine projects with a total investment cost of over €541 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 2008, aims to accelerate the transfer, development, use and enforcement of environmentally sound technologies for the world's poorer regions, helping to bring secure, clean and affordable energy to local people. GEEREF invests in regionally-oriented investment schemes and prioritises small investments below €10 million. It particularly focuses on serving the needs of the ACP, which is a group of 79 African, Caribbean and Pacific developing countries. It also invests in Latin America, Asia and neighbouring states of the EU (except for Candidate Countries). Priority is given to investment in countries with policies and regulatory frameworks on energy efficiency and renewable energy:

In the regions where the 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 €112 million to the GEEREF over the period 2009-2013, the majority of which is provided by from the EU budget. Further financing from other public and private sources was fundraised by GEEREF increasing the total funds under management to € 222 million as of May 2015. GEEREF invests in private equity funds which, in turn, invest in private sector projects, thereby further enhancing the leveraging effect of GEEREF's investments. It is estimated that, with € 222 million of funds under management, over €10 billion could be mobilised through the funds in which GEEREF participates and the final projects in which these funds invest.

The EU through Directorate General Development and Cooperation - EuropeAid also supports African, Carribean and Pacific countries in diversifying their economies; however, these activities are not limited to fossil fuel exporting countries, but are open to ACP countries based on Economic partnership agreements (EPAs). EPAs help ACP countries integrate into the global economy and improve the business environment, build up regional markets and promote good economic governance through reinforced regional cooperation in trade related issues. In 2008 the EU signed a comprehensive EPA with 13 CARIFORUM countries. In January 2009, Côte d'Ivoire and Cameroon have signed interim EPAs. Some ACP partners have signed interim economic partnership agreements with the EU as a first step towards comprehensive regional EPAs. The interim agreements secure and improve ACP access to the EU market and provide for more favourable rules of origin. Negotiations are ongoing with the African and Pacific regions to move from interim agreements to comprehensive regional agreements. The negotiations cover regional trade integration, trade in services, investment and trade-related rules. The strategy for private sector development in the ACP recommends the use of horizontal instruments (applicable to all ACP countries) in five priority areas where the Commission has a good experience and comparative advantages:

(1) Improvement of the macroeconomic framework and regulatory environment for enterprise development (Private Sector Enabling Environment Facility of the Business Environment (PSEEF) or BizClim with €20 million for 5 years);

(2) Investment and inter-enterprise co-operation promotion activities (PROINVEST - €110 million for 7 years);

(3) Facilitation of investment financing and development of financial markets (Investment Facility managed by the European Investment Bank (EIB) as revolving fund with €3,137 billion, completed by the EIB own resources with €2 billion for 2008-2013 and financial envelope of €400 million for the interest subsidies and technical assistance);

(4) Support for Small and Medium- sized Enterprises in the form of non-financial services (Centre for the Development of Enterprise (CDE) with €18 million per year, PROINVEST);

(5) Support for micro-enterprises and micro-finance (ACP-EU Microfinance Framework Programme with €15 million for 6 years, in collaboration with Consultative Group to Assist the Poor program (CGAP) and investment in debt and equity for banks and microfinance institutions provided by the EIB Investment Facility).

More specific information related to these activities can be obtained at:
http://ec.europa.eu/europeaid/what/development-policies/intervention-areas/epas/epas_en.htm

15.3 EU neighbourhood policy

Through its European Neighbourhood Policy (ENP), the EU works with its southern and eastern neighbours to achieve the closest possible political association and the greatest possible degree of economic integration. Energy policy and diplomacy also plays an important role in ENP especially in relation to the newly established Energy Union.

The Energy Union Communication ("A Framework Strategy for a Resilient Energy Union with a Forward-Looking Climate Change Policy") of 25 February 2015 and the European Council Conclusions of 19-20 March 2015 recognised the importance of the external dimension of the Energy Union and asked for greater engagement on energy and climate diplomacy. In particular, Action Point 15 of the Energy Union Communication states:

- The EU will use all external policy instruments to ensure that a strong, united EU engages constructively with its partners and speaks with one voice on energy and climate.
- The Commission, with the HR/VP, and the Member States will revitalise the EU's energy and climate diplomacy.
- The Commission, with the HR/VP, will develop an active agenda to strengthen EU energy cooperation with third countries, including on renewable energy and energy efficiency.
- The Commission will make full use of the EU's external trade policy to promote access to energy resources and to foreign markets for European energy technology and services.

On 20 July 2015, the Foreign Affairs Council adopted Council Conclusions on EU Energy Diplomacy, which included an EU Energy Diplomacy Action Plan. The Action Plan has four pillars:

1. Strengthen strategic guidance through high-level engagement.
2. Establish and further develop energy cooperation and dialogues, particularly in support of diversification of sources, suppliers and routes.
3. Support efforts to enhance the global energy architecture and multilateral initiatives.
4. Strengthen common messages and energy diplomacy capacities.

The EEAS (European External Action Service) works closely with the Commission and the EU Member States to ensure the follow-up of the EU Energy Diplomacy Action Plan.

The 2015 review of the EU neighbourhood policy, emohazised strong support to give energy ooperation a greater place in the ENP, both as a security measure (energy sovereignty) and as a means to sustainable economic development and to support greater energy independence through support to diversification of energy sources, better cooperation on energy efficiency, and transition to the low carbon economy (European Commission 2015c).

IRENA is the International Renewable Energy Agency that supports countries in their transition to a sustainable energy future, and serves as the principal platform for international co-operation, a centre of excellence, and a repository of policy, technology, resource and financial knowledge on renewable energy. IRENA, founded in 2009, promotes the widespread adoption and sustainable use of all forms of renewable energy, including bioenergy, geothermal, hydropower, ocean, solar and wind energy, in the pursuit of sustainable development, energy access, energy security and low-carbon economic growth and prosperity. 145 countries of the world (including the EU) are members of IRENA, 31 more are states in accession. The permanent headquarter is located in Masdar City, Abu Dhabi.

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17 UNITS AND ABBREVIATIONS

t	1 tonne (metric) = 1 megagram (Mg) = 10^6 g
Mg	1 megagram = 10^6 g = 1 tonne (t)
Gg	1 gigagram = 10^9 g = 1 kilotonne (kt)
Tg	1 teragram = 10^{12} g = 1 megatonne (Mt)
TJ	1 terajoule

AWMS	animal waste management systems
BEF	biomass expansion factor
BKB	lignite briquettes
C	confidential
CAPRI	Common Agricultural Policy Regional Impact Assessment model (http://www.capri-model.org/)
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
NH_3	ammonia
N_2O	nitrous oxide
NA	not applicable
NE	not estimated
NFI	national forest inventory
NIR	national inventory report
NO	not occurring
NUTS	Nomenclature of Territorial Units for Statistics
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
CR — Corinair	CR — 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	
OTH - other				
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				